Disambiguation of Instrumental, Dative and Ablative Case suffixes in Sanskrit

Malay Maity, Sanjeev Panchal and Amba Kulkarni
{malayoham,snjvpnchl}@gmail.com, ambapradeep@gmail.com
Department of Sanskrit Studies,
University of Hyderabad

Abstract

Ambiguity is an integral part of any natural language. There are only seven different case markers in Sanskrit that encode both *kāraka* as well non-*kāraka* relations. This introduces an ambiguity at the level of case markers leading to a structural level ambiguity. Two most frequent relations expressed by the ablative case suffix are *apādāna* and *hetu*, by the dative case suffix are *sampradāna* and *prayojana*, and by the instrumental case suffix are *karaṇa* and *hetu*. The first among these pairs is a *kāraka* relation and the second one a non-*kāraka* relation. It is the *yogyatā* between the word meanings that plays an important role in the deciphering of these relations. In this paper we illustrate how by using minimum ontological information such as *dravya* and *guṇavacana*, we can get the correct solution in almost 80% of the cases.

1 Introduction

Ambiguity is an integral part of any natural language. A speaker while expressing his thoughts through language always encounters a tension between precision and brevity. The precision in linguistic expressions brings in clarity. But the natural tendency of a human being is to go for brevity. For example, look at the sentence

Skt: Rāmaḥ Śyāmāya pustakaṃ krīṇāti. (1)
Gloss: Rāma{m, sg, nom} Śyāma{m, sg, dat} book{n, sg, acc} purchase{pr, sg, 3p}
Eng: Rāma purchases a book for Syāma.

On the face of it, we will not find any difficulty in understanding it. But if we try to analyse it deciding the relations between various words, we notice that the word *Śyāmāya* is not directly related to the verb *kṛ* by any *kāraka* relation, nor it is related to any other word in the sentence by any direct relation. A grammarian would relate *Śyāma* to the action of *kṛ* by the relation of *prayojana* (purpose). But to be precise, it is not *Śyāma* but 'giving a book to Śyāma' is the purpose. Sentence (2) provides the precise expression providing this meaning literally.

Skt: Rāmaḥ Śyāmāya dātuṃ pustakaṃ krīṇāti. (2)
Gloss: Rāma{m, sg, nom} Śyāma{m, sg, dat} give{infinitive} book{n, sg, acc} purchase{pr, sg, 3p}
Eng: Rāma purchased a book for giving it to Śyāma.

In this sentence *Śyāma* is the *sampradāna* (beneficiary) for the action of giving (*dā*). Though the relations are different in both the sentences, they are expressed by the same dative case marker, making the dative case marker ambiguous.

The second reason for ambiguity is the lexical overloading. The conceptual space is a continuum while the words are the discrete representation of these concepts. This leads to the overloading

sentence

Skt: Devadattaḥ odanaṃ pacati. (3)
Gloss: Devadatta{m, sg, nom} rice{n, sg, acc} cook{pr, sg, 3p}
Eng: Devadatta cooks rice.

the *vyāpāra* (activity) referred to by *pacati* is described as

adhiśrayaṇodakāsecanataṇḍulāvapanaidho'pakarṣaṇakriyāḥ (ma. bhā. 1.4.23. vā 8)
[an activity of putting a vessel on the stove, pouring water in it, adding rice, supplying fuel etc. and this activity refers to the activity of the *pradhāna kartṛ* (the chief doer of the activity).]

In the sentence
Skt: *sthālī pacati.* (4)
Gloss: vessel {f, sg, nom} cook{pr, sg, 3p}
Eng: A vessel cooks.

the activity is that of *dhāraṇa* (holding) (ma. bhā. 1.4.23.vā 9).

Finally, in the case of
Skt: edhāḥ pakṣyanti. (5)
Gloss: Wood{n, pl, nom} cook{fut, pl, 3p}
Eng: Wood will cook.

the activity is that of *jvalanakriyā* (to provide fire). (ma. bhā. 1.4.23.vā 10).

We observe that the same word *pacati* is being used to refer to different activities. Similarly the *prātipadika*s are also overloaded. These ambiguities in the meanings of the verbal roots and the nominal stems may be due to either homonymy or polysemy.

The third source of ambiguity is the linear representation of the underlying dependency or the constituency tree structure. When a two dimensional tree structure is flattened to a linear structure, loss of information is natural. The stock example of structural level ambiguity in a positional language like English is

He saw a man on the hill with a telescope. (6)

The ambiguity in this sentence is due to multiple possibilities of the attachment of the prepositional phrase 'with a telescope' to
- 'saw', where a telescope is an instrument,
- 'the hill', where a telescope is installed on the hill, and
- 'a man', where he is carrying a telescope.

Here we see that the ambiguity is essentially due to the overloading of the preposition to mark a relation of a noun phrase 'a telescope' with the verb ('saw') as well as another noun phrase ('a man' or 'the hill') and the flexibility of placement of the prepositional phrase not necessarily adjacent to the noun with which it is connected to.

Here is an example from Sanskrit which has a structural ambiguity.

Skt: Rāmaḥ kadaliphalaṃ chittvā khādantaṃ vānaraṃ paśyati. (7)
Gloss: Rāma{m, sg, nom} banana{n, sg, acc} after_peeling eating{m, sg, acc} monkey{m, sg,

acc} see{pr, sg, 3p}.
Eng: Rāma sees a monkey peeling a banana and eating it / Rāma, while peeling a banana, sees a monkey who is eating.

