SHIKSHANA PRASARAKA MANDALI'S

SIR PARASHURAMBHAU COLLEGE, PUNE-30

(AUTONOMOUS)

AS TREE IS SUPPORTED BY ROOTS,
A FLOWER IS SUPPORTED BY..

C A L Y X

2020

Shikshana Prasaraka Mandali's

SIR PARASHURAMBHAU COLLEGE, PUNE - 30.

(Autonomous)

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PUBLISHER
Dr. D. N. Sheth,
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PROJECT CO-ORDINATOR [From 2018-19]
Dr. Sucheta A. Gaikwad
Assistant Professor,
Department of Chemistry

ASSOCIATE PROJECT EDITOR
Devesh C. Shah
T.Y.B.A. (Sanskrit)

EDITOR
Pushkar S. Agashe
M.A.-II (Philosophy)

COPY-EDITORS
Mrunmayee A. Patwardhan
T.Y.B.A. (English)
Nikita S. Bhave
T.Y.B.A. (English)
Aamod M. Kelkar
T.Y.B.A. (Sanskrit)
Saee K. Karve
T.Y.B.A. (German)

COVER DESIGN
Sagar M. Deshpande
T.Y.B.A. (Economics)
Nisha D. Walvekar
F.Y.B.A.

PRINTED AT
PRESSPRINT,
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Pune - 411 030.

Foreword

It gives me an immense pleasure to present the 13th issue of the Student's Magazine Calyx for educational year 2019-20.

Calyx magazine is the student activity run by the students of the Study Circle group. This platform gives young minds an opportunity to think out of the box, go beyond the syllabus and enhance their creative thinking and research abilities. I am sure that the students enjoy this academic space and freedom which helps them to explore their capacities beyond the classroom teaching and examination curriculum.

In this issue, Calyx gives freedom to young researchers to select their own topic of choice for their research articles. The undergraduate and postgraduate students from department of Chemistry, Computer Science, English, German, Mathematics, Philosophy, Physics, Sanskrit, Statistics and Zoology have written articles for this year's issue. The students have researched and have expressed their views while writing these articles. All the work related to Calyx, from selecting the theme to editing the articles, was done by the members of the group and they have worked to the best of their capacities. I would like to appreciate the efforts and contribution of all the study group members, especially the Associate project Editor and Editor the magazine Devesh C. Shah and Pushkar S. Agashe respectively. I must mention our new team which helped us in proof reading all the articles. Their dedication, devotion, motivation and commitment definitely deserves a special mention. I wish all the success to the members of the study circle group. I would also like to thank Sagar M. Deshpande and Nisha D. Walvekar for designing the magazine cover and Devesh C. Shah for coming up with the tagline and back-cover content.

The articles are well researched. The students have selected a wide range of subjects. The research articles namely are: A Science with Solutions, The world of IoT, Will machines become smarter than Humans? Revolution to Evolution, Sapere Aude: Dare to be wise, Recent trends in Mathematics, Dr. Sarvepalli Radhakrishnan's concept of Māyā, Development of Quantum Physics as a subject, Saṭṭaka from the perspective of Daśarūpaka of Nāṭyaśāstra, Development of Statistics as a subject and To study in a scientific manner.

Free will is one of the philosophical concept which roughly translates as the power or ability to make your own decisions. There are lots of different opinions about the practice of free will, what I believe is that by accepting free will there comes the sense of responsibility to the person. In this issue of Calyx, students exercised their free will, which was by selecting their own topic of research. The articles in this magazine very well structured and explored. I hope all the readers enjoy the articles.

I also take this opportunity to thank our Principal Dr. Dilip N. Sheth for his continuous support and encouragement for this extracurricular activity and for assisting the students in exploring their potential. I extend my gratitude to the librarian Mrs. Pratibha R. Sakhare for allowing the students an unfettered access to the library for writing their articles. My sincere thanks to my colleague and Calyx

committee member Mrs. Arundhati N. Agte for grooming the magazine in its initial stage. I also thank our teaching and non teaching staff for their help.

Special thanks are due to Miss Mukta M. Nagpurkar, our Printer, for her help and valuable suggestions in bringing of this issue.

Dr. Sucheta A. Gaikwad
In Charge, Calyx

EDITORIAL

It is with a great pleasure that we present to you the 13th issue of the Calyx magazine. The small project was started by Dr. V. M. Solapurkar to give students a platform through which they can do a theme based research and write a small article about their respective field of study. Students from different departments get a chance to share what has been happening in their field with other students. Thus, making an active effort towards multi-disciplinary approach. For many students, it is their first time to write an article of such kind, which in future will help them to write more such research based papers, articles and essays. This magazine is entirely managed by the students. Which makes this magazine not only about research but also educating about print media and professionalism.

Articles in this year's magazine are written by students of Chemistry, Computer Science, English, German, Mathematics, Philosophy, Physics, Sanskrit, Statistics and Zoology. Some of these articles will make you aware about development of that field, for example, articles from Department of Statistics and Physics gives us an idea why Statistics and Quantum Physics got separated from their parent subject namely, Mathematics and Physics. Which really presents an idea to student about the core reasons due to which they are studied differently. From Department of Sanskrit and Philosophy, we have short research papers. In Sanskrit, the tradition of Saṭṭaka is studied in the light of Nāṭyaśāstra and in Philosophy, a philosophical inquiry of Dr. Radhakrishan's view on concept of Māyā is done. From English, we get an idea of early development of English in India and discussed Indian influence on it. The phrase 'Sapere Aude' is discussed in article with a historical background from Department of German. An essay from Mathematics, an idea of what is happening in that field, with a genuine concern for the subject is presented. IoT is covering day to day aspects of our life and soon many future appliances are going to improve the quality of life. A good view is taken on this by one of the two articles form the Department of Computer Science. Another article from the same department discusses about the very old question which has been terrifying humans from the time of Asimov is that, "Will machines become smarter than Humans?" How a scientific approach is and how a scientific mindset works with its limitations is presented in the article from Department of Zoology. Various Chemicals have been in use in our daily life. Importance of Chemistry in many interdisciplinary fields is highlighted in an essay form Department of Chemistry, which I hope will encourage students from the field to look at interdisciplinary studies and explore more by creating new opportunity.

This year we have newly established proofreading team. Which enhanced quality of the articles. The team of proofreaders have worked very hard to check each and every sentence; trying to eliminate every possible grammatical error. Their work is present on each and every page of this magazine. We are really grateful for completing such a herculean task in a short period of time. We hope that this little change will be carried out by the future Calyx team.

We sincerely thank S. P. College (Autonomous) for providing such a great platform. We thank Dr. Sucheta A. Gaikwad, Project Coordinator of Calyx. Also, to the

Professors who helped students providing valuable guidance. We thank librarian Mrs. Pratibha R. Sakhare and staff for assisting students with study and research material. A thanks must be conveyed to Miss Mukta M. Nagpurkar, who in due time gave this magazine a beautiful look and printed it.

We hope that articles in this magazine will provide you with some new information about respective subjects; turning it into an interesting and educational experience. With that we also encourage students, who like to do research, to contribute for the next issue with more enthusiasm.

Yours Sincerely,
Devesh C. Shah
Pushkar S. Agashe

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SAṬṬAKA FROM THE PERSPECTIVE OF DAŚARŪPAKA OF NĀṬYAŚĀSTRA

Devesh C. Shah
T.Y.B.A. (Sanskrit)

Introduction :

India has a great literary tradition. One of the important parts of literature is drama. In the Vedas, one can find the roots of traditional Indian drama. As in Saṁvāda sūktas, where the poetic frame of ṛucās includes a dialogue format. For e.g. Viśvāmitra-Nadī Sūkta (3.33). There have been many changes in the drama tradition since the era of Vedas till today. In the available Indian literature, *Nāṭyaśāstra* of Bharatamuni is first treatise, dealing with dramaturgy. In this treatise Bharata has discussed about different aspects related to drama and its performance. He has noted ten types of drama with its characteristics. He termed them as Daśarūpaka.[i] Later in Indian dramaturgy, based on Daśarūpaka, we find a new term coined as Uparūpaka. Uparūpakas are the types of dramas which are derived from the Daśarūpaka. For e.g. Nāṭikā is derived from Nāṭaka and Prakaraṇa. In *Nāṭyaśāstra* one can observe that, from the Uparūpaka, solely nāṭikā has been discussed. In Indian rhetorical texts, Saṭṭaka was first mentioned in Bhoja's '*Śṛuṅgāra Prakāśa*'. Later Saṭṭaka, as an uparūpaka is discussed in *Abhinavabhāratī*, *Kāvyānuśāsanam*, *Sāhityadarpanaḥ*, etc. Saṭṭaka is a type of drama, in which dialogues are written only in Prakrit languages.[ii] Saṭṭaka is important as we find the origins of dance-drama in it. Also, we can trace back many Loka-nāṭya traditions such as Tamāśā, etc. to saṭṭaka. As time progressed, only few saṭṭaka text survived. Which provides a different aspect. In the following research paper, Saṭṭaka is discussed from the perspective of *Nāṭyaśāstra* and its place in uparūpaka and its development in early rhetorical text.

This research paper has been supported by texts such as *Nāṭyaśāstra* of Bharatamuni, *Abhinavabhāratī*, *Śṛuṅgāra Prakāśa*, *Kāvyānuśāsanam*, *Sāhityadarpanaḥ*, etc. and some archaeological evidences.

Nāṭyaśāstra and Daśarūpaka:

Nāṭyaśāstra of Bharatamuni is generally assigned to the period circa 1st century B.C.E. to 1st century C.E[1]. In the 20th chapter of *Nāṭyaśāstra*, Bharata has described Daśarūpaka. The word 'rūpaka' is derived from verb √रूप्. In *Abhinavabhāratī*, word 'rūp'[2] is explained as 'a poetry like nāṭaka, etc. which can be

[i] The ten types of dramas mentioned in Nāṭyaśāstra are Nāṭaka, Prakaraṇa, Aṅka (Utsṛṣṭikāṅka), Vyāyoga, Bhāṇa, Samavakāra, Vīthi, Prahasana, Ḍima, and Īhāmṛga.

[ii] Prakrit is a group of the ancient Indian languages spoken by common people. Prakrits used in saṭṭaka belong to the period of 600 B.C.E. to 1000 C.E.

[1] पान क्र. १३१, संस्कृत साहित्यशास्त्राची तोंडओळख.

[2] Pp. 1846, V. S. Apte's The Practical Sanskrit-English Dictionary, Vol. III.

seen directly'.[3] Bharata himself does not use word rūpaka instead rūpa is seen in his treatise.[4] In the first Kārikā, he states the purpose (which in this context is daśarūpaka) and further describes features of each rūpaka. While stating Daśarūpaka, direct mention of nāṭikā is seen and not of other uparūpaka. After describing the features of Nāṭaka and Prakaraṇa in four ślokas the features of Nāṭikā are stated[5]. But according to Mr. Pushpendra Kumar[6] and Prof. R. P. Kangle[7], these ślokas related to nāṭikā are an interpolated part. According to them, the schema of *Nāṭyaśāstra* is first stating purpose and then stating features or characteristics. While checking the editions of New Book Corporation, Kaśī Hindū Viśvavidyālaya, Baroda and Nirṇayasāgar print; Nāṭikā is not mentioned in Uddeśa śloka[8]. Only in Nirṇayasāgar edition nāṭikā is mentioned after describing features.[9] Also, in the chapter of Sandhis not a single mention of nāṭikā is to be found.[10] On this topic there is a need for more research and a critically edited copy of *Nāṭyaśāstra* is required. In rhetoric, it is clearly seen that after rūpaka, uparūpaka got placed. There is no direct mention of saṭṭaka and other uparūpakas in *Nāṭyaśāstra*.

Abhinavagupta's opinion is that Bharata expected not only the ten rūpaka but also Toṭaka, Saṭṭaka, Rāsaka, etc. mentioned by Kohala are included in it. [11]From this we can say that saṭṭaka and other uparūpakas were included into daśarūpakas. Saṭṭaka is mentioned '...of those, features are stated by Kohala and others'[12], while explaining the first śloka of chapter 20th and again explaining the word daśarūpa quoting some another commentator he had mentioned saṭṭaka.[13] Also, 'Rājaśekhara wrote a saṭṭaka in Prakrit language'[14] which is seen in *Abhinavabhāratī*. But actual features of saṭṭaka are not mentioned in *Abhinavabhāratī*. Text written by Kohala is currently unavailable and we can know a few of his views only from the commentary of Abhinavagupta. From this we can rightly infer that Kohala's time period is before Abhinavagupta and after Bharata and ancient dramatist/rhetorician knew the features of saṭṭaka very well.

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[3] रूप्यते प्रत्यक्षीक्रियते योऽर्थः...। - पान क्र. ८०५, अभिनवभारती.

[4] वर्तयिष्याम्यहं विप्राः दशरूपविकल्पनम्। नामतः कर्मतश्चैव तथा चैन प्रयोगतः॥ - नाट्यशास्त्र (न्यू बी.बी.सी.) २०:१
तसेच नाट्यशास्त्र (न्यू बी.बी.सी.) २०:४, ९, १५०.

[5] नाट्यशास्त्र २०:५९,६०,६१,६२.

[6] पान क्र. ८३२, नाट्यशास्त्र (न्यू बी.बी.सी.).

[7] पान क्र. ४, दशरूपकविधान.

[8] नाट्यशास्त्र (न्यू बी.बी.सी) २०:१-३,
नाट्यशास्त्र (काशी हिंदू विश्वविद्यालय) १८:१-३,
नाट्यशास्त्र (बडोदा) १८:१-३,
नाट्यशास्त्र (निर्णयसागर) १८:१-३.

[9] राजोपचारयुक्ता प्रसादनक्रोधदम्भसंयुक्ता। प्रकरणनाटकनाटीलक्षणमुक्तं समासेन ॥ - नाट्यशास्त्र (निर्णयसागर) १८:१०८.

[10] नाट्यशास्त्र (न्यू बी.बी.सी.) २१:३५-४७.

[11] उक्तव्याख्याने तु कोहलादिलक्षिततोटकसट्टकरासकादिसंग्रहः फलं नाटिकायाः उदाहरणत्वादिति। - पान क्र. ८०५, अभिनवभारती.

[12] Ibid. p. 805.

[13] अत एव न दशसंख्याविभागार्थो येन सट्टकादीनां त्यागः स्यात्। - पान क्र.८०७, अभिनवभारती.

[14] ...प्राकृतभाषेति सट्टकः कर्पूरमञ्जर्याख्यो राजशेखरेण तन्मय एव निबद्धः...। - पान क्र. ७२ अभिनवभारती (नाट्यशास्त्र बडोदा प्रत).

Daśarūpaka and Uparūpaka :

As discussed earlier, according to Prof. R. P. Kangle and Mr. Pushpendra Kumar, ślokas of the nāṭikā are interpolation. We find commentary of Abhinavagupta on these ślokas. Hence, this interpolation took place way before the time of Abhinavagupta. Toṭaka, Saṭṭaka, Rāsaka, etc. the types have been named by Kohala and others; this is accepted by Abhinavagupta and other experts of rhetoric imitated his view[15]. Abhinavagupta was the one who included Totaka, Saṭṭaka and Rāsaka in rūpaka. Later, the distinction between daśarūpaka and uparūpaka was clearly seen in Sāhityadarpaṇaḥ of Viśvanatha.[16]

After *Nāṭyaśāstra* till *Abhinavabhāratī*, the saṭṭaka, totaka, etc. had gained a place in rūpaka. After *Abhinavabhāratī* till *Sāhityadarpaṇaḥ*, during this period, it was widely accepted as uparūpaka.

Etymology of the word Saṭṭaka:

Few variations of the word 'Saṭṭaka' are found. Which are Sāṭaka, Saṭṭaaṁ, Sāḍikā etc.[17] There are two etymological theories – i) the word is derived from the Sanskrit verb √सट्[18], ii) According to Prof. A. N. Upadhye, the word is derived from 'स-आट्ट', which has origins in the Prakrit language. The later theory, has some linguistic base of Prakrit grammar. When there is a joint consonant before a swara-sandhi instead of becoming long the vowel sound in consonant remains short. So, when we think about 'स-आट्ट' rather than changing into 'साट्ट' it remains 'सट्ट'. And 'क' is a possessive. So the word is formed. One of the variations of the word is Sāḍikā, which is found in an epigraph from Bhārūt stūpa, if we dissect the word further we get 'स-आडिआ', in some cases described by the sutra 'टो डः।'[19] the 'Ṭ' consonant gets changed into the 'Ḍ' consonant. So, tracing back, the word becomes 'स-आटिआ'. The link between स-आट्ट and साडिका is clear. Now, one may question that what happened to the extra consonant Ṭ which was joined with another Ṭ consonant? Because if we think that the word has originated from आट्ट then by the above mentioned rule it should become आड्ड or आट्ड. To this, the answer is literary Prakrit and Prakrit found in epigraphs have little difference on the level of writing. It is commonly seen that ancient Prakrit epigraphs were subject to minor changes by scribe for various reasons, e.g. available place for epigraph is compact and matter is long etc. So, sometimes while representing a word containing conjunct consonant, only the main consonant is represented symbolically as an alphabet in an epigraph. It is seen in both cases of conjunct consonants, i) where the two consonants are the same and

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[15] आदिशब्दात् कोहलादिलक्षितास्तोटकादयो ग्राह्याः। - पान क्र. ४४५, काव्यानुशासनम्.

[16] नाटिका त्रोटकं गोष्ठी सट्टकं नाट्यरासकम्।...॥

अष्टादश प्राहुरुपरूपकाणि मनीषिणः। ...॥ - साहित्यदर्पणः ६:४-५.

[17] Pp. 1095, Encyclopedia of Indian literature : Devraj to Jyoti, vol. 2.

[18] √सट् – 10 U. (साटयति-ते) – To Show, Display, Manifest – Pp.1611, V. S. Apte's The Practical Sanskrit-English Dictionary.

