10. Technology Watch

10.1 INDIAN LOGIC (Nyaya Darsana) & Artificial Intelligence

- Evolution of Logic in India
- Gautama's Nyaya Sutra – Prachina Nyaya
- Logic's Status in Indian Philosophy
- Jaina Logic & Buddhist Logic
- Navya Nyaya (New Logic)
- Pramana Tattva Chintamani - Gangesa
- Some Comparisons with Western Logic
- AI & Knowledge Systems
- Our Present Agenda

Evolution of Logic in India

- Indian view of life: Brahma Vidya (Atma Vidya)
- The ancient, the medieval and the modern schools of Indian Logic
- Kautilya's Artha Sastra: Reference to Anvikshiki
- Charaka Samhita (Ayurveda, Logic in disease diagnosis and management)
- The art of debate: Tarka and Vada

Gautama's Nyaya Sutra – Prachina Nyaya

- Scope (Acquisition of Valid Knowledge)
- Topics Conceived by Akshapada Gautama (Objects, Means, Doubts, Goals, Analogies, Tenets, Syllogisms, Conclusions, Fallacies)
- Implications of false knowledge – Causal chain leading to cycle of birth and death
- Means of obtaining true knowledge: Perception, Inference, Analogy and Expert Testimony
- Objects of study: Self (desires, dislikes, actions, utilities, knowledge), Body, Sensory organs, Mind, Intellect, Tendencies, Results

Categories of AKSHAPADA GAUTAMA

- PRAMANA Means of obtaining valid knowledge
- PRAMEYA Objects of study, Propositions
- SAMSAYA Doubt, Uncertainty

- PRAYOJANA Objectives (Major and Minor)
- DRISTANTA Instance, Example
- SIDDHANTA Tenet, Theorem
- NIRNAYA Conclusion
- HETVABHASA Fallacy
- AVAYAVA Limbs of the syllogism

Means of Valid Knowledge (Pramana)

- PRATYAKSHA : Sensory Perception (pratyakshaaabhaasa, illusory perception)
- ANUMANA: Inference (Hetvaabhaasa or fallacy in reasoning, wrong inference)
- UPAMANA: Analogy
- SABDA: Verbal Testimony (smriti, sruti, purana, aitihya, aagama as pramana) Sabda can be laukika or alaukika.
- ARTHAPATTI (default reasoning) and ANUPALABDHI (knowledge of non-existence) are considered Pramana by some.

Galaxy of Indian Logicians (Naiyayikas)

Nyaya-Vaiseshika System- Basic Tenets

- There is an objective order of real entities external to and independent of the cognizing subject.
- The clue to these real entities is the universe of experience with which the individual starts.
- All varieties of valid knowledge, whether perceptual or non-perceptual, have an unerring objective reference and attest the presence of universe consisting of real entities in and around us.
- These real entities are absolute facts, which are knowable, but existing prior to and making possible all knowledge referring to them.

Vaiseshika (Aulukya) Darsana

- A philosophy of distinctions among objects). Vaiseshika sutra of Kanada, Prasastapada, the author of Padarthadhramasamgraha is of a much later time.

- While the Vaiseshika system is a system of study of the real world entities, Nyaya is pramana sastra, exploring the reality of chunks of cognized knowledge.

- For the Vaiseshika philosopher, the real is what it is and not what some one imagines it to be. Cognizability (prameyatva) is co-extensive with reality.

Vaiseshika (Aulukya) Darsana

- Padarthas are seven and have the attributes: "isness" (astitva), "nameability" (abhideyatva) and "knowability" (jneyatva). (Prasastapada)

- Satta means existence or reality. Bhava indicates presence.

- Six Bhavas: Substance (dravya), quality (guna), action (karma), universal (samanya), particularity (visesha) and inherence (samavaya)

- Negation or non-being (abhava)

- Is-ness (astitva) is the distinctive character or individuality (svarupa) of a thing. (Sridhara)

Vyakarana as darsana (Language is fundamental.)