The ambiguity is related to the doer of the activity of peeling a banana. The *sūtra samā-nakartṛkayoḥ pūrvakāle* (3.4.21) says that if the two activities have the same *kartṛ* and one activity precedes another activity then the *kṛt* suffix *ktvā* is used with the verb that denotes the preceding activity. Now in this sentence, there are three activities viz. peeling, eating and seeing. And the verb *chittvā* 'peeling' is the preceding activity. If this peeling activity precedes the eating activity, then the monkey, who is the *kartṛ* of the eating activity, would also be the *kartṛ* of activity of peeling. If the eating activity precedes the activity of seeing, then the *kartṛ* of the peeling would be Rāma, the *kartṛ* of the activity of seeing.

Thus brevity and linear representation lead to an overloading at the lexical as well as structural level. In the process of interpretation, a reader or a listener uses various clues both linguistic as well as extra-linguistic to decipher such ambiguities. The mutual meaning compatibility between the words/components involved often helps resolve such ambiguities. In this paper we focus on the ambiguities due to the case markers, and suggest a method for automatic disambiguation of such cases.

In the next section, we look at the overloading of case markers in Sanskrit. This is followed by a discussion on the clues from the theories of *śābdabodha* for disambiguation. In the fourth section we look at the Pāṇinian *sūtra*s which provide various semantic and/or syntactic conditions for the assignment of instrumental, dative and ablative case suffixes to the nouns. In the fifth section we show how the minimum ontological property of *dravya* and *guṇavacana* help in pruning out the wrong solutions. Finally we provide the results of evaluation and conclude with the observations.

2   Overloading of case markers

There are only seven different case markers that encode both *kāraka* as well non-*kāraka* relations. A list of various semantic relations between the words in a sentence was compiled by Ramakrishnamacaryulu (2009). This list contains a little over hundred relations. This list was further shortened by Kulkarni and Ramakrishnamacharyulu (2013) from the computational point of view by removing certain fine-grain distinctions of some *kāraka* relations such as *anubhavakartṛ, karmakartṛ, karaṇakartṛ* and so on. The main reason for removing these fine-grained relations is that in order to mark these relations, one needs an extra linguistic information. For example, in the sentence *kāṣṭhāni pacanti* 'the wood cook', to mark *kāṣṭha* as a *karaṇakartṛ*, one needs to know that it can be used as an instrument. This list of relations was later extended by adding semantic relations encoded by the *upapada*s (Madhusoodan, 2020; Panchal, 2020; Kulkarni, 2019 20), in the course of developing a parser and generator for Sanskrit. The list currently being in use is given in Appendix A, and has 56 relations.

Table 1 lists all the relations from this list, between a noun and a verb, and between two nouns extracted from the Appendix A, which take either the instrumental, dative or an ablative case marker.

From this table we note that all the three case markers viz. instrumental, dative and ablative are ambiguous between more than one relation. The instrumental case suffix is ambiguous between the four[1] relations viz *kartṛ, prayojakakartṛ, karaṇa*, and *hetu* (cause/reason). Sentences (9) and (10) illustrate the ambiguity due to the instrumental case.

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[1]The cases of kriyāviśeṣaṇa, apavargasambandhaḥ and aṅgavikāraḥ involve words which more-or-less forms a closed list, and hence are not discussed here.

Relation	Case-marker
kartā	3 (Passive voice)
prayojakakartā	3 (Passive voice)
kriyāviśeṣaṇam	2,3
karaṇam	3
apavargasambandhaḥ	3
aṅgavikāraḥ	3
hetuḥ	3,5
sampradānam	4
prayojanam	4
apādānam	5
vibhaktam	5

Table 1: Ambiguities with case markers

Skt : *pituḥ ājñayā Rāmeṇa hastena phalaṃ khādyate.* (9)
Gloss: Father{m, sg, gen} permission{f, sg, inst} Rāma{m, sg, inst} hand{m, sg, inst} fruit{n, sg, nom} eat{pr, sg, 3p, passive}
Eng: With father's permission a fruit is eaten by Rāma with a hand.

In this sentence, *ājñā* is a *hetuḥ*, *Rāma* is the *kartṛ* and *hasta* is the *karaṇa*. In the case of a sentence in an active voice, the *kartṛ* being in nominative, the ambiguity is only between *karaṇa* and *hetu* as in (10).

Skt : *Daśarathasya ājñayā Rāmaḥ rathena vanaṃ gacchati.* (10)
Gloss: Daśaratha{m, sg, gen} permission{f, sg, inst} Rāma{m, sg, nom} chariot{m, sg, inst} forest{n, sg, acc} go{pr, sg, 3p}
Eng: With Daśaratha's permission Rāma goes to the forest by a chariot.

In the case of dative case, the ambiguity is between *sampradāna*, *prayojana* and *tādarthya*.[2]

Skt : *rājā brāhmaṇāya yāgāya dāru dadāti.* (11)
Gloss: The king{m, sg, nom} brāhmaṇa{m, sg, dat} sacrifice{m, sg, dat} wood{n, sg, acc} give{pr, sg, 3p}
Eng: The king gives a wood to a brāhmaṇa for sacrifice.

