Adaptability of Pāṇini's System of Grammar and Computational Linguistics

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Abstract: The significance of technical terms and technical devices used in Pāṇini's system of Grammar and its development into further fields of study is the subject matter. The system of Grammar along with the style, language, and logic is analyzed to understand the linguistic peculiarities and its influence on post-pāṇiniyan studies. The method of theorizing the rules of human language and its concordance with that of a programming language is also taken into consideration.
Keywords: Pāṇini's system of Grammar, organization of Pāṇinīyam, computing technique of Aṣṭādhyāyī, codification of Aṣṭādhyāyī, language machine

Introduction

Pāṇini's system or Pāṇinīyam being the vedāṅga-vyākaraṇa, equips one to understand the chandas[1] and the bhāṣā[2] simultaneously. Besides Aṣṭādhyāyī, Pāṇini's system encompasses an accessory group of texts like Dhātupāṭha, Uṇādipāṭha, Liṅgānuśāsana and Phiṭsūtra along with Vārtika of Kātyāyana and Bhāṣya of Patañjali. All these together constitute śabdānuśāsanam, the norms that validate the language. Language being a social dynamic reality, these norms is the result of a theoretical research that aims at the refinement of a language system. From the inventory of letters to the coding of morphology, and to the semiotics it maintains uniqueness in organizing the database. As this system could generate thousands of words and sentences it qualifies all that is needed for a programing language. This outstanding work of recoding the science of Sanskrit language was done in an age when there was hardly any computing machine. An understanding of its method and methodology is vital for the proper understanding of the linguistic model of both Vedic and Classical Sanskrit. The attempt here is to analyze the techniques and technicality of Pāṇinīyam that is equally prescriptive and descriptive in framing the rules of language.

The organization of Pāṇinīyam

In Pāṇinīyam, the rules are coded in a compressed style called sūtra or aphorism. They are the statement of procedures distilled in the least words possible and have been woven together to perceive a particular knowledge system. It is the mode of expressing the essence in a most subtle manner for brevity. Though the sūtras are compact and countable, the resultant formations are innumerable. In this style, the database of Pāṇinīyam is organized in concordance with the phonology, morphology, semantics and pragmatics of Sanskrit. It is comprehensive enough to understand language from a multidimensional perspective. The structure, the function, and the philosophy of language are taken into consideration while formulating standards that are concise and at the same time precise. The configuration of data itself has a pivotal role in the execution of the coded rules. The rules of Aṣṭādhyāyī sūtrapāṭha, the major text of Pāṇinīyam are aligned in various prakaraṇa-s. As the name suggests it is divided into eight chapters, each with four pādas and each pāda with many sūtra-s (total of 3976[3]). According to the nature of its application sutra-s can be categorized in the following manner:

Saṃjñā – rules which assign a particular term to a given entity that can be sorted as śabdasaṃjñā, arthasaṃjñā and dharmasaṃjñā like vṛddhi[4], vibhāṣā[5] and udātta[6] respectively. 84 sūtra-s in Aṣṭādhyāyī could be enumerated as saṃjñāsūtra. This again can be categorized as ekadeśi saṃjñā (contextual) like samāsa and karaka, sārvabhaumikasaṃjñā (holistic) like pada and saṃhitā. The former belongs to a particular set of rules and the latter functions in the whole science. With this kind of technical terms and sorting techniques, an account of linguistic processes is widely opened.

Paribhāṣā – rules to regulate proper interpretation and application. They are meta-rules that don't have direct applications but provide a check on the operational rules. It ensures the proper application devoid of avyāpti, ativyāpti and abhāva. For example, vipratiṣedhe paraṃ kāryam[7], i.e. when two rules are equally applicable the one that is later in order should be applied. *aniyame niyamakariṇi paribhāṣā*. Patañjali also explains that without these kind of sūtra many of the vidhisūtra would be meaningless, as in the world. *itarathā hyasaṃpratyayo yathā loke[8]* .

Vidhi – rules which state a given operation to be performed on a given input. These form the core of grammar. All other rules assist the operational rules.

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[1] synonym for Veda

[2] bhāṣyate śāstravyavahārādinā prayujyate (Śabdakalpadrumam)

[3] Siddhāntakaumudī of Bhaṭṭojidīkṣita

[4] vṛddhirādaic

[5] na veti vibhāṣā

[6] uccairudāttaḥ

[7] Aṣṭādhyāyī 1.4.2

[8] MB 1.37.25 on A 1.1.1

Niyama – restriction rules: rules which restrict the scope of a given rule. When multiple options are present, their curbing may be essential. patiḥ samāsa eva[9] declares that the word pati will be termed 'ghi' only if it is used in a compound and not independently.

Atideśa – rules which expand the scope of a given rule; transference of properties is allowed which may not be possible otherwise, loṭo laṅvat[10]

Adhikāra - rules which introduce a domain of rules sharing a common operation. For instance, prākkaḍārātsamāsaḥ[11] states "all the terms that describe from this point up to the sūtra kaḍarāḥ karmadhāraye[12] will get the designation of samāsa. The validity of adhikāra sūtras extends over many sūtras. These are marked with a svarita tone so that one might know which sūtra has extended influence. They can be treated as super-vidhi sutras.