- In Rg Veda, language is a deity (vac) of creation.

- Vyakarana deals with grammar and linguistic analysis,

- Nirukta deals with etymology or meaning of selected words,

- Siksha deals with phonetics,

- Chandas deals with metrics and prosody.

- Purvamimamsa is called Vakyasastra or the science of sentence interpretation and

- Nyaya (logic) is also intrinsically language oriented.

Vyakarana (Grammar)

- The relation between sabda and artha received wide attention.

- Patanjali defines sabda as that which when articulated, conveys the idea of the referent.

- Mandana Misra in his Sphotasiddhi defines Sabda

as the cause that produces the idea of meaning. Sabda is thus the idea-bearer.

The Mimamsa view

- The letter (permanent articulated sound unit, akshara), or phoneme (varna) are the units of language and the meaning-bearers.

- Mimamsa, called vakyasastra, is concerned with interpretation and cogent explanation of scriptural texts.

- The notion of meaning (artha) itself has problems. Is it the universal that is intended or the particular?

- Mimamsakas hold that the primary meaning of a word is universal.

The Mimamsa View

- Mimamsa gave a semantic definition of the sentence evolving the concepts of

- mutual expectancy (aakaanksha),

- consistency (yogyata) and

- contiguity (aasatti) as factors.

Jaina Syadvada : Multi-valued logic: Saptabhangi Naya

- May be, it is (Syad-asti)

- May be, it is not (Syad-nasti)

- May be, it is and it is not different times (Syadasti-nasti)

- May be, it is and it is not at the same time which means it is indescribable

- May be, it is yet indescribable (Syad-astiavaktavya)

- May be, it is not and also indescribable

- May be, it is and it is not and also indescribable (Syad-asti-nasti-avaktavya)

Buddhist Logic

- Emphasis on Reason (Hetu centricity)

- Pervasion (Vyapti): (vyapnoti = pervades, fills completely) (Salt (vyapaka) pervades the sea (vyapya).). From the relation of cause and effect,

or from identity as a determinant, results a law of invariable concomitance - not through mere observation of the desired result in similar cases, nor through the non-observation of it in dissimilar cases.

- Fallacies in reasoning
- Universals and particulars

Navya-Nyaya (NN)

- The most highly developed school in Indian thought system.
- NN handled with ease the intricacies of all systems - epistemology, grammar, physics (properties of matter)
- "The metaphysical basis of NN is realistic, yet its logic is formal. NN is definitely superior to Aristotelian logic. In its concept of number it seems to anticipate mathematical logic by several centuries." (Daniel Ingalls)

Birth of Navya Nyaya

- Buddhist logic received a setback with the destruction of Vikramsila University by Bakhtiyar Khilji. Sri Harsha's Advaita based criticism of PN provided new impetus to development of NN.
- Gangesa or Gangesopadhyaya , (13th century) is credited to be founder of this NN school of logic at Mithila (near Darbhanga in Bihar). Mithila was the centre of study of his work for two centuries His great work is Pramana-Tattva-Chintamani or simply Tattva-Chintamani (TC).
- Later centre of NN was Navadvipa (Bengal).

Techniques of Navya Nyaya

- 7 Categories (padartha) of Vaiseshika accepted.
- Pramiti (Prama) obtained as Pratyaksha, Anumiti, Upamiti, and Sabda-ja-jnana (Sabda-bodha) through the instruments (karana) of pratyaksha, anumana, upamana, sabda.
- The Vyapti Panchaka (Five definitions of vyapti) NN has deeply examined several definitions of vyapti.
- All non-eternal entities are due to a set of complex

causes (karana) and operations (vyapara), Universal causes - God, time

Techniques of NN (Contd.)