Skt : *rājā brāhmaṇāya yūpāya dāru dadāti.* (12)
Gloss: The king{m, sg, nom} brāhmaṇa{m, sg, dat} sacrificial_post{m, sg, dat} wood{n, sg, acc} give{pr, sg, 3p}
Eng: The king gives a wood to brāhmaṇa for (making) a sacrificial post.

In both sentences (11) and (12), *brāhmaṇa* is the *sampradāna*. In sentence (11) *yāgāya* is the *prayojana* for the action expressed by *dadāti* while in sentence (12) *yūpāya* is the *tādarthya* for *dāru*.

In the case of ablative case, the ambiguity is between an *apādāna, hetu* and *vibhakta* as shown in sentences (13) to (15).

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[2]Tādarthya is not included in Table 1 or in Appendix A. The reason for its non-inclusion is discussed in section 4.1.3

Skt : vṛkṣāt parṇaṃ patati.(13)
Gloss: Tree{m, sg, abl} leaf{n, sg, nom} fall{pr, sg, 3p}
Eng: A leaf falls from a tree.

Skt : Rāmāt Śyāmaḥ nipuṇaḥ asti. (14)
Gloss: Rāma{m, sg, abl} Śyāma{m, sg, nom} smarter{m, sg, nom} be{pr, sg, 3p}
Eng: Śyāma is smarter than Rāma.

Skt : dhūmāt vahniḥ bhavati iti tarkaḥ kriyate. (15)
Gloss: smoke{m, sg, abl} fire{m, sg, nom} be{pr, sg, 3p} argue{m, sg, nom} do{pr, sg, 3p}
Eng: It is argued that the smoke causes fire.

In addition, in each of the cases, the adjective of these *kārakā*s show concord with their head, and hence will have the same vibhakti. For example

Skt : vīreṇa Rāmeṇa tīkṣṇena bāṇena Vāliḥ hanyate. (16)
Gloss: Brave{m, sg, inst} Rāma{m, sg, inst} sharp{m, sg, ins} arrow{m, sg, ins} Vāli{m, sg, nom} kill{pr, sg, 3p, passive}
Eng: Vāli was killed by the brave Rāma by a sharp arrow.

Here the words *vīreṇa* and *tīkṣṇena* are the adjectives of *Rāmeṇa* and *bāṇena* respectively.

3 Handling ambiguity

The multiple choices exist both at the stage of generation as well as at the stage of analysis. During the generation process, the speaker based on his intention chooses an appropriate alternative among the multiple choices available. At the time of analysis, since the speaker's intention is not known to the listener, and due to the reasons mentioned earlier that result in ambiguous linguistic expressions, listener has an extra task of choosing the correct analysis among all possible analyses. The Indian theories of *śābdabodha* discuss three different factors viz. *ākāṅkṣā*, *yogyatā* and *sannidhi* to understand any text.[3] These factors help in resolving the ambiguity. *Ākāṅkṣā* helps in correctly identifying the relations between words following the Pāṇinian grammar and the usage (*loka-vyavahāra*). *Sannidhi* puts restrictions on the sentential structure. *Yogyatā* provides the semantic constraints on the establishment of relations between the words. While *ākāṅkṣā* provides a necessary condition for establishing a relation, *yogyatā* and *sannidhi* provide the sufficient conditions.

4 *Ākāṅkṣā*: necessary condition

In what follows now we look at the clues from the *Aṣṭādhyāyī* as the necessary condition for establishing the possible relations with ablative, dative and instrumental case markers.

4.1 Ablative Case Marker

In *Aṣṭādhyāyī*, *Pāṇini* has given nine different rules for designating *apādāna*. He starts with the rule

Dhruvamapāye apādānam (1.4.24)
[the fixed point in relation to moving away is called *apādānam.*][4]

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[3]Earlier these were discussed by Kumarilabhatta in `Tantravārtikam`. Later on, these were also discussed by Grammarian and Logician.
[4]The English translations are borrowed from (Joshi and Roodbergen, 1975)

For example:

Skt: saḥ grāmāt āgacchati.(17)
Gloss: He{m, sg, nom} village{m, sg, abl} come{pr, sg, 3p}
Eng: He comes from village.

Here the *grāma*(village) is the fixed point with respect to moving away. So, it gets *apādāna* designation. This rule tells us the verbs which have an activity related to movement have an expectancy of *apādāna kāraka*. Pāṇini further lists several cases along with some specific verbs to define *apādāna*. These *sūtras* are provided in the *Aṣṭādhyāyī* from 1.4.25 to 1.4.31. They are as follow:

Bhītrārthānāṃ bhayahetuḥ - 1.4.25
[With having the meaning of *bhī* "fearing" or *trā* "protecting" the term which causes fear is called *apādānam.*]

Parājerasoḍhaḥ - 1.4.26
[With the verbal base *parā- ji* "to be overcome" the item which one cannot endure is called *apādānam*]

Vāraṇārthānām īpsitaḥ - 1.4.27
[With the verbal bases having the meaning of *vāraṇa* "warding off" the item desired to be reached is called *apādāna*, when it becomes instrumental in bringing about the action.]

Antarddhau yenādarśanamicchati - 1.4.28
[The person by whom one wishes not to be seen through the use of something which comes in between in called *apādāna*, when it becomes instrumental in bringing about the action.]