[19] पान क्र. ५३, प्राकृत व्याकरण.

ii) where the two consonant are different. For e.g. In the Nāṇeghāta epigraph of Sātavāhana Queen Nāganikā,[20] we see that in literary Prakrit, the genitive singular case of the word देव is देवस्स but in epigraph we find it sculpted as देवस. (This dropping of one member in the case of genitive singular is seen everywhere in Prakrit epigraphs on stone and on coins, were only स is written instead of स्स). Even the word Putra found as पुत्त in literary Prakrit, पुत is seen in the epigraph. For the second case in the same epigraph, word दखिना which is found in literary Prakrit as दक्खिना/णा in which only the consonant mixed with vowel sound is symbolically represented by an alphabet. So if we believe that in the case of word Sāḍikā, the old version was आड्डिआ then by the nature of Prakrits it became आड्डिआ or आट्डिआ and in epigraph the conjunct Ḍ consonant is dropped, leaving it as आडि by first case and conjunct Ṭ consonant is dropped by second case.

Uparūpaka and Saṭṭaka:

Saṭṭaka is considered as an uparūpaka according to Indian dramaturgy. Saṭṭaka which is written in Prakrit language, is similar to a nāṭikā. In *Kāvyānuśāsanam*, Hemacandra has distinguished poetry thesis into perceptive (prekṣa) and audible (śravya). Perceptive is further divided as prose (pāṭhya) and lyrical (geya). He includes saṭṭaka under prose, where its characteristics are given. Viśvanatha has given characteristics of saṭṭaka in uparūpaka-nirūpaṇa.

- Characteristics of saṭṭaka according to some ancient critics –

i) Rājaśekhara in his saṭṭaka named '*Karpūramañjarī*' states that - Saṭṭaka is the one that closely imitates nāṭikā but Viṣkambhaka, Praveśaka and Aṃka are not present in it.[21]

ii) *'Śṛuṅgāra Prakāśaḥ'* by Bhoja - Saṭṭaka is a Kāvya in which Viṣkambhaka and Praveśaka are not present, it is written in Prakrit language, all the other features of it should be considered similar to the features of nāṭikā.[22] Hemacandra in his *Kāvyānuśāsanam*, has quoted Bhoja.[23]

iii) *'Bhāvaprakaśanam'* of Śāradātanaya - Saṭṭaka is a type of nāṭikā that excludes all sandhis. Nṛutyabheda is its distinct feature, it consists of Kaiśikī and Bhāratī vṛuttī. Raudra etc. rasas are not present in it. Mahārāṣtrī, Śaurasenī and Māgadhī Prakrits should be used.[24]

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[20] पान क्र. ११३, पुराभिलेखविद्या.

[21] सो सट्टओ त्ति भण्णइ दूरं जो णाडिआइ अणुहरइ ।
किं उण पवेसविक्खंभंकाइं केवलं ण दीसंति॥६॥ - पान क्र. ४, कर्पूरमंजरी.

[22] विष्कम्भकप्रवेशकरहितो वस्त्वेकभाषया भवति।
अप्राकृतसंस्कृतया स सट्टको नाटिकाप्रतिमः॥ - पान क्र. ५४०, शृङ्गारप्रकाशः.

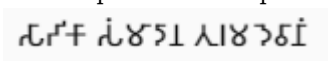
[23] पान क्र.४४४, काव्यानुशासनम्.

[24] सट्टकं नाटिकाभेदो नृत्यभेदात्मकं भवेत्।
कैशिकीभारतीयुक्तहीनरौद्ररसादिकम्॥
सर्वसन्धिविहीनं च नाटिकाप्रतिरूपकम्।
शूरसेनमहाराष्ट्रवाच्यभाषादिकल्पितम्॥
अङ्कस्थानीयविच्छेदचतुर्यवनिकान्तरम्।

iv) *Sāhityadarpaṇaḥ* of Viśvanātha – A prose which is in Prakrit language, Viṣkambhaka & Praveśaka are not present in it, Adbhuta rasa is present in abundance, the aṃka is called javanikā, all the other characteristics are similar to nāṭikā.[25] It should be named after the heroine's name.[26]

In above features, only Śāradātanaya has a different view. He has broadened the features. From this, one can understand features (lakṣaṇa) chronologically. In *Nāṭyaśāstra*[27], *Sāhityadarpaṇaḥ*[28] and *Kāvyānuśāsanam*[29], etc. treatise have given features of nāṭikā. In nāṭikā dance, songs and prose are predominantly seen, including lots of female characters. Saṭṭaka is similar in many of these aspects, dance is prominent in saṭṭaka as well. Rājaśekhara in *Karpūramañjarī* says 'we are going to enact saṭṭaka'[30] (lit. let's dance the Saṭṭaka). Different types of dance forms are included in *Karpūramañjarī*, The dominance of dance in Saṭṭaka is seen in it.

The shallow relief sculpture from Bhārūta stūpa. In the red box the place of inscription.



Inscription in Brāhmī script.

In the available literature, only 5 saṭṭakas are available and the 2 are just mentioned by their name. 'Kappūramanjarī' by Rājaśekhara is older compared to the others. As said earlier the word Sāḍikā is found in an epigraph on the Bhārūta stūpa, that is –

"Sāḍikā Saṁmādāna Turama Devānām"[31]

It is carved under the shallow relief sculpture of dancing females (Apsarās?). This epigraph describes the event depicted in the sculpture. It is understood that, the females in the sculpture are performing a saṭṭaka. Bhārūta stūpa belongs to 300 B.C.E. – 200 B.C.E.[32] this proves the existence of saṭṭaka before 300 B.C.E., though the other things except dance cannot be understood. Due to the common element of dance found in that sculpture and in the saṭṭaka written by Rājaśekhara, we could say that the sāḍikā is an archaic form of saṭṭaka.

.....मागध्या शौरसेन्या वा वदेद्राजेति केचन॥
नाटिकाप्रतिरूपं यद्विशेषो रूपकस्य तत्।
सट्टकं तेन तस्याहुः भाषां तां प्राकृतीं परे॥
राजशेखरक्लृप्तं तद्यथा कर्पूरमञ्जरी। - भावप्रकाशनम् ९:५७.

[25] सट्टकं प्राकृताशेषपाठ्यं स्यादप्रवेशकम्।
न च विष्कम्भकोऽप्यत्र प्रचुरश्चाद्भुतो रसः ॥
अङ्का जवनिकाख्याः स्युः स्यादन्यन्नाटिकासमम्। यथा कर्पूरमञ्जरी। - साहित्यदर्पणः ६:२७६.

[26] नाटिकासट्टकादीनां नायिकाभिर्विशेषणम्॥ यथा रत्नावली-कर्पूरञ्जर्यादिः। - साहित्यदर्पणः ६:१४३.

[27] स्त्रीप्राया चतुरङ्का ललिताभिनयात्मिका सुविहितार्था। बहुनृत्यगीतपाठ्या रतिसम्भोगात्मिका चैव॥ - नाट्यशास्त्र २०:६१.

[28] नाटिका क्लृप्तवृत्ता स्यात् स्त्रीप्राया चतुरङ्किका। .....। वृत्तयः स्यात्कैशिकी स्वल्पविमर्शाः सन्धयः पुनः॥ - साहित्यदर्पणः ६:२६९/२७२.

[29] स्त्रीप्राया चतुरङ्का ललिताभिनयात्मिका सुविहिताङ्गी। बहुगीतनृत्यवाद्या रतिसंभोगात्मिका चैव॥ - पान क्र. ३८३, अध्याय ८, काव्यानुशासनम्.

[30] सट्टअं णच्चिदव्वं। - पान क्र. ४, कर्पूरमंजरी.

[31] Pp. 134, Stûpa of Bharhut.

[32] Pp. 15, Stûpa of Bharhut.

Saṭṭaka from the perspective of Nāṭyaśāstra:

A question arises that 'Why didn't Bharata include saṭṭaka in his *Nāṭyaśāstra*?' to this there are three possible reasons which may satisfy the question.

1) The Bharata may have lived before the Bhārūta stūpa, i.e. Bharata predates the stūpa.
2) In the beginning it seems that Saṭṭaka, by in large consisted different type of Dances and therefore Bharata did not include it into Daśarūpaka.
3) In the 18th chapter of *Nāṭyaśāstra*, Bharata describes in brief what kind of Prakrit should be spoken by which character.[33] For e.g. in a heroic scene the dialogues of a king and of a Śramaṇa (i.e. a Jaina monk) should be written in Prakrit, a female nun's (parivrājikā) dialogues should be in Sanskrit language.[34] Bharata did not expect the whole text in one language. This is clear, if perceived through Bharata *Nāṭyaśāstra,* a rūpaka is not expected to be either entirely in Sanskrit or in Prakrit language.

After Nāṭyaśāstra:

Pre-Rājaśekhara saṭṭakas are not available. Therefore, during the span of 8oo years what changes have exactly happened in this Uparūpaka called Saṭṭaka? To search for the answers if we check text such as Bhāmaha's '*Kāvyālaṅkāraḥ*', Daṇḍī's '*Kāvyādarśaḥ*', '*Kāvyālaṅkāraḥ*' of Rudraṭa and '*Dhvyanyālokaḥ*' by Ānandavardhana, we do not find any evidence.

So another question arises that 'When Rājaśekhara wrote the saṭṭaka was there any other saṭṭaka he referred to as an example? It is difficult to answer this question for now. The characteristic of Saṭṭaka stated by Rājaśekhara is that 'It imitates nāṭikā',[35] there is a great possibility that this feature may have been derived from the features described by Kohala. Therefore, Rājaśekhara's *Karpūramañjarī* saṭṭaka follows many features of nāṭikā. Also, we could say that he wrote this saṭṭaka in accordance with the features of nāṭikā and hence it shows great similarity between both.

In post-Rājaśekhara period rhetoricians took help of *Karpūramañjarī* to define features of saṭṭaka. While defining features of saṭṭaka Viśvanātha took help of *Karpūramañjarī*. He has noted that Adbhuta rasa is dominantly present in saṭṭaka and also it is dominantly present in *Karpūramañjarī*; for e.g. Bhairavānanda brings Karpūramañjarī into the king's court by his magical powers[36], blossoming of a Kevadā plant by a chant given to the queen by Bhairavānanda.[37] Also the feature, a Saṭṭaka to be named after the name of the heroine, comes from *Karpūramañjarī*.

The same way Śāradātanaya defined features of saṭṭaka from *Karpūramañjarī* in his *Bhāvaprakaśanam*. Prakrit languages were mentioned explicitly in it. Same

[33] नाट्यशास्त्र १८:१ – ६१.
[34] Ibid.
[35] See foot note number 18.
[36] पान क्र. २६, कर्पूरमंजरी.
[37] पान क्र. ४२, कर्पूरमंजरी.

sentiments of Rājaśekhara's features were noted by Bhoja in '*Śṛṅgāra Prakāśaḥ*' but he did not mention *Karpūramañjarī*.

It is clear that later rhetoricians defined features of saṭṭaka based on *Karpūramañjarī*. And dramatist used these defined features and *Karpūramañjarī* as a base and guiding principles to write knew saṭṭaka. From this, a question arises that, Was there any other saṭṭaka available for dramatists to refer to besides *Karpūramañjarī*? And if not, then Did pre-Rājaśekhara saṭṭakas got extinct by that time? Also, Are there any references in Jaina-Buddhist literature about saṭṭaka? To find answers to these questions is the next step of this research.

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Development of Quantum Physics as a Subject

Dhananjay V. Shinde
T.Y.B.Sc. (Physics)

What is Quantum Physics?

The Quantum Physics in simple words can be defined as the study of how the Universe works at the level smaller than atoms. Quantum Physics also has a branch known as Quantum Mechanics which deals with study of interaction of energy at subatomic level. It is a very young Science; it is only about 100 years old.

"It is hardly necessary to point out how much quantum theory derivates from everything that one has imagined until now; it is, without doubt, the greatest and deepest revolution to which natural philosophy has been subjected since Newton."

Jules Henri Poincaré
French philosopher and mathematician

Pre-Quantum Physics and Problems:

For a long time, the phenomena of electricity, magnetism and light appeared to be unconnected. In the first half of the nineteenth century, one of the greatest unification of Physics took place. Faraday and Maxwell, together with many others, were able to show that all three phenomena are manifestation of the electromagnetic field. An electric current produces a magnetic field that exerts a force on magnetic materials. Such fields may even propagate through space independently of any charges or magnets, in the form of electromagnetic waves, visible light is one of the examples of electromagnetic waves.

Still there was one problem in Physics that could not be resolved. That problem was change in colour of material due to rise in temperature. For example, a piece of iron when heated at first looks red, then yellow, lastly white.

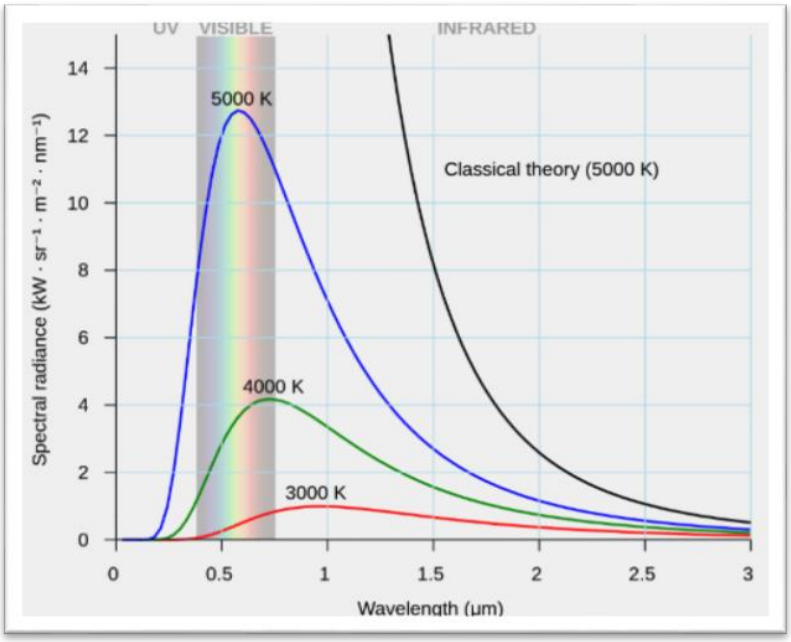
Here are some of the observations that defied all understanding at the turn of the century.

1) The colour of objects at various stages of heating (red, yellow, white).
2) The very different specific properties of elements whose number of electrons is almost the same.
3) The fact that atoms do not change their properties in spite of the many collisions and interactions that they suffer in a gas or in an ordinary piece of matter. They quickly resume their original qualities after the perturbation. Their stability and their ability to regenerate is completely at odds with what we should expect from a planetary system. If our solar system were to collide or pass another star at a close distance its orbits and patterns would be completely changed and it would not return to its original form.
4) The energy content of the atom is quantised. An atom can assume a series of definite energies only and never a value in between. This most surprising fact was found at the beginning of the century and is also completely foreign to a planetary system. There is no reason why the energy of planetary motion cannot change by arbitrarily small amounts, for example, when a meteorite hits a

planet. An atom, however, can accept or lose only definite amount of energy, those that would change its energy from one of the values in the series to another.

It became clear to pre-quantum physicists that the analogy between an atom and a planetary system breaks down completely when atomic properties are examines in detail.

Development of Quantum Physics:



According to the Classical Theory of Radiation, if each Fourier mode of the equilibrium radiation (in an otherwise empty cavity with perfectly reflective walls) is considered as a degree of freedom capable of exchanging energy, then, according to the equipartition theorem of Classical Physics, there would be an equal amount of energy in each mode. Since there are an infinite number of modes, this would imply infinite heat capacity, as well as, a nonphysical spectrum of emitted radiation that grows without bound with increasing frequency, a problem known as the ultraviolet catastrophe.

This catastrophe led the foundation of Quantum Mechanics and ultimately Quantum Physics. (Reference Figure 1). As the temperature decreases, the peak of the black-body radiation curve moves to lower intensities and longer wavelengths. This problem was first tackled by Wilhelm Wien in 1893, but was not able to explain the whole graph, his law was only valid for short wavelengths.

Wien's Displacement Laws -

1) λT = constant
2) ET^ (-5) = constant

Wien's Law -

$$\lambda_{peak} = \frac{b}{T}$$

After this, Rayleigh and Jeans approached the problem with different method but their formula was only in agreement with the long wavelengths.

Rayleigh – Jeans Formula -

$$B_\lambda(T) = \frac{2ck_BT}{\lambda^4}$$

After this in 1901, Max Planck approached this problem with the assumption that each oscillator in black body surface will not emit energy continuously but in discrete packets of energies.

$$E = 0, \varepsilon, 2\varepsilon, 3\varepsilon, \ldots. \text{ (Where } \varepsilon = h\upsilon)$$

Planck's Formula -

$$B_\lambda(T) = \frac{2hc^2}{\lambda^5} \frac{1}{e^{\frac{hc}{\lambda k_B T}} - 1}$$

With this formula he successfully explained the Spectral radiance for each Wavelength of black body radiation.

Discovery of Wave Particle Duality:

This was first observed for visible part of electromagnetic spectrum i.e. light. For reflection we can consider the light as particle but for phenomena like refraction we need to consider the wave nature of light.

When Planck considered, radiation emitted by the body is not in continuous manner but in discrete packets known as quanta, this was the background for the explanation of Photoelectric Effect, as explained by Albert Einstein.

The photoelectric effect is the ejection of electrons from the metal surface when light (electromagnetic radiation) is incident upon the metal surface. Light consists of bundles (called quanta) of energy, Einstein assumed that energy constant E of photon or quanta is related to its frequency by relation.

$$E = h\upsilon$$

(Where, h is Planck's constant.)

Which led to the foundation of de Broglie Hypothesis. He made the argument that if electromagnetic radiation can act like a wave sometimes, and like a particle some other times, then atomic particles like electron, proton should also exhibit wave properties when they are in motion.

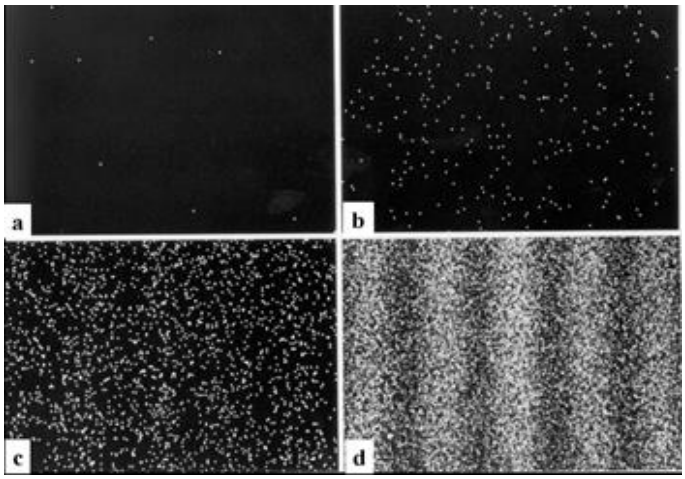


Figure 1 : Single electron events build up to form an interference pattern in the double-slit experiments.