- Instrumental causes - nimitta karana
- Special causes (samavayi and asamavayi karana.)
- (Knowledge of a person also is non-eternal and is a product of causes and operations. Vyapti jnana is the instrumental cause, paramarsa is the operation and the anumiti is the result.)
- prameya pradhanah prachina nyayah, pramana pradhano navya nyayah
- (PN's focus is on objects while that of NN is on instruments of knowledge).

Techniques of NN (Contd.)

- In God exists and God is everywhere, one is in existential sense and the other is in predicational sense.
- Abhava = absence, is of two types anyonyabhava and samsargabhava. The latter is of three types: prag-abhava, pradhvamsa-abhava, atyanta-abhava.
- Earth made into a pot. (prag-abhava)
- Pot broken into pieces. (pradhvamsa-abahava)
- There is no pot in cloth. (anyonya-abhava)
- $\sim$ (fire = water) and $\sim$ (fire R Lake)

Knowledge in NN (jnana to prama)

- True Knowledge is what leads to highest good (Tattva-jnanan Nihssreyassadgigamah).
- The Samskrit word Jnana is awareness rather than knowledge.
- An awareness is produced by a cognitive act that happens at a time. Perception yields awareness. When validated though proper instruments of knowledge (pramana), this becomes veridical (prama).

Veridical Knowledge (Prama)

- The doubt is whether X, a vaguely visible object, is either A or B (for e. g. a snake or a rope).

- The inquiry should yield the valid knowledge X is A. Nyaya inquiry leads to a decision (nirnaya).

- Knowledge-hood and illusion-hood are not mutually exclusive class properties.

- There is a distinction between one's knowing and one's knowing that one knows.

Veridical Knowledge (Prama)

- (Yachcha yadasti tachcha tasyanubhavah prama. Tadvati tatprakaarakanubhavo vaa.

- Yachcha yannasti tachcha tasya jnanam tadabhaavavathi tatprakaarakajnanam vaa aprama) (TC vol.1, p.401).

- Valid knowledge is a truth hitting cognitive episode. It is any awareness that grasps x as F, provided x is F.

Relations

- The edifice of NN rests on the concept of sambandha or relation.

- The concept involves difficulties of various types, ontological, logical and epistemological.

- What is a relation? A relation connects two entities. All relations are dyadic relations between two terms; the first called anuyogin or referend and the second, the pratiyogin or referent.

- A relation is a property resident in the referend.

Relations

- A direct relation - Contact (Samyoga) between two objects. E. g. Bhutale ghato asti.

- The ground (bhutala) is the subjunct (or substratum), the pot (ghata) is the adjunct (or superstratum)

- Navya-Nyaya specifies several relations : qualifierqualified (Viseshana-Viseshya), describerdescribed (nirupaka-nirupita), limitor-limited (avachchedaka-avachchinna) and properties locatee-locus (dharma-dharmin).

Relations

- What is the nature of R itself?

- Is R a real entity like a and b?

- If so, are there relations between a and R and R and b?

- This could lead to an infinite regress, called Bradley paradox

- (Noted long ago by Dharmakirti in Sambandha Pariksha).

Relations

- Determinate cognition (savikalpaka jnana), is an awareness of a whole containing a relation and its two terms. Its content is represented by

- Qualificand (viseshya),

- Qualifier (viseshana), and

- Qualification (vaisishtya).

Classification of Relations Criterion -1:

- Sakshat (direct) and Paramapara (Chain) relations:

- Samyoga (contact), samavaya (inherence) and svarupa are direct relation.

- Samaanaadhikarana (co-locus-ness) is chain relation.

Classification of Relations Criterion - 2

- Occurrence exacting (Vrtti-niyamaka) relations involve the notion of substratum-super-stratum (aadhaara-aadheya bhava), between two distinct objects, otherwise unconnected.

- Non occurrence-exacting relations (Vrttianiyamaka) Examples are vyaapti, abheda (essential identity) and describer-ness - describedness (Nirupakatva-Nirupyatva).