Ākhyātopayoge - 1.4.29
[The person who relates is called *apādāna*, when it becomes instrumental in bringing about the action provided that what he relates is useful.]

Janikartuḥ prakṛtiḥ - 1.4.30
[The material origin of the agent of the action denoted by the verbal base *jñā -* "to originate from" is called *apādāna*, when it becomes instrumental in bringing about the action.]

Bhuvaḥ prabhavaḥ - 1.4.31
[The source of the agent of the action denoted by the verbal base *bhū -* "to become" is called *apādāna*, when it becomes instrumental in bringing about the action.]

In this way, Pāṇini provides either a list of verbs or specifies the meaning of verbs which have the expectancy of *apādāna kāraka*.

4.1.1   Vibhakta (Isolated)

The second use of ablative case suffix is in the sense of *vibhakta*. This is a non-*kāraka* relation and is defined by the Pāṇini's *sūtra*

Pañcamī vibhakte - 2.3.42
[The fifth case endings are added after a *prātipadika* provided the referent is singled out or separated from another referent or a group on the basis of some property.]

For example:

Skt: Māthurāḥ Pāṭaliputrakebhyaḥ āḍhyatarāḥ santi. (18)
Gloss: the_inhabitantas_of_Mathurā{m, pl, nom} the_inhabitantas_of_Pāṭaliputra{m, pl, abl} richer{m, pl, nom} be{p, sg, 3p}
Eng: The inhabitants of Mathurā are more richer than the inhabitants of Pāṭaliputra.

Two other examples of this category are given below.

Skt: tayoḥ karmasannyāsāt karmayogaḥ viśiṣyate. (19)
Gloss: Among{n, pl, loc} karmasannyāsa{m, sg, abl} karmayoga{m, sg, nom} specify{p, sg, 3p, passive}
Eng: Among the two karamayoga(yoga of action) is better than karmasannyāsa(renunciation of action).

Skt: Rāmaḥ Śyāmāt nipuṇaḥ asti. (20)
Gloss: Rāma{n, sg, nom} Śyāma{m, sg, abl} smarter{n, sg, nom} be{p, sg, 3p}
Eng: Rāma is smarter than Śyāma.

4.1.2 *Hetu* (cause / reason)

The third major use of ablative case suffix is to mark the *hetu* (cause/reason). This time the word which is preffered to be a cause should be a guṇavācaka but not a feminine. The Pāṇini's *sūtra* definines these conditions as

vibhāṣā guṇe'striyām 2.3.25
[The fifth case endings are better not added after a *prātipadika* in the sense of *hetu* "ground, reason", when reference is to a *guṇa* "quality", provided that the *prātipadika* concerned is non-feminine.]

Here is an example.

Skt: jāḍyāt saḥ baddhaḥ. (21)
Gloss: Stupidity{n, sg, abl} he{m, sg, nom} imprisoned{m, sg, nom}
Eng: He was imprisoned on account of his stupidity.

4.2   Dative Case Marker

The dative case in Sanskrit is used to mark the *Sampradāna* (beneficiary) kāraka relation predominantly. In addition it is also used to mark two non-*kāraka* relations of *prayojana* (purpose) and *tādarthya* (being a thing for the sake of that).

4.2.1   *Sampradāna* (beneficiary)

Pāṇini in the *Aṣṭādhyāyī* has stated ten *sūtras* that provide the semantics of *sampradāna* followed by some exceptional cases that are extensions of the semantic definition of the *sampradāna kāraka*. The first *sūtra* which defines the *sampradāna* is:

> *Karmaṇā yamabhipraiti sa sampradānam* 1.4.32
> [The item which one has in view through the *karman* is called *sampradāna* when it becomes instrumental in bringing about an action.]

Here is an example:

Skt: Rāmaḥ brāhmaṇāya dhanaṃ dadāti. (22)
Gloss: Rāma{m, sg, nom} Brahmin{m, sg, dat} money{n, sg, acc} give{pr, sg, 3p}
Eng: Rāma gives money to a brahmin.

In the activity of giving, the *kartṛ* viz. Rāma aims at Brāhmin by offering him the money. Hence Brahmin is termed as a *sampradāna*.

Pāṇini further lists several exceptional cases where a verb assigns a dative case suffix to a noun it governs, however it is not obvious that the relation is that of beneficiary. For example, consider the Pāṇini's *sūtra*

> *Rucyarthānāṃ prīyamāṇaḥ* 1.4.33
> [With (verbal base) having the meaning of ruc - "to please" the one who is being pleased is called *sampradāna*, when he becomes instrumental in bringing about the action.]

The example sentence is:

Skt: Devadattāya modakaḥ rocate. (23)
Gloss: Devadatta{m, sg, dat} modaka{m, sg, nom} please{p, sg, 3p}.
Eng: Modaka pleases Devadatta.

In *sūtra*s from 1.4.34 till 1.4.39, Pāṇini covers a few more special case of verbs that assign dative case to the nouns with a specific semantic condition, and he terms all such relations as *Sampradāna*. These *sūtra*s are:

1. *ślāgha-hnuṅ-sthā-śapāṃ jñīpsyamānaḥ* - 1.4.34
   [With (the verbal base) *ślāgha* "to praise", *hnuṅ* "to hide oneself", *sthā* "to position", *śapāṃ* "to curse" the one who is desired to be informed is called *sampradāna* when he becomes instrumental in bringing about an action.]