Which gives miraculous formula, for relation between wave property i.e. wavelength and matter property momentum -

$$\lambda = \frac{h}{p} = \frac{h}{m\nu}$$

This solved the riddles of Prequantum Physics.

Chronological Development of Quantum Physics:

1924: de Broglie published his paper on matter waves.

1925: Pauli published paper regarding existence of fourth quantum number of electron and exclusion principle.

1926: Schrödinger developed his famous Time Dependent and Time Independent Wave Equations.

Time Dependent Wave Equation:

$$i\hbar \frac{\partial}{\partial t} \Psi\ (r,\ t) = \left[\frac{-\hbar^2}{2m} \nabla^2 + V(r,t) \right] \Psi\ (r,\ t)$$

Time Independent Wave Equation:

$$\left[\frac{-\hbar^2}{2m} \nabla^2 + V(r) \right] \Psi\ (r) = E\, \Psi(r)$$

1927: In 1925 Heisenberg put forward the 'quantum-theoretical mechanics based exclusively on relationships between quantities observable in principle'. Using this he formulated his famous uncertainty principle in 1927.

Since then Quantum Physics got separated from Classical Physics.

1933: Schrödinger and Dirac received Nobel Prize for the productive forms of atomic theory.

1934: Fermi developed the famous theory of beta decay.

1948: Richard Feynman states the path integral formulation of quantum mechanics.

1957: Hugh Everett formulates the many-worlds interpretation of quantum mechanics, which states that every possible quantum outcome is realised in divergent, non-communicating parallel universes in quantum superposition.

1964: John Stewart Bell puts forth Bell's theorem, which used testable inequality relations to show the flaws in the earlier Einstein–Podolsky–Rosen paradox and prove that no physical theory of local hidden variables can ever reproduce all of the predictions of quantum mechanics. This inaugurated the study of quantum entanglement, the phenomenon in which separate particles share the same quantum state despite being at a distance from each other.

1973: Makoto Kobayashi and Toshihide Maskawa note that the experimental observation of CP violation can be explained if an additional pair of quarks exist. The two new quarks are eventually named top and bottom.

1980 to 1982: Alain Aspect verifies experimentally the quantum entanglement hypothesis; his Bell test experiments provide strong evidence that a quantum event at one location can affect an event at another location without any obvious mechanism for communication between the two locations. This remarkable result confirmed the experimental verification of quantum entanglement by J. F. Clauser. S. J. Freedman in 1972.

1998: The Super-Kamiokande (Japan) detector facility reports experimental evidence for neutrino oscillations, implying that at least one neutrino has mass.

2014: Scientists transfer data by quantum teleportation over a distance of 10 feet with zero percent error rate, a vital step towards a quantum internet.

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REVOLUTION TO EVOLUTION

Milisha M. Petkar
S.Y.B.A. (English)

What is Language and the Science behind it?

Noam Chomsky, an American linguist, philosopher, cognitive scientist in his book Syntactic Structures, 1957 defines language as "a set (finite or infinite) of sentences, each finite in length and constructed out of a finite set of elements." However, it is not just a set of sound, words or sentences. Language is an abstract system of meanings and symbols for all aspects representing the particular culture of which the language is spoken. It includes speech, written characters, numerals, gestures, expressions and even its meta language." In simpler terms, one sees certain splashes of ink, virtual or otherwise, and infers meaning from it based on prior encounters and knowledge. This is also known as language acquisition.

Language undoubtedly has a very important social purpose because it is mainly used for linguistic communication. The language that we speak defines and determines one's place and identity in the world. The development of language is also important, because it allows us to communicate with others. Language makes it possible to reason with a person and explain why certain behaviour is desirable and other is not. As, our language and communication skills develop; we experience less frustration and can explain how we feel and ask for what we want. Silent, inner communication with oneself can also be used in the control of behaviour. Thus, for proper communication and smooth living a coherent and understandable language is of absolute importance.

For better learning of any language, language contact is the most important. In what situation the language was introduced, the speaker of that language, their position in society, the implementation of that language, play a huge role on the psyche of a person. This lays the base upon which we perceive the entire system of that language. Thus, this article talks about the history and the journey, of one language in particular. This language is the most widely spoken language in the world, all international transactions, treaties, conferences, summits and other activities that take place at the global level proceed in this language; and it is understood easily by most of the laymen. If you guessed it correct, then yes, it is English. This article tries to present an objective word journey of Indian English, from a Foreign language to, "Associate Official Language of Administration", from a subject to be learnt to a language to learn in; from the language of science to the science of language, the journey of Indian English from revolution to evolution.

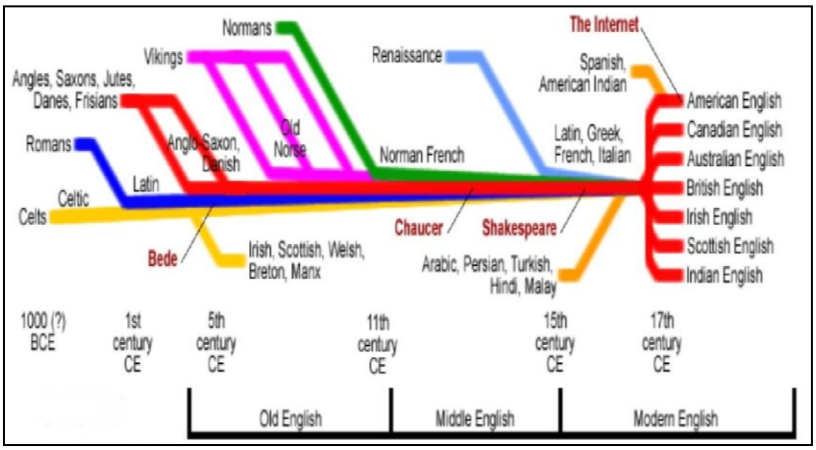
"Often it's not we who shape the words, but the words we use that shape us."

– Nina George, *The Little Paris Bookshop.*

Introduction of English Language:

Before we begin the descent to discuss Indian English, it is important to know about English language first. The term "English" is derived from *Anglisch*, a Proto-Indo-European language spoken by the Angles—one of the three Germanic tribes that invaded England during the fifth century. Over the time, it has changed

and English is conventionally divided into three major historical periods: **Old English, Middle English** and **Modern English**.



Journey Of English

With the establishment of centres of learning in Winchester, Old English was brought to the British Isles by Germanic people: the Jutes, Saxons, and Angles, starting in 449 C.E. The centre of learning gradually moved from Winchester to London, so Old English no longer dominated. Norman French spoken by the aristocracy and Old English spoken by the common people intermingled over time to become Middle English, which was a combination of some 10,000 French words, changes in spelling and grammar; such as, the loss of gender for nouns, some word forms called inflections amongst others. Many scholars consider the early Modern English period to have begun about in 1500 C.E. During the Renaissance, English incorporated many words from Latin via French, from classical Latin (not just church Latin), and Greek. The King James Bible (1611) and works of William Shakespeare are considered to be in Modern English.

With the modernity in language, came the desire of its people to expand its reign. Thus, it was around this time, that English began its journey towards India.

English in India:

The Beginning:

The emergence of English in India and its co-existence with other native languages has been marked time to time by linguists such as Saussure, Jakobson, and Sapir amongst others. There has been a considerable amount of literature on this. Kachru's "Three phase interpretation" sums the emergence of English in India aptly.

The first phase according to Kachru is the "*Missionary Phase*". In 1600s, the English traders established the East India Company and the Queen's Language stepped into the Indian subcontinent. The dates from the trading 'factories' started by the Company were in Surat (1612), Madras (1639–40), Bombay (1674), Calcutta (1690).

Over the next hundred years, the people who had come to trade had started establishing their colonies. The missionaries were allowed to use the ships of East India Company for "conversion" as well as introducing educational activities. Schools such as St Mary's Charity Schools were started in Madras (1715), Bombay

(1719), and Calcutta (1720–31), these were important for diffusion of English, necessary to make Indians "Babus" (clerks) and have them serve in administration. The graph of commercial and colonial expansion was swiftly rising.

Thomas Babington, better known as Lord Macaulay, on February 2, 1835, circulated "*Minute on Education"* -a treatise that offered an idea that English education is not just superior in science, but would also inculcate superior values that were responsible for making English superior. He headed the Anglicist Group, which favoured English as compulsory language.

Raja Rammohan Roy and Rajunath Hari Navalkar were amongst prominent Indians who helped popularise Macaulay's minutes of 1835. They made efforts to persuade the officials of the East India Company to impart instruction in English, rather than local languages. Being impressed with Western thought and culture, and its scientific advances, they wished to encourage the learning of English as a means through which Indians could gain knowledge of such things. This "*local demand for English*" was the second stage according to Kachru, for English to lay its foundation in India.

The third stage was called as "*Government policy*." "The Minute" got the approval of Lord Bentick, and was published on the 7th March, 1835. Thus Macaulay's policy of modern education through English medium was officially passed. The process of producing English-speaking bilinguals in India was established.

Official and Academic Language of India:

The next stage was the diffusion of bilingualism in English. As per the government policy of 1857, three Universities at Bombay, Calcutta and Madras were established. The foundation of these universities marked a new epoch in the history of Indian education. With the spread of colleges and the increase in number of universities, the importance of English increased. People belonging to the middle class advocated for and aspired to pursue their education in English. They saw that the capacity to speak and write in English would enable them for lucrative posts under government, which provided a decent income and an important status in the society.

In 1937, the British ministers busied themselves at once with educational schemes. In these schemes even though vernacular languages were the natural media of instruction, in schools English continued to dominate during the pre-independence days. All approximates in life, all avenues of success could be opened only with the keys of English. This catapulted the spread of schools and colleges, by the end of the nineteenth century two more universities, one in Punjab and the other at Allahabad were setup. This ultimately resulted in the increase of more number of Indians who achieved mastery in this language. English, from a foreign language, became the only official and the academic language of administration during the British rule.

Post-Independence: Indian English

English had to face a few setbacks in India after independence. Retention of English was opposed in India as it was the language of the tyrannical rulers who had tormented the country for two centuries. Not only political leaders but national

leaders of the freedom movement like Mahatma Gandhi also opposed the English language on account that the English education in India would deprave our countrymen of the national respect and integrity.

However, English had become the medium of instruction at the school level as well as at the higher educational levels for a long period of time. Since, India has been a land of many regional languages, English was (and is) the only common language that links the people from all the states of India. Thus, it had already become the *Lingua Franca* in India. Its abolition was therefore impossible and could have made an adverse impact.

Furthermore, Maulana Azad, C. Rajagopalachari and Pt. Jawaharlal Nehru strongly recommended that English language should be retained at any cost for the growth and progress of India at international level. Pt. Nehru said that English acted as the major window for the Indians to the outside world and its closure would spell peril for our future.

Taking all the facts into consideration, the "Official Languages Commission" stated in 1953: "English is one of the foremost languages in the world today. In international bodies and conferences, English has in the last ten years shot ahead of other languages. English is unquestionably the foremost medium of international communication. We in India happen to have already a considerable measure of linguistic competence in the English language developed over the period of a couple of centuries of British rule, and it would be wantonly foolish to throw away this language." Eventually after much conflicts, it was decided that English would accompany Hindi as an associate official language and as the language of administration.

Indian Variety of English:

The complex multilingual situation of India makes it difficult for the Standard variety of English language to establish in India. The Indian variety of English is the result of transfer from Indian languages such as Hindi, Marathi, Punjabi and Gujarati etc. Code switching and code mixing are the major processes for the Indianisation of English in India.

'Indianisation' of English generally means that the word, phrase, idiom, expression or the syntactical usages of the Standard English (British English or American English) has become a part of the Indian subcontinent. This process involves usage that have meaning that is peculiarly of Indian taste and colour. This creativity of English with the Indian taste has encouraged the popularity and the usage of English in the Indian context.

Indian English is best identified through its phonological features. Still the variation in the phonology is widespread. Indian English pronunciation is a relatively close in approximation to the written form. For example, 'fail' is pronounced as /phail/.

Indian English morphology is very creative. It has created many terms. It makes use of compound formation extensively. The compounds cousin-brother and cousin-sister allow the Indian English speakers to designate whether their cousin is male or female. It is a function, which is inherent in the terminology of most Indian languages. Indians also pluralise many English mass nouns which results in words

like woods, furniture's etc. (Trudgill and Hannah:1994) Some other examples are key bunch, chalk piece instead of 'bunch of keys', and 'piece of chalk' respectively.

Indian English speakers also shorten the commonly used terms such as Prof. for professor. Use of 'no' and the tag 'isn't it' at the end of English sentence is very frequent. For example "you are coming, no?" "We are going, isn't it?" The use of "only" and "itself" is also very frequent in English language used in India. For example "I was in Delhi only", "We can meet today itself." Our national language as well as mother tongue has highly influenced the English language spoken in India. For example, speaker of English in India will frequently say "I have to give exam" instead of "I have to write the exam".

• Loanwords and Loan Translations:

Borrowing and adapting of words from other languages has been common since the 17th Century, often moving into the language outside India, for example:

– Words from Portuguese (almirah, ayah, caste, peon).
– Words from indigenous languages, such as Hindi and Bengali. Some are earlier and more Anglicized in their spelling: *anna, bungalow, cheetah, chit/chitty, dacoit, dak bungalow, jodhpurs, pakka, pundit, rupee, sahib*. Some come afterwards and are less orthographically Anglicized: *achcha* all right (used in agreement and often repeated: Achcha achcha, I will go), *basmati* a kind of rice, *goonda* a ruffian or petty criminal, *jawan* a soldier in the present-day Indian Army.
– Words taken directly from Sanskrit, usually with religious and philosophical associations, some well-known, some restricted to such context are *ahimsa* means non-violence, *ananda* means spiritual bliss, *chakra* a mystical centre of energy in the body, *nirvana* release from the wheel of rebirth, *yoga* a system of self-development, *yogi* one who engages in yoga.
– CALQUES from local languages: *dining-leaf* a banana leaf used to serve food, *cousin brother* a male cousin, *cousin sister* a female cousin, *co-brother-in-law* one who is also a brother-in-law.

• Hybrids, adaptations, and idioms:

The great variety of mixed and adapted usages exists both as part of English and as a consequence of widespread code-mixing between English and Hindi:

– HYBRID usages like one component from English and one from a local language, for example: *brahminhood for* the condition of being a brahmin, *kaccha for* road a dirt road, *lathi-charge* (noun) for a charge using lathis, *lathi-charge* (*verb*) for to charge with lathis, *pan/paan shop* for a shop that sells betel nut and lime for chewing which is wrapped in a pepper leaf, *policewala* for a policeman.
– Words more or less archaic in British English and American English, but used in Indian English, such as dicky (the boot/trunk of a car), needful ('Please do the needful, Sri Patel'), Stepney for a spare wheel or tyre, and thrice ('I was seeing him thrice last week').
– The many idiomatic expressions include "to sit on someone's neck" and "to stand on someone's head" 'to watch that person carefully'; "Do one thing, Sri Gupta" for 'There is one thing you could do, Mr Gupta'; "He was doing this thing, that thing" and "He was doing all sorts of things" for 'wasting my time.'

Above are just a few of the examples that prove that Indian English is not just a dialect of British or American English, but an individual and unique variety of the language in itself.

Literature and Other Advancements through Indian English:

The firm establishment of English after independence benefitted India in several ways. Indians not only started learning it but also learnt how to express themselves in an efficient way in English. Several authors started writing in English. This gave a boost for the development of the special field in literature called 'Indian English Literature'. Indian writers not only started writing in English but also started translating their works from their regional languages into English. This brought the authors a worldwide popularity and recognition. Even Sahitya Akademi (the National Academy of Letters) recognizes Indian English literature as a National Literature. Various genres of literature started to employ English language. English worked as a vehicle to transport and popularise Indian works of art throughout the world as well.

Not only in literature has English played a major role, it has also played a vital role in the economic development of the nation. India has been able to advance in the industrial competition in the modern era, especially in business and trade overseas. Even on national platform, it is used in the legal system, pan-Indian and regional administration, the armed forces and national business like the government policies regarding foreign affairs, in the scientific and technological fields, in the media as well. English is one of the link languages in a complex multilingual society, in which it is both a library language and a literary language.

Conclusion:

Overall, English language has travelled along at least half the world, if not the entire. It is quite interesting to note that India, a multilingual nation, is the third largest English-speaking country after the US and UK. In India, it is increasingly being perceived as a 'must-know' language. It has now become a ladder for upward social mobility and 'a window to the world'. In the ever-growing, developing world, English has become one of the leading languages of the world.

English, known as the language of science, is a universal form of communication. It allows a wider scope and better understanding that ultimately leads to scientific progress. There are of course many benefits to having English as a universal language. The most obvious advantage is that results can be more widely accessed, and scientific exchange between countries is significantly enhanced. English has opened not only opportunities for science and other related fields but even in itself, English is studied from a lot of different perspectives, to name a few are sociolinguistics, psycholinguistics, neurolinguistics, pragmatics, so on and so forth. Thus, it is important to keep oneself updated in this language of science as well as the science of language.

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SAPERE AUDE: DARE TO BE WISE

Rasika M. Acharya
T.Y.B.A. (German)

Introduction:

Science as we understand is a term used to study the nature and behaviour of natural things and the knowledge that we obtain through them. Originally, it was derived from the Latin word 'scientia', meaning 'knowledge'. Broadly defined, it incorporates many facets and properties of everything ranging from the basic study of the unicellular micro-organism, from each element of the periodic table, from the basic structure of an atom up to each letter of each word of a language, each terminology of a belief and the nomenclature of the period specific era which it defines with the respective name. Hence, broadly speaking, Science can be further developed and understood as the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence.

As a student of Social Sciences, my research primarily involves bridging the gap between natural sciences and social sciences, amalgamating social sciences and philosophy into what the masses understand as science and connecting it to literature which paved the way for the scientific developments that took place around the world.

To browse through a quick recap, the history of literature in the Modern period in Europe begins with the Age of Enlightenment and it concludes with the Baroque period in the eighteenth century, succeeding the Renaissance and Early Modern periods. The eighteenth century sees the incipient Age of Enlightenment with authors such as Gottfried Wilhelm Leibniz, Immanuel Kant, Voltaire, Jean-Jacques Rousseau, Gotthold Ephraim Lessing being at the forefront.