- Paryapti is a Vrtti-niyamaka relation. Svarupa can be of both types.

Classification of Relations Criterion - 3

- Locus-pervading (vyapya-vrtti) and non-locuspervading relations (avyaapya-vrtti).

- Pervasion (vyaapti) is generally a complete occurrence relation while the Samyoga between two material objects is usually an incomplete occurrence (or non-locus-pervading) relation.

- Samavaaya (inherence) may exist between
- the part and the whole,
- the generic character (jati) and the individual manifestation (vyakti),
- the quality and the substance qualified,
- the action and the substance, which is the substratum of action,
- the eternal substance and the ultimate difference (visesha).

Prakaara - Chief qualifier

- Knowledge having for its content a qualified object is called a relation
- (Visishta-pratiti-niyamaka-viseshasya-ivasambandhatvat).
- When a qualificandum has two qualifiers one expressed in the subject and one in the predicate, the latter is the prakaara or the chief qualifier.

Relations (Adhaara-adheya and dharma-dharmi)

- A property location model suits some relations of NN.
- One aspect of this model is denoted by the dharma-dharmin (locatee-locus) pair.
- When two entities are related, one is often superimposed on the other. A super-stratum (aadheya) rests on the substratum (aadhaara).
- Aadhaara is also called locus (adhikarana) or abode (ashraya).

Avacchedakata and Vishayata

- Avachchedaka is used in two senses: limitor and resident limitor.
- Avachchinna means "limited".
- When Jnaana is analysed its contentness i.e. vishayata becomes important, which includes:
- visheshyata, praakaarata and samsargata, Samsargata refers to relation between the qualifier and the qualificand. The meaning of Samsarga, in this context is point of intersection.

Examples and Explanations

- I know a pot. (Ghatamaham jaanaami)
- This is a pot. (Ayam ghatah)
- This is a blue pot. (Ayam nilo ghatah)
- There is pot on the ground. (Bhutale ghato asti.)
- There is no pot on the ground. (Bhutale ghato nasti.)

Example : This is a pot. (Ayam ghatah)

- POT (ghata) signifies the generic character (jati) and its dharma is pot-ness (ghatatva).
- Pot-ness (ghatatva) distinguishes a pot (ghata) from a piece of cloth (pata).
- The relation between pot and pot-ness is a selflinking relation (svarupa sambandha).
- A pot is pot-ness possessing.
- Pot-ness is called avacchedaka of pot (ghata).
- Here, it is saktyaavacchedaka or the limitor of sakyata or sakti (or import) of the term pot (ghata).

This is a blue pot (Ayam nilo ghatah)

- The phrase "blue pot" and the sentence "pot is blue" produce same jnana.
- Here pot-ness (ghatatva) and blue-ness (nilatva) are two qualifiers for the qualificandum "the pot".

There is pot on the ground. (Bhutale ghato asti.)

- Pot-possessing-ness is a property of the ground. Pot-ness is the property of the pot.
- Pot is aadhara and potness is aadheya in this relation.
- In this relation pot is called Anuyogin (subjunct, predecessor) and potness is called Pratiyogin (adjunct, successor).
- Ground is "pot-possessing" (Ghatavad bhutalam).

Property Possessing Qualifiers

- Ground has pot-possessing-ness.
- The question that arises is "Is x possessing-ness = x?"

- (Compare : The mango is sweet. The mango is sweetness possessing. There is sweetness possessing-ness in mango. There is sweetness in the mango.) (Tadvattvam Tadeva)

- on (pot, ground) (Predicate logic representation)

- xRy, where x = pot, y = ground and R is the relation signifying Contact (Samyoga)

There is pot on the ground. (Bhutale ghato asti.)

- No knowledge that finds linguistic expression can go without a qualifier (prakaarata).