2. *Dhāreḥ uttamarṇaḥ* - 1.4.35
   [With the causative verbal base *dhāri* "to owe" the creditor is called *sampradāna* when he becomes instrumental in bringing about an action.]

3. *Spṛheḥ īpsitaḥ* - 1.4.36
   [With the verbal base *spṛha* "to long for" the item desired to be reached is called *sampradāna* when he becomes instrumental in bringing about an action.]

4. *Krudha-druh-erṣyā-asūyā-arthānāṃ yaṃ prati kopaḥ* - 1.4.37
   [With the verbal base having the meaning of *Krudha* "to be angry", *druha* "to harm", *īrṣyā* "to be jealous" and *asūyā* "to find fault" the person towards whom anger (etc.) is directed is called *sampradāna* when he becomes instrumental in bringing about an action.]

5. *Rādhi-īkṣyoḥ yasya vipraśnaḥ* - 1.4.39
   [With the verbal base *rādhi* "to propitiate" and *īkṣi* "to look" the person about whom different questions are asked is called *sampradāna* when he becomes instrumental in bringing about an action.]

6. *Prati-āṅbhyāṃ śruvaḥ pūrvasya kartā* - 1.4.40
   [In connection with *śru* "to hear" preceded by prati and āṅ the agent(*kartā*) of the prior action of requesting is called *sampradāna* when he becomes instrumental in bringing about an action.]

7. *Anu-prati-gṛṇaḥ ca* - 1.4.41
   [Also with the verbal base *gṛ* "to call out" preceded by *anu* and *prati* the agent(*kartā*) of the earlier action is called *sampradāna* when he becomes instrumental in bringing about an action.]

8. *Parikrayaṇe sampradānam anyatarasyām* - 1.4.44
   [With regard to the action of hiring the most effective means is indifferently called *sampradāna* when he becomes instrumental in bringing about an action.]

Thus, Pāṇini provides either a list of all the verbs which assign dative case to its noun in the sense of beneficiary or specifies the meaning of the verbs (leaving the discretion of inclusion of a verb into this list to the speaker) that assign dative case to the noun in the given semantic sense.

There is one more exceptional case where dative case is used with the motion verbs to denote a *karman*, as in the sūtra:-

Gatyarthakarmaṇi dvitīyacaturthyau ceṣṭāyām anadhvani -2.3.12
[The second or the fourth case endings are added after a *prātipadika* in the sense of *karman* "(direct) object" of verbs of going, provided that movement actually occurs, except the object is the word *adhvan* "road".]

For example:

Skt: saḥ grāmāya vrajati. (26)
Gloss: He{m, sg, nom} village{m, sg, dat} go_out{pr, sg, 3p}
Eng: He proceeds to village.

In this case there is a condition that the action should be physical and not mental. Thus the following sentence is ungrammatical.

Skt: manasā saḥ Pāṭaliputrāya gacchati. (27)
Gloss: Mind{n, sg, inst} He{m, sg, nom} Pāṭaliputra{m, sg, dat} go{pr, sg, 3p}
Eng: He goes to Pāṭaliputra in his thoughts.

4.2.2 *Prayojana* (purpose)
Barring these verbs, in all other cases when a noun in dative case is related to a verb, the relation is that of *prayojana* (purpose). For example;

Skt: pākāya vrajati. (24)
Gloss: cooking{m, sg, abl} go_out{pr, sg, 3p}
Eng: (He) goes out in order to cook.

Here is another example.

Skt: randhanāya sthālī asti (25)
Gloss: cooking{n, sg, dat} pot{f, sg, nom} be{p, sg, 3p}
Eng: The pot is for cooking.

4.2.3 *Tādarthya* (Thing for the sake of that)
The third use of dative case suffix is to mark a relation of a noun with another noun when the first one is for the sake of the second one. The stock example of this relation is

Skt: yūpāya dāru asti. (28)
Gloss: Sacrificial post{m, sg, dat} wood{n, sg, nom} be{pr, sg, 3p}
Eng: The wood is for the sacrificial post.

Here the relation of *yūpa* is with *dāru*. But in this case also, there is an underlying verb *nirmāṇa* 'for the construction' (of a sacrificial post), and then with this verb, *yūpāya* becomes a purpose.[5] Therefore, in such cases also we mark the relation of *yūpāya* with the finite verb(*asti*) as a *prayojana*, and do not mark it as a relation between *yūpa* and *dāru*, as the tradition does. We have taken this decision for the following reasons.

1. As shown above, with every relation of *tādarthya*, there is an underlying action associated with it, which acts as a purpose (*prayojana*) for the main action.
2. Secondly, from the computational point of view, this brings in coarsity in the analysis resulting in a better performance.

4.3 Instrumental Case

In Sanskrit the instrumental case is used to mark three *kāraka* relations viz. *kartṛ*, *karaṇa* (an instrument) and *prayojaka kartṛ* (a causer), if they are not expressed by any other means such as verbal suffix etc.[6] In active voice, since the *kartṛ* is expressed by the verbal suffix, it is in nominative case. Only in the passive voice (*karmaṇi*) and the impersonal (*bhāve*) voice, the *kartṛ* is in the instrumental case. In the causative constructions, in passive voice, the *prayojaka kartṛ* is in instrumental case. Here are some examples.