The Baroque period is classified as the period of extreme conservatism, mainly considered synonymous with terms such as Feudalism, Aristocracy, Absolutism, the dominance and sole authority of the church and the ancient tradition. Hence, the rise of the enlightenment period is very significant for the entire mankind as a period of liberation from all limiting and oppressive socio-political and thought processes. The Era of Enlightenment marked the beginning of an important and integral period which not only impacted the succeeding epochs but primarily changed the approach and conventional and regressive thinking of mankind.

"Enlightenment is about thinking for oneself rather than letting others think for you."

Enlightenment:

The **Age of Enlightenment** (also known as the Age of Reason or simply the Enlightenment) was an intellectual and philosophical movement that dominated the world of ideas in Europe during the seventeenth to nineteenth century. The Enlightenment was the result of the European intellectual and scholarly movement known as the Renaissance Humanism. The ideas of the Enlightenment period primarily undermined the authority of the monarchy and the church and paved the

way for the political revolutions of the eighteenth and nineteenth centuries. The Enlightenment period included a range of ideas centred around the sovereignty of reason and the evidence of the senses as the primary sources of knowledge and advanced ideals such as liberty, progress, tolerance, fraternity, constitutional government and most importantly, the separation of church and state.

"Aufklärung": Enlightenment in Germany – Leibniz to Kant:

Aufklärung or in English, '*The Age of Enlightenment*', a phrase coined by the German philosopher, Immanuel Kant (22 April 1724 – 12 February 1804), represents the change from antiquity to modernity, the period in history where the modern world began, and science replaced superstition.

The German Enlightenment is from 1720 to 1785, beginning with the philosophy of Leibniz and concluding with that of Kant. Leibniz accomplished rationalism in Germany and is regarded as the pioneer of Enlightenment in Germany. The emergence of Enlightenment in the eighteenth century was a logical and sensible step in the direction that Humanism and Renaissance had already taken and found their expression in rationalism and empiricism. Leibniz's theory of monads, adopted from the idea of the atomic theory, asserted that all beings consist of tiny particles and these are the centres of power. They have no shape, cannot be created or destroyed and are individual.

On the other hand, Kant distinguishes between two fundamental powers of cognition, namely, reasoning and understanding (intelligence). Reasoning is distinct from understanding and brings to perception its own subjective forms of space and time. He argues that reasoning and understanding are directed at two different worlds; reasoning gives us access to the sensible world, while understanding enables us to grasp a distinct intelligible world.

The era of Enlightenment is an important time period in the history since it marked the shift of focus from being conformed to the clutches of the church and the Pope to criticising and questioning their authority and role at the apex. For why should we as individuals need political or religious authorities to tell us how to live or what to believe, if each of us has the capacity to figure these things out for ourselves? The spectacular achievement of Newton in particular, engendered widespread confidence and optimism about the power of human reason to control nature and to improve human life. One effect of this new confidence in reason was that traditional authorities were highly questioned.

It began with the ideas and interest of what the people want, what the people have to say and what they as individuals wish to do or pursue. It all revolves around tolerance in the society and moreover religion, breaking the stringent and rigid barriers of the norms which were ironically intended to unite. It emphasises on the upliftment of the middle class (*das Bürgertum*), thereby ending the age-old Aristocracy and leading towards a scientific approach with rationalism and understanding of mankind and humanity.

"Enlightenment is man's exit from his self-inflicted immaturity.
Immaturity is the inability to use one's mind without the guidance of another.
This immaturity is self-inflicted if the cause of it is not the lack of reason but of resolution and courage."

– Immanuel Kant

Immanuel Kant is the central figure in modern philosophy. He synthesised early modern rationalism and empiricism, set the terms for much of nineteenth and twentieth century philosophy. The fundamental idea of Kant's "critical philosophy" – especially in his three critiques: **The Critique of Pure Reason (1781, 1787), the Critique of Practical Reason (1788), and the Critique of the Power of Judgment (1790)** – is human autonomy. He argues that the human understanding is the source of the general laws of nature that structure all our experiences; and that human reason gives itself the moral law, which is our basis for belief in God, freedom, and immortality. Therefore, scientific knowledge, morality, and religious belief are mutually consistent and secure because they all rest on the same foundation of human autonomy, which is also the final end of nature according to the teleological worldview of reflecting judgment that Kant introduces to unify the theoretical and practical parts of his philosophical system.

Kant, in the first sentence of the essay, *Kritik der reinen Vernunft (Critique of Pure Reason)*: "Enlightenment is man's emergence from his self-incurred immaturity (*Unmündigkeit*)" argues that immaturity is self-inflicted not from a lack of understanding, but from a lack of courage to use one's reason, intellect, and wisdom without the guidance of other. Kant argued that using one's reason is considered dangerous by most men and all women. He explains that the motto of the Enlightenment is "**Sapere aude!**" (Dare to be wise!) or in German – "*Habe Mut, dich deines eigenen Verstandes zu bedienen*!" (Have the courage to use your own understanding.)

Kant, whose moral philosophy is centred on the concept of autonomy, distinguishes between a person who is intellectually autonomous and one who keeps him/herself in an intellectually heteronomous, i.e. dependent and immature status.

With the shift of focus and importance from the church to the state, from the Pope to the citizens, from the narrow conventional prism to the broad liberal spheres of living, the age of Enlightenment is considered to be of extreme relevance, both in terms of natural sciences as well as a variety of social sciences linked to the spectrum of research and academia in general.

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Will machines become smarter than Humans?

Mrunal J. Babar, Namrata S. Baile
M.Sc. Part-I (Computer Science)

Introduction:

Machine Learning (ML) is the most popular branch of Artificial Intelligence (AI). In simple terms, ML is an area of research in Computer Science which studies special type of algorithms that improve automatically based on experience. In other words, what makes ML algorithms different from others is that they are able to learn from the data that we feed them and from past experience, which is one of the main reasons why ML is so extensively useful. ML is closely related to computational Statistics, which focuses on making predictions using computers. The study of mathematical optimisation delivers methods, theory and application domains to the field of ML. In its application across business problems, ML is also referred to as predictive analytics. To summarise, ML is the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions, relying on patterns and inferences.

Before this technology, software engineers needed to create a long list of rules to be able to develop a programme which can respond to our necessities, but now this has changed because instead of writing thousands of lines of code, ML algorithms create the rules to get into the expected output by themselves. This has shifted the focus from coding rules into feeding data, making complex problems relatively easier to solve.

ML is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to perform the task. Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or infeasible to develop a conventional algorithm for effectively performing the task.

History of ML and Relationships to Other Fields:

Arthur Samuel, an American pioneer in the field of computer gaming and artificial intelligence, coined the term *"Machine Learning"* in 1959 while at IBM. A representative book of machine learning research during the 1960s was Nilsson's book on *Learning Machines,* dealing mostly with machine learning for pattern classification. The interest of ML related to pattern recognition continued during the 1970s, as described in the book of Duda and Hart in 1973.

As a scientific endeavour, ML grew out of the quest for AI. Already, in the early days of AI as an academic discipline, some researchers were interested in having machines learn from data. They attempted to approach the problem with various symbolic methods, as well as what were then termed *'neural networks';* these were mostly perceptron and other models that were later found to be reinventions of the generalised linear models of Statistics.

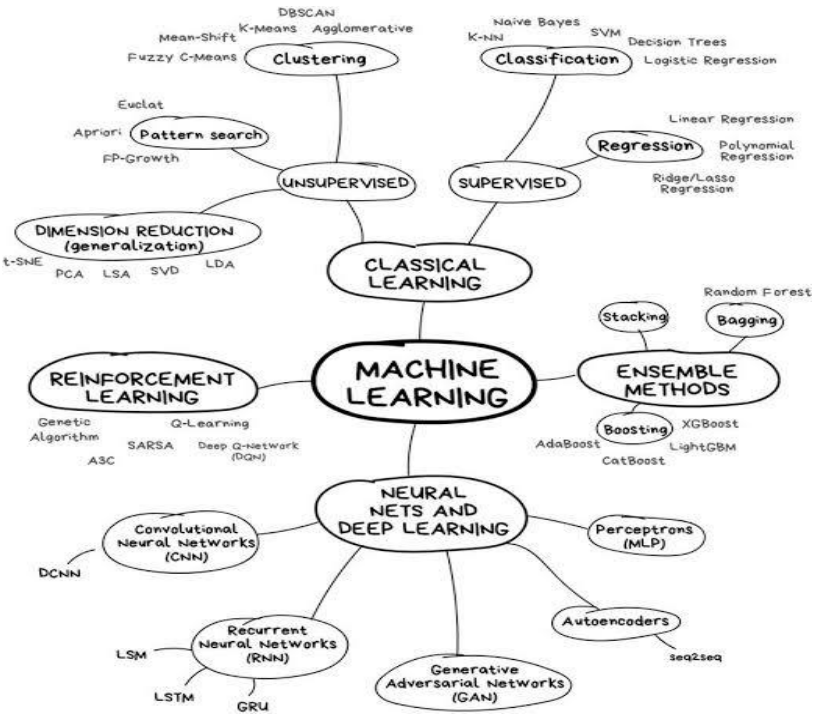
However, an increasing emphasis on the logical, knowledge-based approach caused a rift between AI and ML. Probabilistic systems were plagued by theoretical and practical problems of data acquisition and representation. Work on symbolic/knowledge-based learning did continue within AI.

ML, reorganised as a separate field, started to flourish in the 1990s. The field changed its goal from achieving AI to tackling solvable problems of a practical nature. It shifted focus away from the symbolic approaches it had inherited from AI, towards methods and models borrowed from statistics and probability theory. It also benefited from the increasing availability of digitised information, and the ability to distribute it via the Internet.

The map of the Machine Learning world:

Part 1: Classical Machine Learning

The first methods came from pure Statistics in the 1950s. They solved formal math tasks searching for patterns in numbers, evaluating the proximity of data points, and calculating vectors' directions. Nowadays, half of the Internet is working on these algorithms. When you see a list of articles to "read next" or your bank blocks your card at a random gas station in the middle of nowhere, most likely it's the work of one of those little guys.



Big Tech. companies are huge fans of neural networks. Naturally, for them, 2% accuracy is an additional 2 billion in revenue. But if it is a small scale company, it does not make any profits as Big Tech companies. We have heard stories of the teams spending a year on a new recommendation algorithm for their E-commerce website, before discovering that 99% of traffic came from search engines. Their algorithms were useless**.** Most users did not even open the main page. Despite the popularity, classical approaches are so natural that you could easily explain them to a toddler. They are like basic arithmetic; we use it every day, without even thinking.

1.1 Supervised Learning :

Classical machine learning is often divided into two categories – Supervised and Unsupervised Learning. In the first case, the machine has a "supervisor" or a

"teacher" who gives the machine all the answers, like whether it's a cat in the picture or a dog. The teacher has already divided (labelled) the data into cats and dogs, and the machine is using these examples to learn. One by one.

Clearly, the machine will learn faster with a teacher, so it's more commonly used in real-life tasks. There are two types of such tasks: classification – an object's category prediction, and regression – prediction of a specific point on a numeric axis.

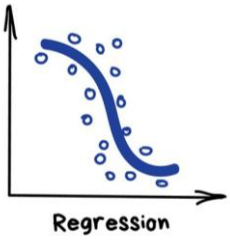
Few of the classification methods are:

- Spam filtering.
- Language detection.
- A search for similar documents.
- Sentiment analysis etc.

Regression is basically classification where we forecast a number instead of a category. Popular algorithms are Linear and Polynomial regressions.

"Draw a decision boundary through these dots. Yes, that is ML."

Here are a few examples where Regression methods are used:



- Stock price forecasts.
- Demand and sales volume analysis.
- Medical diagnosis.
- Any number-time correlations.

1.2 Unsupervised learning :

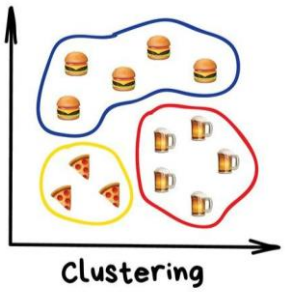
Unsupervised learning means the machine is left on its own with a pile of animal photos and a task to find out who's who. Data is not labelled, there is no teacher, and the machine is trying to find some pattern on its own. Unsupervised learning is a machine learning technique, where you do not need to supervise the model. Instead, you need to allow the model to work on its own to discover information. It mainly deals with the unlabelled data.

Clustering -

"Divides objects based on unknown features.

Machine chooses the best way"

Nowadays used for:



- For market segmentation (types of customers, loyalty).
- To merge close points on a map.
- For image compression.
- To analyse and label new data, etc.

Part 2: Reinforcement Learning

Finally, we get to something which looks like real Artificial Intelligence. Reinforcement learning is used in cases when your problem is not related to the data at all, but you have an environment to live in. "Throw a robot into a maze and let it find an exit."

Nowadays it is used for:

– Self-driving cars.
– Robot vacuum cleaners.
– Games.
– Enterprise resource, planning, etc.

Part 3. Ensemble Methods

"A bunch of stupid trees learning to correct errors of one another."

It's time for modern, grown-up methods. Ensembles and neural networks are two main fighters paving our path to a singularity. Today, they are producing the most accurate results and are widely used in production. Despite all the effectiveness the idea behind these networks is overly simple. If you take a bunch of inefficient algorithms and force them to correct each other's mistakes, the overall quality of the system will be higher than even the best individual algorithms.

You shall get even better results if you take the most unstable algorithms that are predicting completely different results on small noise in input data. Like Regression and Decision Trees, these algorithms are so sensitive to even a single outlier in input data to have models go mad. In fact, this is what we need. We can use any algorithm we know to create an ensemble. You just have to take a bunch of classifiers, apply regression, and measure accuracy.

Nowadays it is used for:

– Everything that fits classical algorithm approaches (but works better).
– Search systems.
– Computer vision.
– Object detection, etc.

Part 4: Neural Networks and Deep Learning:

"We have a thousand-layer network, dozens of video cards, but still we have no idea where to use it.

If no one has ever tried to explain neural networks to you using "human brain" analogies, you are happy. Any neural network is a collection of neurons and connections between them. Neuron is a function with a bunch of inputs and one output. Its task is to take all numbers from its input, perform a function on them and send the result to the output.

Here is an example of a simple but useful in real life neuron: sum up all numbers from the inputs and if that sum is bigger than N give -1 as a result. Otherwise -zero.

Connections are like channels between neurons. They connect outputs of one neuron with the inputs of another so they can send digits to each other. Each connection has only one parameter - weight. It is like connection strength for a signal. When the number 10 passes through a connection with a weight 0.5 it turns into 5. These weights tell the neuron to respond more to one input and less to others. Weights are adjusted when training - that is how the network learns. Ultimately, that is all there is to it.

When doing real-life programming nobody is writing neurons and connections. Instead, everything is represented as matrices and calculated based on

matrix multiplication for better performance. A network that has multiple layers which have connections between every neuron is called a Perceptron (MLP) and considered the simplest architecture for a novice.

Today it is used for:

– Replacement of all algorithms above.
– Object identification on photos and videos.
– Speech recognition and synthesis.
– Image processing, style transfer.
– Machine translation, etc.

Applications:

There are many applications for ML, including:

Agriculture, Anatomy, Adaptive websites, Affective computing, Banking, Bioinformatics, Brain–machine interfaces, Cheminformatics, Citizen science, Computer networks, Computer vision, Credit-card fraud detection, Data quality and many more.

Conclusion:

Machines are good at pattern matching but the ability of humans to learn unlimited patterns indicates that humans will always be smarter than machines. Another major issue is the concept of '*Context*' that human beings can infer easily. The personification of visual perception is the activity of dividing a complex scene into its separate constituent objects followed by the activity of attaching standard labels to the now-separated objects. (i.e., the identification of the component objects as members of various pre-established categories, such as 'car', 'dog', etc.). Perception is far more than the recognition of members of already-established categories, which involves the spontaneous manufacture of new categories at arbitrary levels of abstraction. Machine Learning is there by going to be the future, leading to growth in Artificial Intelligence. As machine learning algorithms evolve, the future will have more machines than humans. However, people will always be faster to adjust than computers, because that is what humans are optimised to do. Maybe, sometime many years from now, computers will catch up with human's ability to define new categories. In the meantime, humans will have learnt how to harness computing to augment their own native capabilities. That is why humans will always stay smarter than machines.

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https://noeliagorod.com/2019/05/21/machine-learning-for-everyone-in-simple-words-with-real-world-examples-yes-again/

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Development of Statistics as a Subject

Ninad V. Jadhav
T.Y.B.Sc. (Statistics)

Introduction:

Simple forms of statistics have been used since the beginning of the civilization, when pictorial representations or other symbols were used to record numbers of people, animals and inanimate objects on skin, slabs or sticks of wood and the walls of caves. Before 3000 B.C.E. the Babylonians used small clay tablets to record tabulations of agricultural yields and of commodities bartered or sold. The Egyptians analysed the population and material wealth of their country before beginning to build the pyramids in the thirty-first century B.C.E. The biblical books of Numbers and Chronicles are primarily statistical works, the former containing two separate censuses of the Israelites and the latter describing the material wealth of various Jewish tribes. Similar numerical records existed in China before 2000 B.C.E. The ancient Greeks held censuses to be used as bases for taxation as early as 594 B.C.E.

The Roman Empire was the first government to gather extensive data about the population, area and wealth of the territories that it controlled. During the Middle Ages in Europe few comprehensive censuses were made. The Carolingian kings Pepin the Short in 758 C.E. and Charlemagne in 762 C.E. ordered surveys of ecclesiastical holdings. Following the Norman Conquest of England in 1066 C.E., William I, king of England, ordered a census to be taken; the information gathered in this census, conducted in 1086 C.E., was recorded in the DOMESDAY BOOK.

Some scholars pinpoint the origin of statistics to 1662 C.E., with the population of Natural and Political Observations upon the Bills of Mortality by John Graunt. Early applications of statistical thinking revolved around the needs of states to base policy on demographic and economic data, hence its stat-etymology. The scope of the discipline of statistics broadened in the early nineteenth century C.E. to include the collection and analysis of data in general. Today, statistics is widely employed in government, business and the natural and social sciences.