- The qualifier may be or implicit. In "ghatavad bhutalam", one of the qualifiers is the pot (ghata) is mentioned, and the other, pot-ness, (ghatatva) is not mentioned.

- The NN analysis considers the human reflective introspection concerning perceptual experience (anubhava).

- The floor functions as the primary qualificandum (mukhya-viseshya).

Bhutale ghato asti

- Analysis reveals - A prakaarata attached to potness, a viseshyata attached to the pot, a prakaarata attached to the pot, a viseshyata attached to the floor, Another viseshyata attached to the floor, and a prakaarata attached to the floor-ness.

- These six components constitute a unity by virtue of two epistemic relations:

- nirupaka-nirupita relation and the avacchedakaavachinna relation.

There is no pot on the ground. (Bhutale ghato nasti.)

- There is constant absence of one object, pot, with respect to the second object, ground. This is called atyanta-abhava.

- The knowledge that is contradicted "association of pot with the ground" is called pratibadhya and the contradictory knowledge "the constant absence of the pot in the same ground" is called pratibaadhaka.

Bhutale ghato nasti

- The relation between the place where something

is absent and the absence, denoted by (ground) R (absence of pot).

- This relation is called absential-qualification (abhaaviya-viseshanata).

- This relation relates a positive entity (viz. the ground that is present) with an absence.

- This may be represented as - There is absence of pot. Ghataabhava asti.

There is no pot on the ground. (Bhutale ghato nasti.)

- In this (absence), the pot is called counter-positive (Pratiyogi), with the property pratiyogita located in the pot.

- Pratiyogita qualified by pratiyogitatva is a relation between ghata (pot) and ghata-abhava (absence of pot).

- The absence is an accepted object (klupta padaratha) and

- pratiyogitatva is an indivisible property (akhandopadhi) located in all pratiyogitas.

Bhutale ghato nasti

- Mutually interrelated objects are called either nirupita (determined, described) or nirupaka (determiner, describer).

- In case of negative judgment , the pratiyogita (counter-positive-ness) residing in the ghata is determined (nirupita) by the absence (abhava) of the ghata.

- Conversely, the abhaava is the nirupaka (determiner) of the pratiyogita. The absence-ness (abhaavatva) is the limitor of the nirupakata existing in the abhaava.

Bhutale ghato nasti. NN description

- ghatatva-visista-abhava ghata-abhava vaisistyam cha sva-avachinna-pratiyogikatva-sambandhena

- or, sva-nisthata-avacchedaka-nirupita pratiyogitanirupakatva- sambandhena

Relation and Inference

- Standard example for inference

- Wherever there is smoke, there is fire.

- There is smoke on the yonder hill.
- Therefore, there is fire there.
- Indian logic schema - Predicate calculus version
- The hill is fiery (fire possessing).
- Because it is smoky (smoke-possessing) (or because of smoke), For example, the kitchen hearth.

Inference (Continued)

- If P denotes the paksha or 'ground' of the inference, the hill, 'h' the hetu or reason property, and 's' the sadhya or 'to be inferred' property, then the schema is now represented as:
- A (h, p)
- s pervades h
- Therefore, A(s, p).
- In the relational context, abstractions such as pakshata, hetuta and sadhyata arise. Pakshata lead to paksha-dharmata (e.g. dhumasya, because of smoke)

Inference (Continued)

- The Indian schema depends on two relations, one between properties and locations, the other between properties and properties. In the Aristotelian syllogism a relation of 'belongs to' relates classes (as in 'mortality belongs to all men').
- "One property, by virtue of its logical relation with another property, forces the substitution of the latter in its place" (Matilal)
- p has h pervaded-by-s.
- Therefore, p has s.

What is AI?

- AI studies computer simulation of intelligent processes such as learning, reasoning, and understanding symbolic information in context.
- AI models aspects of human thought on computers through symbolic knowledge representation, for making inferences.

Five Limbed Syllogism in Indian Logic

- Hypothesis (Assertion) (Pratijna) (The hill has fire.)