Skt: Rāmaḥ bāṇena Vāliṃ hanti. (29)
Gloss: Rāma{m, sg, nom} arrow{m, sg, inst} Vāli{m, sg, acc} kill{pr, sg, 3p}
Eng: Rāma kills Vāli with an arrow.

In this sentence *bāṇa* in instrumental case and is the *karaṇa* (instrumental).

Skt: Rāmeṇa bāṇena Vāliḥ hanyate. (30)
Gloss: Rāma{m, sg, inst} arrow{m, sg, inst} Vāli{m, sg, nom} kill{pr, sg, 3p, passive}
Eng: Vāli is killed by Rāma with an arrow.

In this sentence two nouns viz. *Rāmeṇa* and *bāṇena* are in instrumental case, of which the first one is a *kartṛ* and the second one is a *karaṇa*.

Skt: mātrā śiśuḥ dugdhaṃ pāyayate (31)
Gloss: Mother{f, sg, inst} child{m, sg, nom} milk{n, sg, acc} feed{pr, sg, 3p, passive}
Eng: The milk is fed to child by his mother.

In this sentence mother is a causer and the causative verb is in passive voice. Therefore it is in instrumental case.

In addition, the instrumental suffix also marks the relation of *hetu* (cause/reason). Here is an example:

Skt: saḥ adhyayanena atra vasati. (32)
Gloss: He{n, sg, nom} study{n, sg, inst} here{ind} stay{pr, sg, 3p}
Eng: He stays here because of study.

In this sentence the noun *ahyayanena* which is in the instrumental case is the *hetu* (cause/reason) for the stay.

The vārttika *prakṛtyābhya upasamkhyānam*[7] assigns instrumental case to the words belonging

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[5]vā. tādarthye caturthī vācyā - siddhāntakaumudī, vol-I
[6]kartṛkaraṇayoḥ tṛtīyā (2.3.18)
[7]Under kartṛkaraṇayostṛtīyā(2.3.18) in the Mahābhāṣya

to this *gaṇa*. This is an open list. Here is an example.

Skt: saḥ prakṛtyā cāruḥ asti. (33)
Gloss: He{m, sg, nom} nature{f, sg, inst} good{m, sg, nom} be{pr, sg, 3p}
Eng: He is good by nature.

Pāṇini's *sūtra yenāṅgavikāraḥ* (2.3.20) assigns an instrumental case to the words denoting a cause for deformity, as in the following.

Skt: akṣṇā kāṇaḥ. (34)
Gloss: Eye{n, sg, inst} blind{n, sg, nom}
Eng: Blind with eye.

5 *Yogyatā*: sufficient condition

Now let us come to the problem of analysis. In order to choose among the possible relations proposed by the condition of expectancy, we need to decide the meaning compatibility among the meanings of the words involved. In Indian Tradition, the relation between a word and its meaning is considered to be of three types viz. *abhidhā* (the primary meaning), *lakṣaṇā* (the extended or the secondary or metaphoric meaning) and *vyañjanā* (the suggestive meaning) [8]. It has been pointed out that the suggestive meaning exists in parallel with the other two meanings (Kulkarni, 2015). In order to get the suggestive meaning one needs to look at the coherence between the texts at sentential and paragraph level. Thus, only on the basis of sentential analysis, it is not possible to decide the suggestive meaning even if it exists. In order to look at the meaning compatibility at sentential level, we need to look at the meaning compatibility with both *abhidhā* as well as *lakṣaṇā*. To devise rules for testing the meaning compatibility for each of the cases of various *kāraka* and non-*kāraka* relations covering both the primary and secondary meanings is a huge task. We have not decided in this momment what kind of information is needed, how to organize it and so on.

Yogyatā is defined as an absence of incompatibility and also as the presence of compatibility. Modeling it as an absence of incompatibility ensures less chance of type-2 error viz. the possibility of missing any correct solution. This helps in increasing the recall (Kulkarni, 2015; Panchal and Kulkarni, 2018). We get a clue to distinguish between the nouns which are related by a *kāraka* relation and those which are related by a non-*kāraka* ones in the *Aruṇādhikaraṇa* of the *Śābara bhāṣya*. Under the commentary of Mīmāṃsā sūtra 3.1.6, it is mentioned that

> *na ca amūrta-arthaḥ kriyātaḥ sādhanaṃ bhavatīti* (Jha, 1933, p 654)
> No unsubstantial object can ever be the means of accomplishing an act.

Thus anything other than *dravya* can not be a *kāraka*. There are some words which designate a quality and also a substance in which this quality resides. For example the word *śukla* (white). It designates a color. In addition, it also designates a thing which is white in color. Such words have a technical name in Sanskrit grammar. They are called the *guṇavacana*s. Since the *guṇavacana*s also can designate a *dravya*, all the *dravya*s as well as the *guṇavacana*s are qualified to be a *kāraka*. The rest, i.e. nouns which denote either a *guṇa* which is not a *guṇavacana* (for example *gandha*) or a *kriyā* (verbal nouns), would have a non-*kāraka* relation with a verb.

With this background now we discuss the disambiguation of the ablative, dative and the instrumental case markers in this order.