The sophistication of the structure of the Pāṇinīyam is preserved with the aid of certain techniques that are extraordinary. The language of composition that is referred to as meta-language is so ideal in dividing a language into components and rules governing how the components interact with each other. While formulating the rules the Pāṇinīyam bears the following techniques:

Akṣarasamāmnāya is the orderly arrangement of phonemes with special markers called it (इत्) with fourteen sutras. Markers have significant role in phonological operations. There are nine vowels (five monothongs & four diphthongs), four semi-vowels, twenty five class consonants and four sibilants. It is the phoneme catalogue along with its phonetic properties like mātrā, accent and nasality. Two ayogavaha-s[13], two jihvāmūlīya-s and two upadhmānīya-s are also part of phonetics. By the very grouping, all the possible permutations and combinations of similarities amongst the letters of the alphabet are encoded. The whole of Aṣṭādhyāyī rests on akṣarasamāmnāya. *so:'yamakṣarasamāmnāyo vāksamāmnāyaḥ puṣpitaḥ phalitaścandratārakavat pratimaṇḍito veditavyo brahmarāśiḥ/ sarvavedapuṇyaphalāvāptiścāsya jñāne bhavati*[14].

Pratyāhāra are notational abbreviations formed by combining the first and last letters of the portion of text being referred to. With the segmentation or technique of the pratyāhāra, the letters अल्[15] represents the whole alphabet of Sanskrit language along with its properties as a segment. Addition, elision and replacement of phonemes, compounding of words and amalgamation of affixes are the major operations carried out in the process of refinement of language with the aid of pratyāhāra.

Asiddha is the technique of invalidity to block selected applications. It is the technique of exposition based on the arrangement of data. The saṃvṛta nature of *a* is maintained using this technique[16]. pūrvatrāsiddham[17] states that the later sūtras be treated as non-existent. Thus, in the first seven chapters and a quarter (referred to as sapādi), the sūtras are applied progressively, one after the other to a given situation; in the last three quarters (the tripādi) the same arrangement continues, but with the sūtras in the final three quarters are treated as non-existent with respect to the previous.

Utsarga- apavāda is where a method has been devised to include a range of formations with a single effort that can be termed as utsarga but at the same time need to discard certain formations with similar conditions. Utsarga means general statement and apavāda means exceptional statement. Such formations could be validated through exceptional statements called apavāda. ādguṇaḥ[18] vṛddhireci[19] is an example. Similar scope of application is for the nityānitya and antaraṅgabahiraṅga method, where nitya and antaraṅga dominate.

Adhyāhāra is for the sake of intended interpretation. The words though not mentioned in rules are taken either from the rules that occur immediately before or after and also by skipping the continuity of rules. halantyam[20] completes the sense with the word upadeśe and it, which are picked from upadese:'ajanunāsika it[21].This approach is to arrest unnecessary repetition of padas in sūtras if their mention occurs in preceding or successive sūtra-s. Adhikāra-sūtra-s carries out their intended functions similarly. The omission of verbs in sūtra completes the meaning in this manner. The presence of implicit words is termed anuvṛtti, and the process that marks it is adhyāhāra.

Pratiṣedha are negation rules which counter an otherwise positive provision of a given rule. There are two kinds of negations namely prasajya-pratiṣedha and paryudāsa.

Vibhāsā, are optional rules, and it is of three types namely prāpta, aprāpta and prāptāprāpta.

Nipāta are rules which provide forms to be treated as derived, even though without derivational details. They are to accomplish three goals: aprāptiprāpaṇa, prāptivāraṇa and adhikārthavivakṣā.

Vipratiṣedha is the state where only successive rules will function in comparison to the preceding if two rules have an equal chance to operate. The sequence is known as vipratiṣedha i.e. opposition of rules of equal force. In the example *dhanuṣā vidhyati*, there both the karaṇasaṃjñā and the apādānasaṃjñā equally find the scope of action. The apādānasaṃjñā being the latter prevail

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[9] Aṣṭādhyāyī 1.4.8

[10] Aṣṭādhyāyī 3.4.85

[11] Aṣṭādhyāyī 2.1.3

[12] Aṣṭādhyāyī 2.2.38

[13] anusvāravisargau

[14] Mahabhāṣya āhnika. 2

[15] aiuṇ, ṛḷk,eoṅ, aiauc, hayavaraṭ, laṇ, ñamaṅaṇanam, jhabhañ, ghaḍhadhaṣ, jabagaḍadaś, khaphachaṭhathacaṭatav, kapay, śaṣasar,hal

[16] Aṣṭādhyāyī 8.4.68

[17] Aṣṭādhyāyī 8.2.1

[18] Aṣṭādhyāyī 6.1.87

[19] Aṣṭādhyāyī 6.1.88

[20] Aṣṭādhyāyī 1.3.3

[21] Aṣṭādhyāyī 1.3.2

and the pañcamī vibhakti is chosen. Nitya, para, antaraṅga and bahiraṅga are also some of the strategies employed to the functions of rules evading conflicts.