Because of its empirical roots and its focus on applications, statistics is usually considered to be a distinct mathematical science rather than a branch of mathematics. Its mathematical foundations were laid in the seventeenth century C.E. with the development of probability theory by Blaise Pascal and Pierre de Fermat. Probability theory arose from the study of games of chance. The method of least squares was first described by Carl Friedrich Gauss around 1794 C.E. The use of modern computers has expedited large scale statistical computation, and has also made possible new methods that are impractical to perform manually.

G. Achenwall is usually credited with being the first to use the word “statistics”, but statistics, in the modern sense of the word, did not really come into existence until the publication. In this article, I will highlight why there was a need to separate Statistics as a subject from Mathematics. I realise that these distinctions may not be universal but I hope my broad strokes can help to highlight some fundamental distinctions between the disciplines.

Role of the context:

A primary difference between the two disciplines is that in statistics, context is crucial. Whereas Mathematics is an abstract field of study; it exists independently of context. Mathematicians often strive to “strip away” the context that can get in the way of studying the underlying structure. For example, one can study linear functions for their own mathematical properties, without considering

their applications. Indeed, one could argue that worrying about the complications of real data diverts attention away from the underlying mathematical ideas. But in statistics, one cannot ignore the context when analysing data. Even while writing the simple straight line equation passing through the origin we write $Y = mx + c$ (where m is the slope of the line and c is the intercept) but in statistics while writing the simple linear regression model we write $Y = \beta 0 + \beta 1 X i + \in i$ (where Y is the dependent variable, $\beta 0$ is the intercept, $\beta 1$ is the slope, Xi is the independent variable and $\in i$ is the random error component. Random error component should always be taken into consideration when one deals with real life data.

Another example of how context is paramount in statistics, let us consider the scatterplot of data from a study about whether there is a relationship between the age (in months) at which a child first speaks and his/her score on a Gesell aptitude test taken later in childhood (Moore and McCabe, 1993). If we draw the least squares regression line on the plot, we observe that the scatterplot and line reveal a negative association between the variables, indicating that a large value of one variable tends to appear with a small value of the other. Moreover, the slope of the line is statistically significant. But on closer inspection, we see that this apparent negative association is driven largely by the two extreme cases in the bottom right of the plot. What do we make of this? Should we conclude that whether there is a negative association here or not? Should we discard the outliers or not? Of course, to answer this question, we must first consider the context. So, our conclusion here contains two parts; children who take an exceptionally long time to speak tend to have low aptitude, but otherwise there is virtually no relationship between when a child speaks and his/her aptitude score. (We should learn more about how this data was collected before deciding whether these results generalise a larger group, and we could gather more data to examine whether those two exceptional children are indicative of a larger pattern). Once again, the context directs our analysis and conclusions. Fitting a line to this data without considering the context would have mislead us for much of what the data reveals about the underlying question of speaking and intelligence.

Importance of data collection:

One can study and do mathematics without analysing data, but even when mathematicians examine data they typically focus on detecting and analysing patterns in the data. How the data was collected is not relevant for purely mathematical analyses, but it is a crucial consideration in statistics. The design of the data collection strategy determines the scope of conclusions that can be drawn. Can you generalise results of a study to a larger population? It depends on whether the sample was randomly selected or not. Can you draw a cause-and-effect conclusion from a study? It depends on whether it was a controlled experiment or randomised experiment

Data collection is one of the most important step of data analysis. One of the incident is US ELECTIONS of 1948.[1]

"Dewey Defeats Truman" was an incorrect banner headline on the front page of the *Chicago Daily Tribune* (later *Chicago Tribune*) on November 3, 1948, the day after incumbent United States President, Harry S. Truman, won an upset victory over Republican challenger and Governor of New York, Thomas E. Dewey, in the 1948 presidential election. It was famously held up by Truman at a public

appearance following his successful election, smiling triumphantly at the error. The erroneous headline of the *Chicago Daily Tribune* (which later shortened its name to *Chicago Tribune*) became ill-famed after a jubilant Truman was photographed holding a copy of the paper during a stop at St. Louis Union Station while returning by train from his home in Independence, Missouri, to Washington, D.C. The *Tribune*, which had once referred to Democratic candidate Truman as a "nincompoop", was a famously Republican-leaning paper. In a retrospective article some 60 years later about the newspaper's most famous and embarrassing headline, the *Tribune* wrote that "Truman" had as low an opinion of the *Tribune* as it did of him".

Later it was known that the data was collected by visiting each and every home but that year the statistician collected the data through landlines and mostly the upper class people that is the rich people had landline and hence according to their opinion Dewey was the most eligible candidate, but the statistician did not include the rest of the population which was large and hence according to rest of the people Truman was the most eligible candidate and the whole data analysis went wrong.[2] Thus, Data collection is one of the most important step in statistics and it should be done with utmost care with minimum bias.

Lack of Definitive Conclusions:

Statistics and mathematics ask different types of questions and therefore reach to different kinds of conclusions, with different thought process which links question to conclusion. Mathematics involves rigorous deductive reasoning, proving results that follow logically from axioms and definitions. The quality of a solution is determined by its correctness and succinctness, and there is often an irrefutable correct answer.

In contrast, statistics involves inductive reasoning and uncertain conclusions. Statisticians often come to different but reasonable conclusions when analysing the same data. In fact, within these judgments lies the art of data analysis. All of statistical inference requires one to use inductive reasoning, as informed inferences are made from observed results to defensible, but ultimately uncertain conclusions.[3]

In statistics we summarise conclusions with phrases such as "We have strong evidence that…" and "The data strongly suggest that…" but steadfastly resist saying things like "The data proves that…". The quality of conclusions lies in the analyst's ability to support and defend their arguments.

Communicating Statistical Knowledge[4]:

Terminology is essential in mathematics as well as in statistics, but one difference is that many common terms from everyday language have technical meanings in statistics. Examples include words such as- bias, sample, statistic, accuracy, precision, confound, correlation, random, normal, confident, and significant. Students are very tempted to use these words loosely, without considering their technical meanings. Rather, studying statistics is akin to studying foreign language, because students need lots of practice to become comfortable with using these terms correctly. They often stumble at first as they are not familiar with the language and its correct usage. Although, there are English terms such as "multiple" and "factor" with a technical meaning in mathematics, it seems that students expect to see more technical terms in mathematics than in statistics. Communication is essential in both disciplines, but more so in statistics because it is a consulting enterprise. Statisticians routinely must interact with clients whose technical skills vary greatly, from eliciting a clear statement of the problem from those clients through communicating to them the results and conclusions of the analysis. While amateur students are far from professional statisticians, the ability

to communicate statistical ideas in layperson's terms is essential and an important component of many courses. Communication is important in mathematics also, but that communication is more often done symbolically in mathematics.

Issues of Measurement:

Another important issue that distinguishes statistics from mathematics is that measurement issues play a large role in statistics. Measurement is also important in mathematics. In mathematics, measurement includes getting students to learn about appropriate units to measure attributes of an object such as length, area, and volume and to use formulas to measure those attributes. In statistics, drawing conclusions from data depends critically on taking valid measurements of the properties being studied. Many other properties of interest in statistical studies of human beings are hard to measure accurately; examples include unemployment, intelligence, memory ability, and teaching effectiveness.

Conclusion:

We have argued that statistics is a different discipline than mathematics, that it involves a different type of reasoning and different intellectual skills. Even if you find our case persuasive, the question remains: Why should we care?

We see two primary reasons:

I) A different type of instructional preparation is needed for teaching statistics.

II) Students react differently to statistics than to mathematics.

In order to help students to know the relevance of context, measurement issues, and data collection strategies in statistics, it is imperative that teachers present real data in meaningful contexts from genuine studies.

Instructors also need to help students learn to relate their comments to the context and to always consider data collection issues, when stating their conclusions.[5] The experiences and reactions of students in studying Statistics are different from studying Mathematics. Because of the differences between Statistics and Mathematics, teachers should expect that some mathematically strong students may get frustrated while studying Statistics. But on the bright side, many students who may not get initially excited by Mathematics will be intrigued and empowered by their experiences with Statistics. Another difference in terms of instructional preparation is that many teachers do not have ample opportunities to develop their own statistical skills and understanding of statistical concepts before teaching them to students. This challenge is especially acute because few programs in Mathematics teacher preparation offer much instruction in Statistics, and much of the instruction that is provided concentrates on the Mathematical aspects of Statistics. The recent Mathematical Education of Teachers report makes these points quite forcefully. Helping students to develop their communication skills and statistical judgment, so crucial in the practice of Statistics, is also very challenging and an area in which Mathematics teachers are provided with little instruction. The experiences and reactions of students to studying Statistics are different from studying Mathematics. Educational research shows that students have tremendous difficulties with reasoning under uncertainty. Also, many students are very uncomfortable with uncertainty, with the lack of definitive conclusions, and with the need for detailed interpretations and explanations that are integral to studying statistics. Helping students to develop a healthy skepticism about numerical arguments, without allowing them to slip to the extremes of cynicism or naïve acceptance, is a great challenge. Finally it all depends on the students and how much knowledge they can exploit from both the subjects. But still we need help of both the subjects since both subjects are interlinked with each other. Differentiating Statistics and Mathematics is difficult, instead we should have a

different perspective that how Mathematics is helping Statistics to give more accurate outputs.

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Dr. Sarvepalli Radhakrishnan's Concept of The Māyā

Pushkar S. Agashe
M.A. Part-II (Philosophy)

Introduction:

In Indian Philosophy, there are many concepts which are discussed thoroughly. Māyā is one of such concept which affected the life of common man in multiple ways. The concept was mainly discussed and briefly elaborated by Adi Śaṅkarācārya. Later many philosophers interpreted the concept of Māyā. Dr. S. Radhakrishnan was one of them. Dr. Sarvepalli Radhakrishnan (5th September 1888 - 17th April 1975) was an Indian philosopher, Academic and Statesman. He served as the first Vice President of India and later President of India. A twentieth century scholar of comparative religion and philosophy. He was an academic philosopher with rare power of interpreting and intermingling Eastern and Western culture.

Dr. S. Radhakrishnan left no stone unturned to restate the ancient ideals of life in accordance with the needs of the modern scientific age. His philosophy is an attempt to interpret the traditional philosophy of the East to compose the current distraction of the western tradition. His motto is to bring the force and energy of western philosophy to strengthen 'the apathy' of its eastern counterpart. The traditional philosophical wisdom of our heritage has been brought out by Dr. S. Radhakrishnan from the dark abyss of abstractions into the open to be viewed in the light of the present philosophical beliefs and understandings. It is indeed true that it is not an easy job to characterise Radhakrishnan's philosophy in any of the existing model, such as, idealism, realism, pragmatism etc. without further adjectives. The following research paper talks about the different concepts of Māyā and broadly Māyā's interpretation by Dr. S. Radhakrishnan.

The Concept of Māyā:

The word Māyā literally means "illusion". It has multiple meanings in Indian philosophies depending on the context. In ancient Vedic literature, Māyā literally implies extraordinary power and wisdom. In later Vedic texts and modern literature dedicated to Indian traditions, Māyā connotes a "magic show, an illusion where things appear to be present but are not what they seem". Māyā is also a spiritual concept connoting "that which exists, but is constantly changing and thus is spiritually unreal", and the "power or the principle that conceals the true character of spiritual reality". In Hinduism, Māyā is also an epithet for goddess, and the name of a manifestation of Lakṣmī, the goddess of "wealth, prosperity and love".[1]

Words related to Māyā or containing the word Māyā, such as Māyāva, occur many times in the Vedas. These words have various meanings, with interpretations that are contested[2] and some are names of deities that do not appear in texts of 1st millennium B.C.E. and later. The use of word Māyā in the later era is used in the context of "magic, illusion, power", in Rig Veda occurs in many hymns. One titled

Māyā-bheda (मायाभेदः, Discerning Illusion) includes hymns 10.177.1 through 10.177.3, as the battle unfolds between the good and the evil. It is as follows,

पतङ्गमक्तमसुरस्य मायया हृदा पश्यन्ति मनसा विपश्चितः ।
समुद्रे अन्तः कवयो वि चक्षते मरीचीनां पदमिच्छन्ति वेधसः ॥१॥

पतङ्गो वाचं मनसा बिभर्ति तां गन्धर्वोऽवदद्गर्भे अन्तः ।
तां द्योतमानां स्वर्यं मनीषामृतस्य पदे कवयो नि पान्ति ॥२॥

अपश्यं गोपामनिपद्यमानमा च परा च पथिभिश्चरन्तम् ।
स सध्रीचीः स विषूचीर्वसान आ वरीवर्ति भुवनेष्वन्तः ॥३॥

The wise behold with their mind in their heart the Sun, made manifest by the illusion of the Asura;

The sages look into the solar orb, the ordainers desire the region of his rays. The Sun bears the word in his mind; the Gandharva has spoken it within the wombs;

Sages cherish it in the place of sacrifice, brilliant, heavenly, ruling the mind.

I beheld the protector, never descending, going by his paths to the east and the west;

Clothing the quarters of the heaven and the intermediate spaces. He constantly revolves in the midst of the worlds.

– Rig Veda X.177.1-3, Translated by Laurie Patton[3]

The Upaniṣads describe the universe, and the human experience, as an interplay of Puruṣa (the eternal, unchanging principles, consciousness) and Prakṛti (the temporary, changing material world, nature).[4] In Śvetāśvataropaniṣad, the Māyā is termed as 'Prakṛti'. Māyā is the 'Prakṛti' and Maheśvara is the wielder of Māyā. (Śvetāśvataropaniṣad 4.10, ईश्वरस्य मायाशक्तीः प्रकृतिः ।) The former manifests itself as Ātman (Soul, Self), and the latter as Māyā. The Upaniṣads refer to the knowledge of Ātman as "true knowledge" (Vidyā), and the knowledge of Māyā as "not true knowledge" (Avidyā, Nescience, lack of awareness, lack of true knowledge).[5] Bṛhadāraṇyaka Upaniṣad, states Ben-Ami Scharfstein, describes Māyā as "the tendency to imagine something where it does not exist, for example, atman with the body".[5] To the Upaniṣads, knowledge includes empirical knowledge and spiritual knowledge, complete knowing necessarily includes understanding the hidden principles that work, the realisation of the soul of things.

Brahman alone is the 'Ultimate Reality', while everything else is false. Māyāśakti is contained in Brahman and is not separate from Brahman. It (Māyāśakti) is the inherent character of Brahman. Śaṅkara in his introduction to the commentary on the "Brahmasūtra" he says that the essence of all illusory perception is that one thing is mistaken for another, that the qualities, characteristics or attributes of one thing are taken for the qualities, characteristics or attributes of another. Illusion is defined as the false appearance in some object of something experienced before, resembling a memory change. Vedanta thinks that the illusion is not merely subjective, but that there is actually a phenomenon of

illusion as there are phenomena of actual, external objects. The illusion is generated by the defect of the senses, whereas the phenomena of external objects are not due to specific doṣas.[6] Māyā is the empirical reality that entangles consciousness. Māyā has the power to create a bondage to the empirical world. The theory of Māyā was developed by the ninth century Advaita philosopher Adi Śaṅkarācārya. However, competing theistic Dvaita scholars contested Śaṅkara's theory,[7] and stated that Śaṅkarācārya did not offer a theory of the relationship between Brahman and Māyā.[8]

A later Advaita scholar Prakasatman addressed this, by explaining, "Māyā and Brahman together constitute the entire universe, just like two kinds of interwoven threads create a fabric. Māyā is the manifestation of the world, whereas Brahman is the cause of the world."[9] Māyā is not real as Real things cannot be sublated. By 'Real', Śaṅkara means Trikālasatya. It transcends all empirical existence. It is free from all differences of space and time. It is not real because it has no existence apart from Brahman. Giving an independent place to Māyā will mean accepting fundamental dualism between Brahman and Māyā. Neither it is unreal for it projects the world of appearance; it is true at least till it lasts.[10]

Dr. S. Radhakrishnan interpretation of Māyā:

Dr. S. Radhakrishnan considers the importance of the problem of Māyā from axiological and soteriological status of the world. He emphasises about its need on both levels - first thought and action, secondly theory and practice in our life. Naturally, unless the world is considered as real, our ethical actions become meaningless. For Radhakrishnan, the task of philosophy is not mere logical analysis, not only to interpret the problems of life but to illuminate and guide our very existence. That is why, he describes human perfection as a sort of wedding between 'high thought' and 'just action'. Again, he suggests that, "we need constructive philosophy, an articulation of ultimate presupposition about the world we live in"[11] and the concept of Māyā is one such ultimate presuppositions about the phenomena of nature. It does not matter whether such presuppositions or root principles of experience be proved or disproved by our discursive intellect. In fact, it is neither verified nor falsified. Since he understands philosophy in its multidimensional aspects, he is not to deduce conclusions from a set of dogmas, but the explication of the presuppository of experience.[12] Thus, we see that Radhakrishnan's view on Māyā is an outcome of his motive to inspire positive ethical action in the universe.

For Radhakrishnan, the universe is driving at-something, driving not irrational in movement, but is a constant progress to some higher meaning an experience. 'An idealist' to quote his own words. "can find no rest until he gains a view or a vision of the world of things and persons which will enable him to interpret the manifold experiences as expressive in some sort, of a purpose".[13] He considers that the prime task for a philosopher is to find an explanation of the universe. Like the traditional Vedantins, Radhakrishnan conceives ultimate reality as spiritual, sometimes he calls it 'Brahman', and sometimes the 'Absolute'. It is called absolute, because it is "pure consciousness and pure freedom and infinite possibility."[14] In addition to Brahman or Absolute, in different writings, Radhakrishnan admits the principle of God. But like Śaṅkara, he does not make

any distinction between empirical (Vyavahāriika) and transcendental (Pāramārthika) standpoints as the basis of the distinction between God (Saguṇa Brahman) and the Absolute (Nīrguṇa Brahman) for an explanation of the world of multiplicity without contradicting the monistic conception of reality. Radhakrishnan feels it necessary to admit a principle that would account for the order and purpose of the universe. If primary 'Being' is not conceived as creative, one cannot account for the dynamic creative nature of the world of our experience. Thus, for Radhakrishnan infinite possibility the Absolute "we call the Supreme, the Absolute when we view it apart from the cosmos, God in relation to the cosmos. The absolute is the pre-cosmic nature of God, and God is the Absolute from the cosmic point of view "[15].