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[8]These aspects are discussed by all the three school of śābdabodha tradition i.e - Vaiyākaraṇa, Naiyāyika and Mīmāṃsaka, and Ālaṅkārika also. Prominent discussions among them are accumulated by K. Kunjanni Raja in `Indian Theories of Meaning`.

5.1 *Deciding the meaning of ablative case marker*

The ablative case marker is used to mark three relations viz. *apādāna*, *hetu* and *vibhakta*. Among these, *apādāna* is a *kāraka* relation, and Pāṇini, in addition to the semantic definition of *apādāna*, has provided a list of exceptional cases[9] where he provides either a list or a semantics of the verbs involved. Thus only in case of these verbs, there is a possibility of *apādāna* relation.

Pāṇini's *sūtra*
vibhāṣā guṇe'striyām 2.3.25
[(The fifth case endings are) better not (added after a *prātipadika* in the sense of *hetu* "ground, reason"), when reference is to a *guṇa* "quality" provided that (the *prātipadika* concerned is) non-feminine.][10]
This *sūtra* provides two syntactic clues to infer the relation of *hetu*. They are
1. The word which is in the ablative case should be a *guṇa* (whose reference is a quality), and
2. it should not be in feminine gender.

In the case of *vibhakta*, the seperateness is indicated by a comparison. Pāṇini mentions four suffixes for expressing comparison. The relevant sūtras are *atiśāyane tamabiṣṭhanau*(5.3.55) and *dvivacanavibhajyopapade tarabīyasunau*(5.3.57). And the suffixes are - *tamap, iṣṭhan, tarap* and *īyasun*.

With these clues now the rules for disambiguating the ablative case suffix may be stated as
1. In the presence of words with the suffixes *tarap, tamap, iṣṭhan* and *iyasun*, the word in ablative case has a relation of *vibhakta* with another noun.
2. If the verb does not have any expectancy of *apādāna* and the noun in ablative case refers to a quality *guṇa* which is not a *guṇavacana*, then the relation of the noun in ablative case with the verb is that of *hetu*.
3. If the verb has an expectancy of *apādāna* and the noun in ablative case refers to a *dravya* or a *guṇavacana*, then the relation between the noun in ablative case and the verb is that of *apādāna* and otherwise it is a *hetu*. In the case of verbs in the sense of fear, this condition is further relaxed, and even a *guṇa* which is not a *guṇavacana* would be a possible *apādāna kāraka*, on the basis of the *sūtra* '*bhītrārthānām bhayahetuḥ* (1.4.24)'.

In addition to these, we also came across some special cases in Bhagvadgītā, where the verbs themselves indicate the seperateness such as *viśiṣyate* and *atiricyate*. Moreover words like *adhika*, *para*, *kuśala*, *pravīṇa* etc. also indicate a seperateness. In such cases the relation is marked as *vibhaktam*.

5.2 *Sampradāna* versus *Prayojana*

With the availability of Pāṇini's *sūtra*s which provide a list of verbs or the meanings of the verbs that have an expectancy of *sampradāna*, we get an almost complete list of all the verbs that have a *sampradāna* expectancy. If a verb does not belong to this list, then it does not have any expectancy for a *sampradāna*, and safely we can say that any word in the dative case represents the *prayojana*. So the only challenge is with the verbs having an expectancy for *sampradāna*. In such cases we will have to decide whether the word in dative case is a *prayojana* or a *sampradāna* with respect to the given verb. With the above condition that a *kāraka* should necessarily be a *dravya*, in sentences such as (35), one can correctly assign a relation of *prayojana* to the dative word *paṭhanāya*.

Skt: Rāmaḥ paṭhanāya pustakaṃ dadāti. (35)
Gloss: Rāma{m, sg, nom} study{n, sg, dat} book{n, sg, acc} give{pr, sg, 3p}

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[9]Patañjali explains how these are not exceptions but can be justified with the original definition of apādāna.
[10]By 'better not added' is indicated a less-preferred optionality.

Eng: Rāma gives a book for study.

Of course this condition is just a necessary and not a sufficient one. For example, consider a sentence

Skt: Rāmaḥ pustakāya dhanaṃ dadāti. (36)
Gloss: Rāma{m, sg, nom} Book{n, sg, dat} money{n, sg, acc} give{pr, sg, 3p}
Eng: Rāma gives money for a book.

Here *pustaka* is a matter(*dravya*) and hence it will be marked as a *sampradāna*. But we know that in this sentence *pustaka* is not a beneficiary. A beneficiary should be an object that has an ability of receive. The living beings have an ability to receive. But imposing this restriction can handle only sentences with *abhidhārtha* (primary meaning). It is possible that a word is used in a metaphoric sense as in

Skt: Rāmaḥ pāṭhaśālāyai dhanaṃ dadāti. (37)
Gloss: Rāma{m, sg, nom} school{n, sg, dat} money{n, sg, acc} give{ pr, sg, 3p}
Eng: Rāma gives money to a school.

In this sentence, the noun in dative *pāṭhaśālā* is used in the sense of an institution and not in the sense of a building. Though an institution is not a living body, but still it shares some properties of a living body such as an institution grows just like a living being. Untill a good model for *lakṣaṇā* is developed, we decided to keep the condition of mutual congruity as wide as possible so that the recall is closer to 100%. Thus, instead of allowing only living beings to be candidates for *sampradāna* we allow any *dravya* or a *guṇavacana* to be a possible *sampradāna*. This increases the type-1 error, allowing the cases of *pustaka* to be a *sampradāna* in the sentence (35), but reduces the type-2 error by allowing *pāṭhaśālā* to be a *sampradāna* as in (37).