- Reason (Hetu) (Because it has smoke)
- Example or analogy (Udaharana) (Wherever there is smoke, there is fire, e.g. a hearth in a kitchen.)
- Application (Upanaya) (The example applies to the present situation.)
- Conclusion (Nigamana) (Therefore, conclude: The hill has fire.)

Pancha-avayava Nyaya-Vakya

- Parvato vahniman iti pratijna
- Dhumavatvat iti hetuh
- Yo yo dhumavan sa vahniman yatha mahanasa
- Iti udaharanam
- Tatha cha ayamiti upanayah
- Tasmattatheti nigamanam

Aristotelian Syllogism

- Aristotle (384-322 B. C.) defined syllogistic logic. Every syllogism is a sequence of three propositions such that the first two imply the third, the conclusion.
- There are three basic types: hypothetical, disjunctive, and categorical.
- (A) The hypothetical syllogism, modus ponens,
- If p then q; p, Therefore q.
- (B) The disjunctive syllogism, modus tollens
- Either p or q; not q, Therefore p.

Aristotelean Syllogism

- (C) The categorical syllogism comprises three statements of the form
- All x are y; No x is y; Some x is y, or Some x is not y.
- All philosophers (minor term) are men (middle term);
- All men are mortal;• Therefore, All philosophers are mortal (major term).
- Aristotle noted five basic rules governing the validity of categorical syllogism

Intelligent Systems

- Smart devices designed using AI, cognitive science, computational neuroscience, CAD, control theory, economics, expert systems, image understanding, knowledge engineering, machine learning, mechatronics and bionics, modeling, philosophy, real-time computing, simulation, vision, and visualization

- These perceive, reason, plan, act, learn and and perform tasks autonomously and support humans at such tasks becoming our intelligent partners, perceiving our needs, and learning our habits in our homes, offices, and factories..

Uncertainty in AI - The Three Prisoner's Paradox

- A, B, C, are tried for murder and are in jail.

- The judgement identified one of them as murderer, who will be hanged to death the next day and the other two will be acquitted.

- Only the reliable jail warden knows the verdict.

- At night, A calls the warden and gives a letter to him with a request that the letter be given to one of the other two who will be released the next day.

- After a while, A asks the warden "Please tell me to whom you have handed my letter." The warden says that he gave the letter to B.

Uncertainty in AI - The Three Prisoner's Paradox

- A has a new worry. He says "Prior to talking with the warden, I thought that the probability that I will be declared guilty and hanged is 1/3.

- The a posteriori probability has increased to 1/2 as now I know that B will be released tomorrow."

The Three Prisoner Paradox

- Let GA, GB and GC be the propositions A, B and C will be declared guilty

- Let IA, IB and IC be the propositions A, B and C will be declared innocent.

- Assume $P(GA) = P(GB) = P(GC) = 1/3$.

- By Bayes Theorem, when A receives the information "B judged innocent"

- $P(GA|IB) = \{P(IB|GA)P(GA)\} / \{P(IB|GA)P(GA) + P(IB|GB)P(GB) + P(IB|GC)P(GC)\} =$

- $1. (1/3) /[1. (1/3) + 0. (1/3) + 1. (1/3)] = 1/2$

The Three Prisoner Paradox

- The message that Warden gave A was not "B will be declared innocent" (IB) but "The letter was given to B".

- Let this proposition be LB.

- $P(GA|LB) =$

- $\{P(LB|GA)P(GA)\} / \{P(LB|GA)P(GA) + P(LB|GB)P(GB) + P(LB|GC)P(GC)\} = \{ (1/2). (1/3)\} /[(1/2). (1/3) + 0. (1/3) + 1. (1/3)] =(1/6)/(3/6) = 1/3.$

- What is the correct calculation?