Radhakrishnan says that watertight compartment between 'necessity' and 'accident' is not well grounded in case of reality. Therefore he says that, "it is in the nature of the absolute to grow into the world, world is the affirmation of the Absolute."[16] He explains the derivative, meaning of the word 'Brahman' which comes from the root 'बृंह्' means to grow. If this is contended, then "we do not have the infinite and the finite, God and the world, but only the infinite as and in the finite, God as and in the world. The question as to why the Absolute limited itself is irrelevant. For, there is no such thing as the Infinite which first was an Infinite and then transformed itself in the finite".[17] It is precisely here, Śaṅkara explains the multiplicity of the world and the monistic conception of reality by a recourse to Māyā as mysterious or anirvacanīya. But Radhakrishnan here instead of giving a negative explanation of the world that is ultimately illusory, gives a positive explanation although he admits, that human minds which functions through concepts and categories can at the best known fragmentary elements of the universe.

The concept of Māyā is not a pivotal concept to formulate a system of philosophy by Dr. S. Radhakrishnan. It is rather a concept that makes some erroneous understanding of the basic issues of Indian Philosophy clear. And to give a rejoinder to erroneous interpretations Dr. S. Radhakrishnan very aptly explains the multi-dimensional implications of the concept of Māyā as used in the Vedas and Upaniṣads. According to Dr. S. Radhakrishnan, as an epistemological concept Māyā indicates the inexplicability of the exact relation between the universe and the Absolute, Phenomena and Noumena. As a creative force or cosmogenic concept, Māyā, in Radhakrishnan's philosophy means, the self-becoming power inherent in Īśvara. Introducing Māyā as a primal matter Dr. S. Radhakrishnan tries to give the Sāṅkhya dualism a pertinent position in his own 'Monistic Idealism'. He further brings out the soteriological and axiological relevance of Māyā which shows his modernist tendency to make the traditional concepts suitable in the new changing socio-cultural context. And last but not least, he shows the 'one-sided dependence' indicated by Māyā along with the maintenance of the integrity of Absolute.[18]

The concept of Māyā for Radhakrishnan is absent in the Upaniṣadic texts in the sense of illusion. Radhakrishnan's interpretation also clarifies the intention of Śaṅkara's illustration by the perception of snake in a rope. "The appearance of snake which is really a rope is analogous with the appearance of the world which is

really Brahman. Brahman appears to be the world. Brahman emanates or lets loose the world. But this "letting loose" is not a transformation because there is no change of substance". Radhakrishnan in interpreting Māyā has tried his best to retain the metaphysical Absolute of Vedanta Philosophy. For him, these two realms are not contrary, they are rather the two dimensions of one and the same Reality, namely, Brahman. To Radhakrishnan, like Swami Vivekananda, the concept of essential unity of everything owes its origin to the Advaita Philosophy. (Vivekananda also says that the creation of the world, although on account of Māyā, is not illusory. In his Neo-Vedantism, he clearly exposes that the finite and the infinite are not only different paths which men take through various tendencies, all lead to the same goal, as different streams having the sources in different places, lead to the ocean.)

It may further be noted in this connection that Śaṅkara also does not deny the reality of the world altogether, he also affirms relative reality of the world. The world is relative, because it cannot be absolutely categorised as real or unreal. He admits the value of God or Saguṇa Brahman for realising the higher spiritual level of Brahman (Nīrguṇa) as the absolute reality. He says that as long as man remains under the veil of Māyā, the world along with all human values are real to him. Only the liberated person, a person who has realised that Brahman is the only reality that is everything, including this world. Brahman is not under the influence of Māyā and not puzzled with the multiple modalities of the universe as many reals.

Impact of Hegelian thought:

Absolute Idealism is an ontologically monistic philosophy attributed to G. W. F. Hegel. Hegel developed a comprehensive speculative metaphysics that found an all-inclusive unity in the Absolute Spirit (Non-personal, Non-Creator and Hegelian rational God). Hegel argued that the Absolute Spirit unfolds itself as history, which encompasses all natural, social, and historical events and phenomena. Since Hegel's idealism is based upon the notion of Absolute Spirit, his idealism is called "Absolute Idealism." His philosophy can be best understood within the contexts of German idealism beginning with Kant. Hegel presented his philosophy as an answer to the questions raised by Kant and other German idealists. Hegel's idealism greatly impacted philosophers in the twentieth century. However, they developed their thoughts partly as a rejection and reaction against Hegel's speculative metaphysics. Hegel was hugely influential throughout the nineteenth century. His influence has continued in contemporary philosophy but mainly in Continental philosophy.

We cannot characterise Dr. Radhakrishnan's philosophy with idealism, realism, pragmatism etc. We can observe a philosophical synthesis of nondualistic Vedanta and the philosophy of Absolute Idealism of Hegel. His Vedanta is the Vedanta of integral experience. He reconciles the monistic character of the Vedantic Reality with Absolute Idealism's dictum that everything is a necessary aspect of the One. As a result of this unique synthesis, it is not possible to describe his thought by any of the current metaphysical models. Dr. Radhakrishnan's philosophy is a philosophy of 'Monistic Idealism'. By 'idealism' he means not 'idea-ism' but 'ideal-ism'.

Conclusion:

The conclusion of the paper is to say that, Radhakrishnan's all-inclusive conception of absolute, which is said be on account of the influence he receives from the Hegelian Absolutist philosophical Tradition and his earnest desire to assimilate it with the Upaniṣadic understanding of reality. In other words, without the reality of the world, the absolute is no absolute reality. Now, it appears that Dr. S. Radhakrishnan tries to retain the pure metaphysical profundity of traditional Vedanta philosophy on the one hand, and embraces a functional method of presentation of the theme for the present day enquirers. Dr. S. Radhakrishnan without emphasising much on the doctrinal dispute explains the different meanings of use of the word Māyā as against its illusory sense in order to meet the need of the day. Dr. S. Radhakrishnan questions whether the concept of Māyā is later graft or an essential feature of Indian Philosophy or traditional culture. According to him, the doctrine of Māyā in the sense of illusion, is not a tenet of the original Vedanta. Dr. S. Radhakrishnan is arguing that the meaning or value of the world, not its existence is related to the problem of Māyā. The earthly life has a positive value for the evolution of the soul it is the place unavoidable.

Hence, the earthly life is not to be regarded as illusory. Dr. Radhkrishnan's interpretation of the concept Māyā is the need of today's society, which is kind of a step ahead to the Saṅkara's interpretation of Māyā.

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THE WORLD OF IoT

Mandar N. Gaikwad and Dnyaneshwari J. Bhosale
M.Sc. Part I (Computer Science)

Introduction:

After four decades from the advent of Internet by ARPANET, the term "Internet" refers to the vast category of applications and protocols built on top of sophisticated and interconnected computer networks, serving billions of users around the world in 24/7 fashion. Indeed, we are at the beginning of an emerging era where ubiquitous communication and connectivity is neither a dream nor a challenge anymore. Subsequently, the focus has shifted toward a seamless integration of people and devices to converge the physical realm with human-made virtual environments, creating the so-called *Internet of Things (IoT*) utopia.

A closer look at this phenomenon reveals two important pillars of IoT: "Internet" and "Things" that requires more clarification. Although, it seems that every object capable of connecting to the Internet will fall into the "Things" category, this notation is used to encompass a more generic set of entities, including smart devices, sensors, human beings, and any other object that is aware of its context and is able to communicate with other entities, making it accessible at anytime, anywhere. This implies that objects are required to be accessible without any time or place restrictions.

IoT is a trendy buzzword in the technology industry, and companies have been trying to determine how much of it is hyped and how much of it is real. The promise of new data streams or a higher degree of automation is certainly tantalising, but the greatest benefit comes from large interconnected systems that present a challenge for many organisations. An Internet of Things strategy requires new technology along with new business processes and collaboration.

History of "IoT":

Kevin Ashton, co-founder of the Auto-ID Center at the Massachusetts Institute of Technology (MIT), first mentioned the internet of things in a presentation he presented to Procter & Gamble (P&G) in 1999. Wanting to bring Radio Frequency ID (RFID) to the attention of P&G's senior management, Ashton called his presentation "Internet of Things" to incorporate the cool new trend of 1999 – the internet.

MIT professor Neil Gershenfeld's book, "*When Things Start to Think"*, also appeared in 1999. It did not use the exact term but provided a clear vision of where IoT was headed. IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMSes), micro services and the Internet. The convergence has helped tear down the silos between Operational Technology (OT) and Information Technology (IT), enabling unstructured machine-generated data to be analysed for insights to drive improvements. Although, Ashton was the first to mention the Internet of Things, the idea of connected devices had been around since the 1970s, under the monikers *embedded internet* and *pervasive computing*. The first internet appliance, for example, was a Coke machine at Carnegie Mellon

University in the early 1980s. Using the web, programmers could check the status of the machine and determine whether there would be a cold drink awaiting them, should they decide to make the trip to the machine.

IoT evolved from Machine-to-Machine (M2M) communication, i.e., machines connecting to each other via a network without human interaction. M2M refers to connecting a device to the cloud, managing it and collecting data. Taking M2M to the next level, IoT is a sensor network of billions of smart devices that connect people, systems and other applications to collect and share data. As its foundation, M2M offers the connectivity that enables IoT. The internet of things is also a natural extension of Supervisory Control and Data Acquisition (SCADA), a category of software application programs for process control, the gathering of data in real time from remote locations to control equipment and conditions. SCADA systems include hardware and software components. The hardware gathers and feeds data into a computer that has SCADA software installed, where it is then processed and presented in a timely manner. The evolution of SCADA is such that late-generation SCADA systems developed into first-generation IoT systems. The concept of the IoT ecosystem, however, did not really come into its own until the middle of 2010 when, in part, the government of China said it would make IoT a strategic priority in its five-year plan.

Why "IoT"?

The internet of things helps people live and work smarter, as well as gain complete control over their lives. In addition to offering smart devices to automate homes, IoT is essential to business. IoT provides businesses with a real-time look into how their systems really work, delivering insights into everything from the performance of machines to supply chain and logistics operations.

IoT enables companies to automate processes and reduce labour costs. It also cuts down on waste and improves service delivery, making it less expensive to manufacture and deliver goods, as well as offering transparency into customer transactions.

As such, IoT is one of the most important technologies of everyday life, and it will continue to pick up steam as more businesses realise the potential of connected devices to keep them competitive.

Building Skills in "IoT":

As with many emerging technologies, the tendency is to focus on "IoT-specific" skills. Businesses might search for an IoT Architect or an IoT Security Specialist. These positions might make sense for companies that are heavily investing in IoT strategies, but these specialised roles can mask the fact that IoT support is more likely to be a

	Critical skill	Needs improvement
IT security	63%	42%
Data management	61%	38%
Networking	59%	37%
Data analysis	58%	36%
Device support	55%	61%
Cloud computing	51%	36%
Artificial intelligence	36%	40%

Figure 2: Skills needed for IoT.

combination of existing skills that are augmented to some degree with IoT expertise. It is no great surprise to see that IT security tops the list of skills that companies view as critical to IoT success. Merging the digital and physical worlds opens a host of potential security issues.

The next set of skills are certainly familiar to IT professionals, though there may be varying degrees of proficiency. Data management and analysis are key to unlocking the potential of IoT, but companies may need to start with basic data fundamentals if disciplined data practices are not in place. Networking and device support skills are a given in most IT departments, but companies are still looking for improvement around devices, since those are the "things" in these new systems.

The low ranking of cloud computing and artificial intelligence shows that companies may not yet appreciate how different trends complement each other. Some IoT implementations might be small, but more often they are large-scale projects. Such scale exceeds the capacity of most on-premises infrastructure, and the ongoing management and analysis requires some amount of automation. Cloud computing and AI will be necessary ingredients of any broad IoT initiative. Hardware and software are not the only resources that need to be expanded for IoT. In order to fill the many different skill gaps, companies expect to utilise a wide variety of professionals and partners.

Overall, the tendency to focus on "IoT-specific" is reflected in the types of resources that businesses expect to utilise. Three of the top four resources on the list are new IoT-specific technical staff (cited by 44% of companies), new IoT-specific vendors (38%) and new IoT-specific solution providers (38%). However, these options may be more applicable in the long term, as robust plans are developed and these types of resources become more widely available.

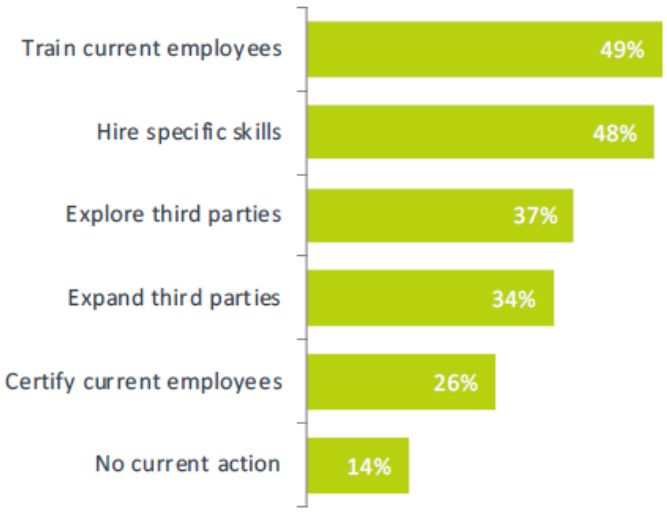

Figure 3: Current Actions to Improve Skills

In the short term, companies have to work with what they have. The top option for improving IoT skills is to train current employees. This choice is understandably more popular among large and medium-sized companies, who have more resources on board that can be trained. Just over a quarter of firms in the survey plan to go beyond training and pursue certifications to validate employee expertise.

When current internal resources are scarce or hiring is challenging due to a competitive environment, third parties can provide a supplement or even take the lead on IoT activity. As with other technology trends, medium-sized firms are most likely to explore new third-party relationships or expand the partnerships they already have.

Solution providers entering the IoT space should be just as aware of the IoT ecosystem as the companies that are standing up new projects. Most solution providers will likely view IoT hardware as an adjacent space where they can provide offerings, and 68% of companies currently using a partner for IoT use them for hardware provisioning and support. The most popular way to use third parties, though, is in the area of software. The approach to software development is changing, with more companies doing custom development rather than simply purchasing packaged software. Solution providers should prioritise their own software skills, and they should also consider services around IoT systems or consulting around IoT rules and standards.

IoT in Day To Day Life:

The Internet of Things, like it or not—understand it or not—has, in recent years, successfully disrupted our daily lives to the point that even the non-technologically inclined have started to buy into the convenience, the comfort, and the valuable insights that it offers. From connected home hubs, smart thermostats, remote door locks, and all the various app-controlled appliances, chances are, you already know how helpful IoT is in your everyday life.

The truth is, IoT is growing in importance, both for industrial use and everyday use. It is making our lives better in so many ways, and it will likely continue to do so. Along with the problems we know we have, it is solving problems we did not even realise were a problem – that is until the solution magically appeared.

IoT penetration in our daily lives is on the increase, too. The global market for IoT is on track to reach $520 billion by 2021, representing a growth of about 50 percent in each successive year since 2017.

The term IoT refers to things that we use every day that also connect to the internet, allowing us to either control or receive data about that "thing" from our smartphone or computer.

Examples of how we use Internet of Things in our everyday lives include:

- Smart appliances (stoves, refrigerators, washers and dryers, coffee machines, slow cookers).
- Smart security systems, smart locks, and smart doorbells.
- Smart home hubs (that control lighting, home heating and cooling, etc.)
- Smart assistants (like Amazon Alexa or Apple's Siri).
- Fitness trackers, sleep trackers, and smart scales.

Emerging consumer trends in IoT that include smart active wear, smart athletic shoes, and connected vehicles that tell us everything from how close we are to the vehicles around us to the best route to take to avoid rush hour traffic.

No matter what type of smart IoT application you use, most of you will agree that the information and convenience you get as a result has saved you time, money, and a lot of worry.

How industrial IoT is making our lives better –

IoT helps us work smarter, live smarter, and gain complete control over our lives, but it is also supporting our wellbeing behind the scenes.

In addition to our smart home devices, IoT is an essential technology in business and industry, as it gives businesses a real-time glimpse into the inner

workings of their company's systems. From the factory floor to the customer's door, IoT delivers insights into everything from machine performance to supply chain and logistics operations.

IoT allows companies to automate processes and save money on labour. It also reduces waste and improves service delivery, making it less expensive to manufacture and deliver goods and providing transparency into customer transactions.

It allows companies to reduce costs, increase safety, and improve quality from end-to-end, which translates to a win-win for everybody. As a result, consumer goods are less expensive to produce, shipping is more predictable, and companies can grow, stimulating our economy while delivering a sense of satisfaction we can take to the bank.

Future of IoT:

IoT devices are becoming a part of the mainstream electronic culture and people are adopting smart devices into their homes faster than ever. By 2021, it is estimated that there will be up to 21 billion connected devices to the internet. IoT devices will be a huge part of how we interact with basic everyday objects.

In just one year alone, we went from having 5 million IoT devices connected to the internet to billions. The future is happening now, and these devices are getting smarter every day through machine learning and artificial intelligence. To prove that IoT is taking off rapidly, Target opened up a store in San Francisco that exclusively sells IoT devices. There is big money in the IoT space currently, and it will only continue to grow as technology advances.

The more data that IoT devices collect, the smarter they will become. Cities will transform into smart cities through the use of IoT connected devices. Think of smart traffic lights that collect data on traffic, and use that data to sync lights to peak traffic times.

Overall, this improves cities overall efficiency and saves the government money since everything can be remotely managed. Smart homes, thermostats, lighting systems and coffee makers will all collect data on your habits and patterns of usage. All this data will be collected to help facilitate machine learning.