Grouping of suffixes as kṛdanta are words ending with kṛt pratyaya. Dhātoḥ[22] (tiṅ varjita pratyayāḥ kṛt syāt) formulates another noun from a noun by adding the suffix to denote a special meaning. Taddhitāḥ [23] is the rule that enumerates taddhita suffixes. Uṇādi suffixes along with the sutra, uṇādayo bahulam[24] gives much freedom to analyze words that are otherwise difficult to dissect into roots and suffixes. saṃjñā pramāṇatvāt[25], pṛṣodarādīni[26] are to give attestation to words used by common folks that do not hold root-suffix rules. This kind of liberty sanctioned in this system is approved by Patañjali thus- pāṇinīyaṃ mahatsuvidhitam.[27]

Besides Aṣṭādhyāyī, the Pāṇinīyam has the Dhātupāṭha, the Gaṇapāṭha, the Uṇādisūtra, the Phiṭasūtra and the Liṅgānuśāsana as associated works for the applications of sūtra-s of Pāṇini. The Dhātupāṭha is the listing system of dhātu-s along with their meaning. The roots are grouped by the form of their stems like bhū-ad-juhoti-div-su-tud-rudh-tan-krī and cur. The Gaṇapāṭha consists of groups of similar words, to which certain rules of grammar apply identically with the listing of verbal prefixes, etc.The Uṇādisūtras serve to supply the affixes and rules required to derive the irregular words that are otherwise difficult to examine the etymology. The Phiṭsūtras deal with the accents in the nominal stem. The rules on accent presuppose knowledge of accent in nominal bases and so the phiṭ sūtras are essential to complete the rule-system governing accents. The liṅgānuśāsanam gives the rules for gender of words. The genders are classified as feminine, masculine, neuter, feminine-masculine and variable, and also nominal which can be used in all three genders.

Encyclopaedia Britannica acknowledged the significance of Pāṇinīyam thus:

> "The construction of sentences, compound nouns, and the like, is explained through ordered rules operating on underlined structures in a manner strikingly similar, in part, to modes of contemporary theory. As might be imagined, this perceptive Indian grammatical work has held great fascination for twentieth-century theoretical linguistics."[28]

An extensive discussion of Panini's rules of 500 BCE is contained in the Vārttikas of Kātyāyana of 300 BCE that are known only as references in Patanjali's Mahābhāṣya of 200 BCE. Both discuss the validity of various rules, their formulation and their relation to other rules. Both thoughts throw light on various aspects of language. Pāṇini formulates the rules of three characteristics viz. sāmānya, viśeṣa and śeṣa. Patañjali too attests that the basic purpose of Grammar is to govern the words in a language by framing the rules as sāmānya, viśeṣa and śeṣa. The sūtra-s of Pāṇini, as a linguistic science, attained a palpable form with the Mahabhāṣya of Patañjali. The principles of Grammar got elaborated thus providing a source for knowing the cultural, geographical, and historical India. From Kāśikāvṛtti of Jayaditya and Vāmana to Vaiyākaraṇasiddhāntakaumudī of Bhaṭṭojidīkṣita, there is a continuous study of the sūtra-s of Pāṇini with different approaches. Pāṇiniyam also needs a back-and-forth reading in a critical way that alone could gain a true understanding of this system and the framework that supports it. Pānini counts common usages along with strict derivations. It is to formulate rules having a well-defined scope of application, so that they can capture usage in its reality. This could be one of the innovative features of the work and still a field of study for the linguists of East and West alike. Also, it enhances the potential of Sanskrit as a language for scientific study as well as the language for scientific coding. The mode of framing rules, the meta-language applied and the conflict-evading techniques are quite adaptable in the fields like Computational linguistics. Information theory that deals with the compression of information and Information Dynamics that deals with better designing of information too have enough to extract from the Pāṇinīyan approach.

Conclusion

The Pāṇinīya system of Grammar and its tradition of linguistic scholarship is one of the most comprehensive sciences of Grammar ever developed. It is the codification of language in a highly sophisticated manner using a set of rules to understand the nature of Sanskrit language in its granular form. The methodical aspect of the Pāṇinīya system of Grammar is comparable to a mathematical model that competes with the logical structure of any computing device. The database of this system consists of the definition that mentions characteristics of the fundamental components of a language, the rules that postulates the grammatical operations and the meta rules that are additional attributes precisely designed for the rules of grammar. Thus it has its own vocabulary and syntax that gives a clear understanding of the algorithm for language processing. Understanding of Pāṇinīya system, hence is absolutely essential in order to identify the constituents of a sentence for its application in the area of Natural Language Processing and Sanskrit Computational Linguistics and also to build the parse for other modern languages of the same family.

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[22] Aṣṭādhyāyī 3.1.91

[23] Aṣṭādhyāyī 4.1.76

[24] Aṣṭādhyāyī 3.3.1

[25] Aṣṭādhyāyī 1.2.53

[26] Aṣṭādhyāyī 6.3.109

[27] Mahabhāṣya 3.2.3

[28] *Encyclopaedia Britannica*, Vol.23,p.50, under the head"History of Linguistics".

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