The Three Prisoner Paradox : Nyaya view

- Samsaya is an essential category of Nyaya. Doubt (samsaya) is often the precursor of knowledge. Acquisition of jnana is initiated by doubt and sustained by inquiry (paramarsa).

- The Jnana of A at t1 is the three uncertain scenarios - (GA, IB, IC), (IA, GB, IC) or (IA, IB, GC)

- But the scenarios of real concern to A are: (GA, IB, IC), and (IA, GB or GC)

- At t2 the Jnana-base is added with prama (through sabda-pramana) LB.

Nyaya view

- At t3 paramarsa of A leads to prama IB through anumana.

- At t4 the Jnana-base of A is the two uncertain scenarios (GA,IC) and (IA,GC).

- The Samsaya regarding himself and C unaffected by prama regarding B. The judgement of the judge was given prior to t1.

- Compare with the well known rajju-sarpa bhranti (the rope-snake illusion), modified to ropenonpoisonous snake-poisonous snake case. Comparison with Western Logic

- A fallacy and comparison of the Greek and

Indian logic systems [E. Rich, Artificial Intelligence, (1983) (Q.11 Chapter 6)]

- What is wrong with the following argument in set 1?

- Set 1: Men are widely distributed over the earth, Socrates is a man. Therefore, Socrates is widely distributed over the earth.

Example: Continued

- The syntax of set 1 appears analogous to that of Aristotelian Syllogism (Set 2)

- Men are mortal.

- Socrates is a man.

- Therefore, Socrates is mortal.

- Plausible representations of sets 1 & 2

- " x man (x) ® widely-distributed-on-earth (x)

- " x man (x) ® mortal (x).

Example: continued

- An English speaker, understands as - Mankind is widely distributed over the earth not each individual man. In Greek logic, one has to take recourse to semantics to explain this fallacy. AI program fails.

- The Indian syllogism has no assumed universal affirmatives. The first sentence there has to be obtained as an inductive generalization or inference based on examples such as "Aristotle is widely distributed on earth", "So is Plato" etc. to validate and state the universal in this form.

Class and Object

- You see a chair-1. It is a piece of furniture, made of Teak wood, with hand rests, four legs, with a back, a seat for one and has owner X and has a price tag of 1000 rupees.

- You see another chair-2, made of steel, with a price tag of rupees 500, without hand rests, with a bent steel tube, which makes it stand, painted gray, has owner Y and with a back rest.

- These are objects.

- The generic chair is a class.

Class and Object

- You may learn by induction after seeing several chairs, the properties of a generic chair as

- "A chair is a piece of furniture with a seat for one and has a backrest."

- The generalization is identifying general features (samanya lakshana) from (svalakshana).

- What one observes every time is only an individual chair and a generic chair is only an abstraction of the reality. NN (Navina Nyaya) calls this property the "chairness" of a CLASS called chair.

Induction

- All knowledge is empirical. It is generated by Pramana. Mathematical concepts do not reveal knowledge. They produce only (vikalpa or aharya). Knowledge is dependent on something obtained from outside (artha, semantics). This makes it fallible - doubt (samsaya), exceptions (vyabhichara) and temporal contradictions (badha) arise.

- Pramana itself may be svatah or paratah.

- How does one arrive at a universal proposition? - Vyaptigrahopaya.

- Upadhi (associate condition) plays an important role.

How to gain knowledge regarding the prameya?

- (Or How to write your thesis?)

- Definite knowledge (tattva) established by means of six elements.

- Introduction (upakrama) and Conclusion (upasamhara) taken together (for checking consistency between them).

- Repetition (abhyaasa), uniqueness (apurvata), purpose (phala), topicality (arthavada) and additional proof (upapatti).

Applications of NN to AI

- Semantic Web - Intelligent Search

- Natural Language Processing - Summarization tools

- Relational Databases - Intelligent query answering

- Cognitive Science - Mind models, Consciousness studies

- Knowledge-Based Systems - Improved KR tools

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