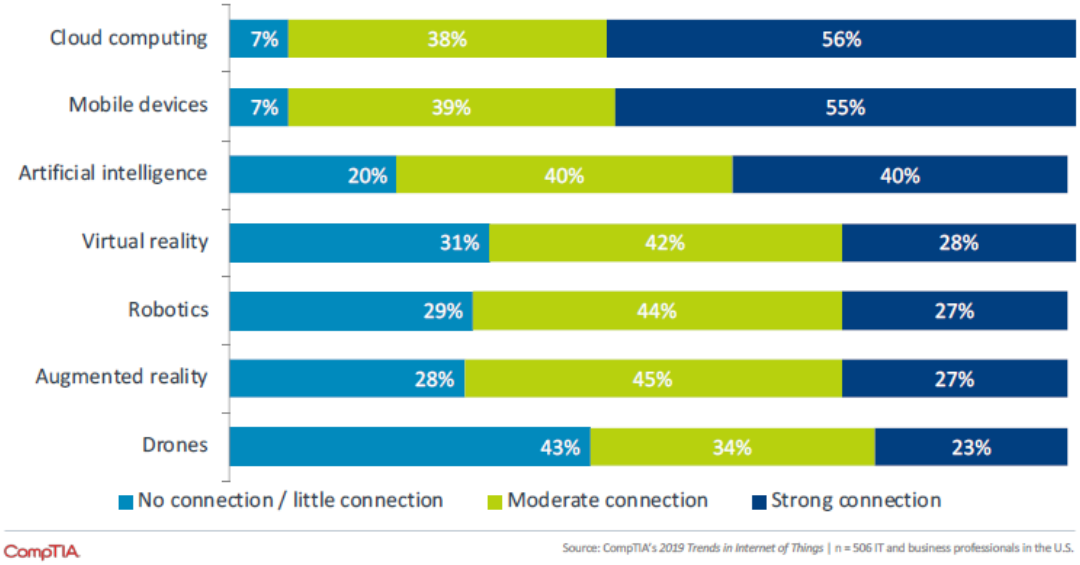

Figure 4: Connection between IoT and Technology.

IoT Security and Privacy Challenges:

The increasing popularity of this concept has raised a lot of security issues, especially privacy concerns that make IoT users susceptible to Cyber Attacks and identity theft. Major IoT providers also use default or hardcoded passwords that can create room for security breaches. This and many other loopholes can be exploited by cybercriminals to gain remote access to devices and wreak havoc on the devices or the users.

The increasing security threat to IoT underlines the importance of finding practical solutions that may address the issue and drastically reduce the rate at which IoT devices are attacked by criminals operating from the cyberspace.

The DDOS (Distributed Denial of Service) attacks that affected IoT services and devices around the world in 2016 is an eye-opener and a proof that the security threat against IoT is real.

However, all hope is not lost. You can put some personal security measures in place to fortify your devices against attacks by harmful cybercriminals. This is where IoT security comes in.

What is IoT Security?

IoT Agenda defines IoT security as "the technology area concerned with safeguarding connected devices and networks in the Internet of Things (IoT)." Simply put, IoT security refers to the precautionary measures taken to beef up the security of IoT devices and reduce their susceptibility to attacks from unauthorised criminals.

Five proven solutions that you may implement to increase the security of your IoT devices are:

1. Use IoT Security Analytics

The vulnerabilities and security issues associated with IoT can be drastically reduced by implementing security analytics. This involves collecting, correlating, and analysing data from multiple sources that can assist IoT security providers to identify potential threats and nip such threat in the bud.

Thus, there is a need for multi-dimensional security analytics apart from monitoring IoT gateways alone. Malicious and suspicious anomalies can then be identified by correlating data from a wide range of domains. That allows security experts to correct such anomalies and prevent them from having a negative impact on the connected devices.

More so, a spike on the sensor's CUP, if the devices are still performing its assigned task or other related security issues, can easily be detected. The combination of such valuable pieces of information and threat intelligence data can prove helpful in effectively detecting harmful threats and finding effective solutions to the threats.

2. Use Public Key Infrastructure

The Public Key Infrastructure is a "Set of policies, software/hardware, and procedures, which is required for the creation, management, and distribution of the digital certificates." This security process has proven over the years to be an effective solution to IoT security issues.

PKI ensures the encryption of data through both asymmetric and symmetric encryption processes. In the former, both the data encryption and decryption is done with the same key while different keys are used for the data encryption and decryption in the latter. The data encryption and decryption ensure that data privacy is maintained and the chances of data theft are reduced to the bare minimum.

Security measure involve using digital certificates for verifying the identity of all the devices connected together in an IoT. It also maintains the privacy of information to keep it away from the reach of potential attackers.

Cryptographic key and X509 digital certificate are some IoT PKI security methods that can be used as well as public or private key management, distribution, and revocation.

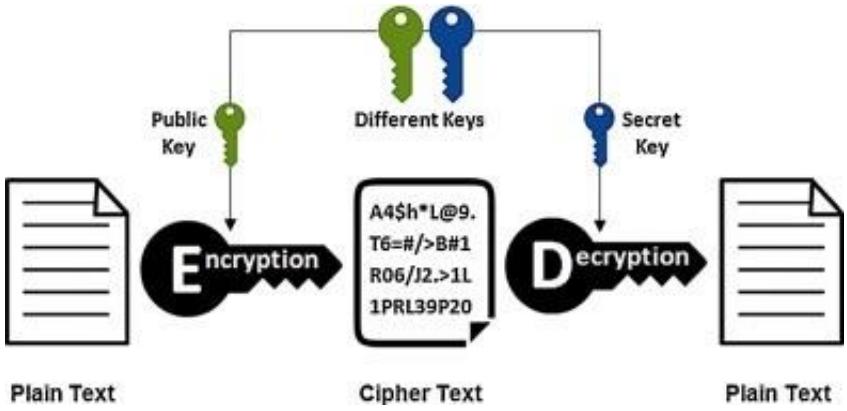

Figure 5: Public Key Infrastructure.

3. Ensure Communication Protection

The IoT concept works on communication between the connected devices. However, when communication is compromised, there will be a communication breakdown that can render the devices useless.

Many people do not know how to prevent putting themselves at risk online regularly. They do not know that to ensure smooth communication always, the communication should be encrypted. The same principle applies to communication between the connected devices and the interface such as web apps and mobile apps.

Some notable encryptions that can be implemented are AES 256, HTTP, AES 128, and a host of others. This layer of protection renders the interface impregnable to potential hackers.

4. Secure the Network

IoT devices are connected to back-end systems that are already connected to the Internet via an IoT network. This network plays a crucial role in the smooth operation of IoT devices.

To sustain the smooth operation, there is a need for the IoT network to be protected and secured. By employing some endpoint security features like anti-malware, antivirus, intrusion prevention, and firewalls, you can effectively protect the network and secure it against attacks.

5. Ensure Device Authentication

You can also reduce your IoT devices' vulnerability to attacks if you carry out a comprehensive device authentication for your devices.

There are multiple authentication features that are available for IoT devices. Some, like digital certificates, two-factor authentication, and biometric, ensure that nobody can have unauthorised access to your devices. A potential attacker will need some personal information to gain access to the devices and pieces of information that you are the only one that has access to.

Although using IoT devices is not a crime and poses zero threat, the vulnerability to attacks from the cyberspace makes it important that you secure your devices and reduce your exposure to attacks.

When you implement some of the suggested security options discussed in this piece, rest assured that your IoT devices are well secured against external breach of security. Thus, you will enjoy the numerous benefits of having IoT devices at home, in the office, and somewhere else.

Understanding IoT:

Rapid growth in technology has resulted in a limited understanding of the IoT. For consumers to make use of the internet and all that the IoT has to offer, it is essential to work upon their awareness of the changes taking place within IoT to make it more efficient. Not only will the comprehension empower them, it will prepare them mentally and they will possibly be able to find solutions on how to take caution from any of the mentioned problems.

Conclusion:

It's quite evident that organizations all over the world are boarding onto IoT-driven digital transformation ventures to drive competences and business suppleness, in addition to better meet the demands of their customers and citizens. There might be risks to these ventures, but, nonetheless, if coped appropriately, organisations could be further assured and the road to IoT victory and efficiency should be impartially smooth.

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Recent Trends in Mathematics

Srujana V. Acharya
M.Sc. Part-II (Mathematics)

Introduction:

Ask any layperson, who has at least a little bit of academic background, if she can tell one application of mathematics. Most probably, she will tell you one application of Mathematics. Most probably, she will tell you that she uses numbers in her day to day life. Whenever she goes to a market, she purchases something and to pay the bill, she needs to do some basic arithmetic operations. Similarly, every one of us uses numbers in some or the other format in our lives on a daily basis. But, is Mathematics just about numbers?

Now, ask a Physicist, where does she use Mathematics? Her answers might include 'Thermodynamics'. She must have used differential equations to solve various heat equations. And now, ask an Economist which branch of Mathematics she requires often? She may tell you that she uses calculus and graph theory.

Different people with different backgrounds and professions use at least some concept of Mathematics, every day. Mathematics is a necessary and equally important too. It serves as a motivation for other sciences as well as it is motivated by the same.

Mathematics started when there was no formal divisions between sciences. It all started when the question of comparison came and has been developing ever since. But the formal development of Mathematics started in the fourth century B.C.E. when Euclid wrote all the mathematics that he knew formally. Some of the notable mathematicians in the last 300 years are, G. W. Leibniz (logician, mathematician and natural philosopher) Johannes and Jacob Bernoulli (mathematicians and physicist), Johann Carl Fredrich Gauss (mathematician and physicist), Augustin-Louis Cauchy (mathematician, engineer and physicist), Evariste Galois, Neils Henrick Abel, Karl Weierstrass (physicist and botanist), Bernhard Riemann, Henri Poincare (engineer, physicist and philosopher), Georg Cantor. Many of these mathematicians did collaborative research, which is also one of the trends in Mathematics seen today. So, what are the recent trends in Mathematics?

Recent trends in Mathematics:

The recent trends in Mathematics can be broadly categorised into three categories, namely, Collaborative Research, Research in Mathematics and Mathematics Education. We will see these trends briefly below.

Collaborative Research:

Collaborative Research is an interdisciplinary research, that is, one or more mathematicians work together in two or more disciplines of science to develop theories in all those disciplines. It merges mathematics expertise with proficiency in another discipline, usually computer science, physics, business, medicine or engineering. Nowadays, mathematicians highly used computers and programming

while doing this type of research. Let us look at some fields in which mathematics is used to develop these fields.

a. Computer Science and Mathematics:

Logic is the mathematical foundation of computers. Other fields such as calculus, combinatorics and probabilistic statistics are also used in computer science. Artificial Intelligence and Data Sciences are two of the most important fields in the computer science which are used in industries. Artificial Intelligence (A.I.) deals with reproduction or mimicking of human intelligence, self-awareness, knowledge, conscience and thoughts in computer programs. The essential quality of a machine which thinks in a manner similar to or on the same general level as a real human being. Data Science is an interdisciplinary field about scientific methods, processes and systems to extract knowledge or insights from data. Both of these fields use liner algebra, graph theory, multivariate calculus, real analysis, probabilistic statistics, optimisation, etc.

b. Physics and Mathematics:

Mathematics is primarily used to model the real world. The following are some examples of how Mathematics can be used in Physics. In the twentieth century C.E., Albert Einstein was developing an extension to his theory of special relativity. Special relativity codified the relationship between the dimensions of the space and time. In the extension, he wanted to incorporate the effects of gravity in his theory. To extend his theory, he had to use a special branch of differential geometry called the 'Riemannian Geometry'. He was able to do this because of his friend and collaborator, Marcel Grossman, who was a mathematician. Another revolutionary development of the twentieth century was Quantum Theory, which needed a theoretical framework based on probabilistic interpretation of states and, evolution and measurements in terms of self adjoint operators. This mathematical theory was developed in its elementary form by David Hilbert and Frigyes Riezs and rigorously defined within axiomatic modern version by John Von Neumann. In the current research in Quantum Theory, abstract algebra is being used extensively. For example, the group SO(3) is used to describe the possible rotational symmetries of an object as well as the possible orientation of an object in space. Its representations are important in physics, where they give rise to elementary particles of integer spin.

c. Business and Mathematics:

Mathematics is typically in commerce which includes elementary arithmetic, elementary algebra, statistics and probability. Use of calculus, metrics algebra and linear programming can make business management more effective. Mathematics is also used in accounting, inventory management, marketing, sells forecasting and financial analysis. In Economics, mathematical methods represent theories and analyse problems in economics. Conventionally, these applied methods are beyond simple geometry, such as differential equations, matrix algebra and mathematical programming. Advances in the mathematical statistics and a cadre of mathematically trained economists lead to econometrics, which was the name proposed for the discipline of advancing in economics by using mathematics and statistics.

Research in Mathematics:

Since research in mathematics does not require any apparatus, people often wonder about how research is done. Mathematical research is about posing a problem and solving it. It requires just a pen and some papers. Some of the mathematicians carry on the research done by previous mathematicians or they try to solve some previously posed unsolved problems.

Following are some problems which have been solved recently:

1. The sum of three cubes – Is there a number that is not 4 or 5 (modulo 9) and that cannot be expressed as a sum of three cubes?

   It was discovered that for a natural number n such that n < 100, except for the natural numbers 33 and 42, all numbers which are not equal to 4 or 5 (modulo 9) can be return as a sum of three cubes. Recently, Andrew Booker settled that for n = 33,

   $33 = (8866128975287528)^3 + (-8778405862239)^3 + (-2736111468807040)^3$.

   And, he also established that there are no solutions for n = 42.
2. The ever winning lottery ticket – Is there a lottery ticket that always wins? This question was a mathematical mystery for almost fifty years and has been recently solved by Asger Dag Tornquist. Unfortunately, the answer is negative. There is no such lottery ticket. The answer was given using Ramsey Theory.
3. An alternative and easier way to solve quadratic equations – A general quadratic equation is $ax^2 + bx + c = 0$. Dr. Po-Shen Loh goes around traditional methods to find solutions of quadratic equations. Following is an example of this method.

   Consider the quadratic equation $x^2 - 8x + 12 = 0$. Then let a and b be the solutions of this equation. Now, we want $a + b = 8$ and $a \times b = 12$, let $a = 4 - u$, $b = 4 + u$. Then we have $a \times b = (4 - u) \times (4 + u) = 16 - u^2$. That is $u^2 = 4$. So, $u = 2$ or $u = -2$. And so, we get the solutions to be 2 and 6.

The above are the examples of some problem oriented to Mathematical Research. But, sometimes mathematicians also develop some new branches in the field of Mathematics to find solutions of problems which belong to other areas of mathematics or other sciences. For example, this is how Fourier analysis was developed. Recently, Dr. Karen Uhlenbeck founded modern geometric analysis. It is the field of mathematics, where techniques of analysis and differential equations are interwoven with the study of geometrical and topological problems. She won the 2019 Abel Prize and was the first woman to win the same.

Mathematics Education:

Mathematics education is the practice of teaching and learning mathematics along with associated scholarly research. Researchers in mathematics education primarily develop new methods of teaching; so that the students can learn mathematics better.

Even today, researchers mainly deal with primary and secondary school mathematics education, which includes basic Arithmetic, Algebra and Euclidean geometry. There is no substantial research done to teach the undergraduate and postgraduate students.

The following are some of the methods developed to teach mathematics to school children.

1. Conventional approach – This includes teaching Mathematics in the order that most of us have learnt, starting with arithmetic, algebra and geometry and then increasing the difficulty levels.
2. Computer based education – This includes use of computers to teach Mathematics as well as using a computer software to solve problems.
3. Exercises – This includes the reinforcement of mathematical skills by completing large numbers of exercises of a similar type.
4. Problem Solving – This includes cultivating mathematical and logical thinking of the students by asking them to solve various types of open ended and concrete problems.

One of the recent trends in school education is 'Mathematics Lab'. It has various mathematical models which explain concepts and allows the students to understand, visualise and manipulate them. It provides an opportunity for students to do and enjoy mathematics.

When a student decides to pursue higher mathematics, the traditional methods of reciting the theorems and typical problems form the textbooks does not work. The students must have a smooth transition from their school education to their further education. Therefore, Mathematics education is a field which is in dire need of attention.

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TO STUDY IN A SCIENTIFIC MANNER

Atharv M. Sambarat
T.Y.B.Sc. (Zoology)

Introduction:

Science is both, a way of thinking about the natural world and the sum of the information with a theory that results from such thinking where information is limited to perception. Fundamentally speaking, living organisms are made up of lifeless molecules. This sentence is proved authentically but it also disheartens many to a great extent. This is because everyone lives according to their routine and innate emotions. Everyone lives a life in a specific way; determined by their birth, upbringing and biological development and most importantly peers. People are satisfied with a basic feeling that they are alive, no matter how it may be. In favour of this satisfaction, people do various activities; each one having their personal philosophies, abilities, limitations, responsibilities and reasons. But some people go ahead of these things.

The Questions:

Science is defined as a detailed study, analysis and if possible any application of any system.

1) Why to do science?

Asking 'why' is a result of anxiety to seek a closure to various dissatisfying questions; getting answers from such questions and understanding them is similar to understanding the question and answer as a whole. Science starts here itself.

2) Why to understand such systems of things?

People are likely to enjoy more if they understand any system indetail. A system is a set of things which are interrelated in a series of actions. When one understands a system, he/she knows it then and knowing leads to fascination. If a person's favourite song is played, they sing along or dance (at least in your mind) without even thinking about it; they know the next word, next beat and next note. Basically, the person enjoys the song. On the other hand, it is not as joyful to dance to an unknown song (old or new or of different genre). Science works in a similar way, while studying such systems people are fascinated by what they get to know. The only unique prospect of science is that people seek closure in terms of truth. It excludes all types of depictions and perspectives as truth is always absolute.

3) What do you actually mean by truth? Why truth has to be given significance?

Truth is a convincement in the most logical manner and the most logical perceived input are the practical proofs. Truth is not a perspective to look from; many people believe truth as the most idealistic perspective but fail to see as such believes are relative as well as arbitrary. Science believes only in genuine experimental evidences and practical proofs. By considering it in this manner avoids confusion and provides genuineness to the theory. If one raises his hands up and says, "I have extra two hands in my pockets" then it can be easily disproved practically. This shows the significance of practical experiments. On the other hand,

most of the times people try explaining in terms of analogies which may lead to depiction. Depictions are analogies of what happens or has happened somewhere and what we want to understand. Even though people try to spread awareness through art by creating huge collages, making posters and paintings but a photo of a dead octopus with debris in his body is much more convincing than a 'best out of waste' art as shown in the figure.

A work of art showing an octopus eating debris from the sea.

Following a depiction or an incepted concept could be misleading. If erasing the existence of all the mythologies and all kinds of tales then reproduction of such stories is almost impossible. But if all the scientific evidences were erased, yet there will be some people with equal amount of curiosity who will try to analyse and understand the same system and get the same results. He/she will conduct the same experiment many times, keeping the parameters same, to get the same results every time. Such things seem fascinating at times and with enough intelligence one can derive single or multiply applications out of it. And again, if he/she is not satisfied with results then they ask, "Why is this happening? What phenomenon keeps the result unchanged?" Thus, the depth of the experiment increases.

4) What does science has to do with my life? What are Life Sciences?

Life Sciences is a set of fields of science dealing with progression in respective fields which is in favour of the lives of the modern human (*Homo sapiens sapiens*) population. These include Chemistry, Biotechnology, Microbiology, etc., which are all studied in an integrated form to derive maximum applications. People living their daily life are not much aware about the role of science in their daily routine as they simply pay for it. Payment in the form of currency decreases or increases the valuation of any product. They are simply living their regular routine.

5) What is life?

It is a broad term question which can be seen by various aspects. Biological aspects reciprocate social aspects. However, answer from either of the side will be rude, illogical or nonconventional to the other significantly. In social terms, we are human beings, independent by identity and obliged to follow culture, traditions, peers, national patriotism and the ethics as a human. In short, everyone lives in a society built by an artificial construct. Considering this, people separate themselves from the nature and start objectifying different concepts and phenomena. Biologically, humans are classified as animals, a complex system of elements. All living organisms are made up of cells where cell is the structural and functional unit of life. In terms of thermodynamics, living organisms live in a dynamic steady state[38] means to maintain the system by consuming energy and resist going with the entropy. It is fascinating to know that any organism is so unique but on a fundamental level every organism is formed of the same hydrocarbons viz. nucleic

[38] Page no. 6, Lehninger Principles of Biochemistry.

acids, proteins, lipids and carbohydrates and metallic and non-metallic ions as well.

The fascination:

As stated earlier, Modern Humans are fascinated by the things around them. For example, a modern human is fascinated by the nature and objectifies it; many even spend money and energy to go and see sunsets, mountains, pilgrimages, etc. At every point of time, due to Earth's rotational motion a sunset is happening in some or the other part of the Earth. Thus, one cannot see a sunset/sunrise for a longer duration. Also, one cannot see it as per their convenience.

Humans think that there's something special about the way they perceive the world yet they live in a bubble of their own, seldom questioning their choices, content and most of the part, to be told what next. Terms such as beauty, ugliness, euphoria, rude, intriguing, perfect, etc. are felt very emphasising and have varied depth of importance in different contexts. But again, rhetorically speaking, they are all various ways of perceptions.

The truth about life is simple. The answers get simplified when the origin of it is studied. The origin of life has many theories and the most acknowledged is the Directed Panspermia; which won a Noble Prize. The theory includes the origin of life and cell as a fundamental unit of life which is not native to Earth; rather it states that the life on earth has been directed by extra-terrestrial beings.

People often question the nature of the cell as why do they multiply instead of growing further into a sphere. Let us suppose the radius of the cell is r then the surface area is in terms of r^2 and the volume in terms of r^3. If the radius doubles, $2r$ then the surface area increases in terms of $4r^2$ and the volume increase in terms of $8r^3$. Here, the initial ratio of surface are to the volume of the cell is 1: r and after doubling the radius is 1:$2r$. Hence, we can conclude that the surface area grows insufficient to the volume and therefore it divides to increase the surface area and reduce the volume. Division includes two types; mitosis and meiosis. In mitosis the daughter cells have identical genetic material (asexual reproduction) and meiosis has two daughter cells with different genetic content formed by overlapping of chromosomes while dividing (sexual reproduction). With the changing entropy of the universe, an organism has to match it or it will not survive. Hence, sexual reproduction is prevalent in current conditions as well. Sexual reproduction leads to variations (other factors also influence such as mutations or genetic drift) and if the offspring which survives in the changing entropy, it propagates its progeny. Evolution is another detailed study of the progress made by an organism to counter the entropy.

The above explanation may sound irrational to some people. It is a way of perception to find it that way. Humans have evolved so ahead that they have the ability to understand systems; millions of years of evolution has led to the current world. Entropy is nature itself and living organisms tend to resist it and thus might be the reason for us to reciprocate the nature itself.

Every species tries to cover the entire crust of the Earth but the survival of the fittest and natural selection does imply here. All the organisms interact with each other as one species cannot live in entire solitude. To avoid depletion of a

species it produces offspring to match with the entropy. The number of offspring is more if the species is more vulnerable to the surroundings.

What to do? How to do?

What to do is clear as we are practicing science or studies as such. There is a significant difference between 'to perceive' and 'to learn'. What one perceives through all the five sensory organs is the perceived phenomena. But while learning, one needs to consider the object of study, define its reference frame, reference line and the position; unless and until all the enlisted things are not complete, it is difficult to study. The study is further carried out by using the appropriate theorems. Theorems are made up of postulates; postulates are considered truths. The need of postulate arose to have a medium of communication between ourselves. For example, '1' is called 'one' and not 'two'. So to speak, any language is a theorem. Studies are done in detail of every subject as precise as possible for better understanding. Also, specification of the parameters, postulates, data and reference frame is also very important.

Limitations of science:

Understanding systems doesn't remain a veto power if one increases the depth and the reference frame of a study; it makes us feel like the things are out of our reach, hence known as a limitation. The word 'limitation' is widely used to explain the limit of one's physical ability or psychological abstract impedance but rarely used with reference to the understanding.

The world knows a lot through Science but the limitations come along as well. Some facts are still unknown like how is the universe expanding? The fundamental atomic structure as atoms composed of electrons, protons and neutrons or to be specific – quarks, leptons and fermions and many other particles. The composition of the particles is still unknown. Why do we have to conduct detailed study about? Greater depth leads to greater understandings and then the content becomes more vulnerable to our interests.

Pushing such limits leads to transcended view which is always more significant than an ascended view. Transcendence is broad but short, ascendance is narrow but long. The way of understanding has its own nature and the cycle never ends. Science starts from the farthest galaxy to the tiniest and closest to an atom; one just plays around between them not knowing that the human brain is simply not enough to learn about the entire nature itself.

Another limitation is regarding the theories is that they are constructed to study a generalised facts but exceptions do occur; a large exceptional group is considered as a new group later on. For example, people first concluded that matter is made up of various elements formed of small particles but these elements showed different characters hence classified as metals and non-metals. In later discoveries, some elements showed both the characteristics of a metal and a non-metal both, categorised as metalloids. General conception – all metals are solid, exception is mercury. A generalised view favours better understanding but exceptions do sometimes spoil the whole study.

Conclusion:

Any living entity is a system in dynamic steady state. Such a living system tries to create order in the disorder of universe (entropy). To create such harmony by creating order is fundamental nature of living beings. With time given the growth of living organisms is exponential to the entropy. We have inferred about the origin of life which was so infinitesimally small but has evolved into the present world.

Humans practice science by exploiting systems under their understanding for the wellbeing of humans or for personal satisfaction. Spontaneity is the root of causality which results in all natural phenomena. Such fundamentals rule the laws of nature. One cannot study all the aspects and prospects of science. Hence, they are divided into different fields such as Physics, Chemistry, Astrology, Quantum Mechanics, Biotechnology, etc. Studying one field at a time helps in understanding the depth of the respective field. Then, to create applications one must practice integrated studies i.e. considering more than one scientific aspect to maximise the outcome. To understand and practice such activities is the primary intuition to study science.

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A Science with Solutions

Harshada S. Deo
M.Sc. Part-II (Inorganic Chemistry)

Introduction:

From the early days of our education, we have always been taught that food, clothing and shelter are the basic needs of mankind. In today's world, one can add sanitation, education, healthcare and the internet to this list. All of these can be summarised in two words, "Matter" and "Energy", which are most often found in a chemistry textbook. The following text aims at briefly introducing Chemistry, its interconnection with the other sciences and its contribution to the same. It also includes a glimpse of various research and applications in the different dimensions of man's needs.

The study of matter, "Alchemy" was derived from Arabic term "al-kimaya" which came from the ancient Greek word "khēmia" i.e. transmutation of earth and this later came to be recognised as Chemistry, the study of manipulating matter called chemicals. It involves identifying, observing, studying and applying the knowledge of various changes that occur all around us. Chemistry teaches us that every interaction, whether it is between matter and energy or within matter itself can be explained, reasoned, reproduced and can further prove to be resourceful for mankind.

Over a period of time the concepts and applications of Chemistry have changed. This was particularly after the noteworthy work of Boyle, the first modern chemist who studied various gases and the very first one to disagree with the Greek idea of the presence of four elements in his book "*The Skeptical Chymist*". This marked the inception of a new era for science. From John Dalton-who introduced 'atoms' to the world to Erwin Schrödinger- who gave us the Quantum mechanical model of the atom, chemistry has come a long way. It has gained cognisance in each and every aspect of life.

Academically, Chemistry consists of four basic core branches which Physical, Organic, Inorganic and Analytical Chemistry; equally potent and developing skilful chemists. Lately, Geochemistry, Biochemistry, Medicinal Chemistry, Environmental Chemistry, Industrial Chemistry, Nano-chemistry and many more have been emerging to satiate the requirements of the modern world.

Role of Chemists:

Chemists all over, quest for new "solutions" to quench their curiosities. They also fight a 'multifaceted hydra' that emerges with new challenges like constantly changing world and its newly evolving concerns like environmental protection and rejuvenation, need of green and sustainable sources of energy, proper and affordable medical diagnosis and treatment to

name a few. One of the many such efforts is the set-up of an organisation named “Chemists without Borders” by two Californian chemists Bego Gerber and Steve Chambreau.[1]

The organisation actively works on solving humanitarian problems worldwide. This shows that chemists not only investigate various observed phenomena but also work on implementing the gained knowledge as a beneficial resource for the society.

Interdisciplinarity of the field:

Chemistry does not work alone in addressing the challenges of the world. Like an arachnid’s web, studies, discoveries and innovations in every field of chemistry and related sciences are interwoven and are spreading rapidly with chemistry at its centre. It is ‘a central science’ that has thrived and evolved through its close and crucial links with many other fields.

Computers in Chemistry:

Computational Chemistry is a budding branch of Chemistry that deals with mathematical simulations and models to solve chemical queries and conduct research in the same. Most of the models work on the principles and calculations of Quantum Mechanics. It helps to identify the geometry of different molecules using calculative models. It is possible for chemists to carry out their research in-silico. Many complex reaction mechanisms can be predicted without entering the chemical laboratory. One need not play with chemicals to find the “solution”. Not only have the synthetic chemists been assisted by these computational chemists, but also fields like Astrochemistry, for instance, astrochemists perform experimental studies to generate data for interpreting and explaining astronomical observations, to provide input data for these computational models. Together they are used to test theories about the formation and evolution of large and small molecules in various astrophysical environments.

Physics in Chemistry:

Physics and Chemistry are bridged together by Physical Chemistry. Thermodynamics, for instance, uses physical energetics to explain feasibility and spontaneity of various chemical reactions.

A very remarkable application of Physics in Chemistry is the advancement of Spectroscopy where interaction of matter with physical phenomena like light, electromagnetic radiations, etc. are studied. The Magnetic Resonance Imaging (MRI) is one such famous tool for detection and diagnosis. Another application of Physical Chemistry can be found in a diagnostic device called the PET scanner (Positron Emission Tomography) a medical imaging technique that produces a 3D image of functional processes in the body. It works on the principle of energy released in positron-electron (antimatter - matter) annihilation. The PET scanner detects this radiation

given off by the previously injected tracer, and produces color-coded images of the body that show both normal and cancerous tissue.

Role of Polymer Chemistry in Bioengineering:

Polymers have made a remarkable impact on the medical field. Every medicine practitioner uses polymers in every step of patient treatment. From dressing wounds to surgical sutures, one is surrounded with polymers like Teflon, highly hydrophobic, non-degradable materials that can be applied as a vascular graft to polyesters of lactic acid like the common degradable polymers like poly(glycolic acid) (PGA) that are available in different shapes for orthopaedic applications and drug eluting coatings on vascular stents.[2]

Contribution of Chemistry to Medical Diagnosis:

A very recent jewel on the crown of Chemistry in India, took place in Pune is the production of low-cost indigenous polymer swab prototypes by the scientist Dr. Milind Kulkarni of the Centre for Materials for Electronics Technology (C-MET). It was a joint project of C-MET (which comes under the Ministry of Electronics and Information Technology), Sri Research for Tissue Engineering Private, Rangadore Memorial Hospital, Indian Institute of Science (IISc), Bengaluru and Additive Manufacturing Society of India.

These swabs are usually imported and are used for sample collection in the diagnosis of Covid-19.[3] Advances in the field of diagnostics is witnessing the use of biosensors and gene amplification that can possibly predict and detect various discomforts and ailments by simply analysing molecular DNA and this can work towards preventing and curing them. Wearable devices are being used to monitor blood sugar without collecting blood, and some of them can also monitor hospital patients' vital signs.

Advancement in the field of Medicine owing to the development of Chemistry is well known. The well-known Ancient Indian practice of medicine, the Ayurveda, deals with Phytochemicals and their therapeutic effects. Chemistry is the fundamental principle behind use of various drugs for the treatment of a wide range of infirmities. From Cisplatin and Taxol that show antitumor activity to a regularly used Paracetamol (acetaminophen) to reduce fever, all of these are contributions of chemists to medicine. It would also be only fair to mention the notable contribution of Synthetic Chemistry and Pharmacochemistry for developing efficient ways of manufacturing Hydroxychloroquine, a proven supporting medicine that could be called the ambrosia during the very trying outbreak of Covid-19.[4]

Chemistry in Environment and Energy:

It is no news that the need for alternative energy sources and efficient ways of generating power is prominent and a priority. The very fact that matter is converted into energy forms the substructure for research and role of Chemistry in Energetics. The vast knowledge gained from the study of the

structure-property correlations in the area of catalysts, batteries, fuel cells, thermoelectric and optical materials can be utilised in designing newer and efficient materials for energy. Hydrogen is considered to be a clean, green and efficient fuel as it has a high calorific value, leaves no residue and is eco-friendly. One of the challenges this Hydrogen fuel cell faces is storage of the gas. Material Scientists are working on developing suitable storage materials[5]. Significant research is also progressing towards 'Chemoremediation', a process of searching for a 'remedy' against enrichment of land and water with heavy metals such as Lead, Arsenic, Mercury, etc.

Concluding Remarks:

This science of chemicals has amazed mankind throughout the ages and will continue to surprise us. The recent involvement of the computational models in Chemistry has revolutionised the research in the field of chemical sciences to an extent that one may imagine the whole "lab-on-a-chip". And its interdisciplinary presence has proven Chemistry to be more than test tubes and beakers in a laboratory, it has the ability to bridge subjects like Physics and Biology by participating in characterisation techniques and diagnostics. It is one of the platforms for many sciences to reach out to the masses and make a difference. Although, Chemistry has seen the world throughout its course of changes and one daresay it has been one of the active contributors to this change, it may seem that chemical sciences are yet adolescent and are growing profusely. The conventional experiments are now being replaced by the "in-silico" models and are now advancing towards Green Chemistry. One can say that Chemistry, fuelled with 'curiosity' assisted with 'consistency' and guided by 'conscience' has the ability to 'create' a self-sustained utopia. It has undoubtedly proven to be remarkable in being one of the Applied Sciences where one can find a question and actively work towards finding an answer. After all, Chemistry does deal with "Solutions".

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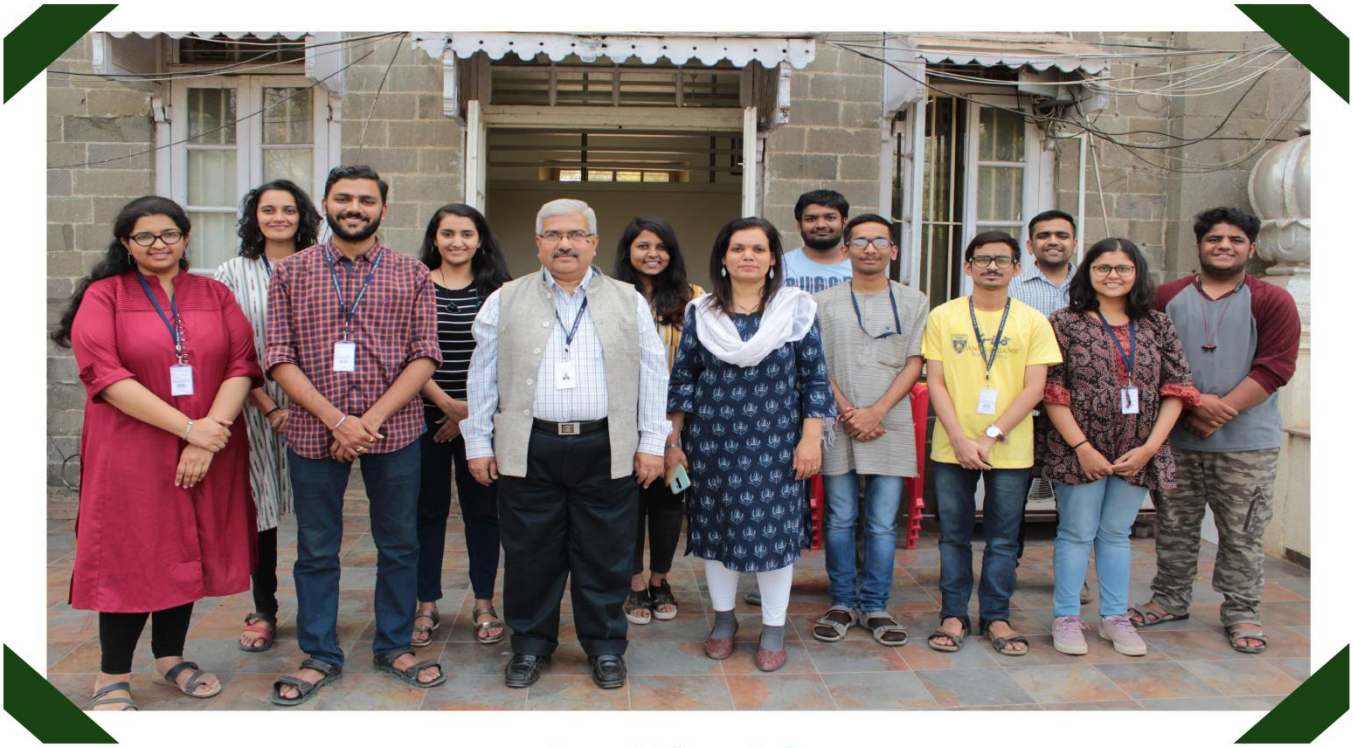

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