Sentence (35) was an example of ellipsis. The complete sentence without ellipsis would be something like

Skt: Rāmaḥ Mohanāya pustakāya dhanaṃ dadāti. (38)
Gloss: Rāma{m, sg, nom} Mohana{m, sg, dat} book{n, sg, dat} money{n, sg, acc} give{ pr, sg, 3p}
Eng: Rāma gives money to Mohana for a book.

Now the parser with an extra condition that if there are two *dravyas* with dative case then the one which refers to a living being is preferred to be a *sampradāna*, would yield a correct result.

5.3 *Karaṇa* versus *Hetu*

There is similarity between the ambiguity of instrumental case suffix with that of dative and ablative case suffix. All the three are used for both *kāraka* as well as non-*kāraka* relations. But there is a major difference and that is: *Pāṇini* has provided a clues as to which verbs have an expectancy for *sampradāna kāraka* and *apādāna kāraka*. But no such list has been provided for the verbs with an expectancy for the *karaṇa*. In the case of *karaṇa*, there was no such major extension except two cases viz. the verb *div* and the verbs denoting *parikrayaṇa*.[11] The list of verbs having an expectancy of *sampradāna* or an *apādāna* is small in comparison with the verbs having an expectancy of an instrument.

Another difference is, it was easy to formulate a criterion to rule out the candidates for

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[11] *divḥ karma ca*(1.4.43), *parikrayaṇe sampradānam anyatarasyām*(1.4.44)

sampradāna and *apādāna* simply using the criterion of being a substantial object. Thus a simple ontological information such as whether the word designates an object or not helped in the formulation of rules. However in the case of a *karaṇa*, the things are not that simple, for the following reasons.

First the number of the verbs having an expectancy for a *karaṇa* is much more than the number of verbs having an expectancy for *sampradāna* or *apādāna*. Therefore formulating a general semantic criterion that will cover all the verbs is difficult. Secondly in the case of passive voice, even the *kartṛ* takes the instrument case suffix along with an instrument and a cause or a reason. Finally the *karaṇa* has its own activity which is a part of the complex activity denoted by a verb. Thus in order to decide whether the denotation of a word can be an instrument or not completely depends on the nature of the activity denoted by the verb. Hence in order to decide whether something is an instrument or not, one needs to know the associated semantics of the verb. In view of these difficulties, we decided to look at the problem afresh and search for clues that will rule out the non-players than the clues that will shortlist the possible candidates.

Pāṇini defines *karaṇa* as *Sādhakatamaṃ karaṇam*(1.4.42). The most effective means is termed as a *karaṇa*. The *karaṇa* has an action associated with it and this action is a part of the activity indicated by the main verb, and is the last sub-activity among the group of activities associated with the activity of main verb. For example, consider the sentence (29). Here the action is denoted by a verb *han*. *Rāma*, the agent picks up an arrow, and then shoots his bow towards *Vāli*. Now this arrow, after leaving the hands of *Rāma* travels through the air and pierces *Vāli*. At this point *Vāli* gets killed. So, the activity of the arrow of piercing is the last activity in the complex activity of *han*, and is the activity of an instrument. Thus we observe that in order to qualify to be an instrument, the object under consideration should have an activity of its own. This is true only of the matter(*dravya*). Hence only (*dravya*) or a *guṇavacana*(those which refer to a quality as well as the one which possesses the quality) are qualified to be a *karaṇa*.

This criterion thus helps us in ruling out the possibility of *adhyayana* to be a *karaṇa*, in the sentence (32), since it does not refer to a *dravya*. Further, the condition that the instrument cannot be an animate object would further help disambiguate in the following example:

Skt: Rāmeṇa bāṇena Vāliḥ ahanyata. (39)
Gloss: Rāma{m, sg, inst} arrow{m, sg, inst} Vāli{m, sg, nom} kill{pr, sg, 3p passive}
Eng: Vāli is killed by Rāma with arrow.

In this sentence, both *Rāmeṇa bāṇena* are in instrumental case. But *Rāma* is the name of a person and thus denotes an animate object while *bāṇa* refers to an inanimate object and hence *bāṇa* is a *karaṇa* (instrument) and *Rāma* is a *kartṛ*.

We came across some examples where the *karaṇa* is not a *dravya*. Here is an example.

skt: ghoṣeṇa āpūrayan diśaḥ. (40)
Gloss: sound{m, sg, inst} fill_out{m, sg, nom} directions{f, pl, acc}
Eng: Fill out the directions with sound.

In this sentence, the word *ghoṣa* refers to a *guṇa* and yet it is an instrument for the activiy denoted by *āpūrayan*. We noticed that in the case of verbs that denote activities associated with mind, brain etc. such as *bhartsa, abhi-jñā* etc. words denoting *śabda* act as a *karaṇa*.

With these criteria, now the rules for ruling out non-candidates for *karaṇa* may be summarized

as:

- If the verb denotes a mental activity, words denoting *śabda* can act as a *karaṇa*.
- In all other cases of verbs having an expectancy for a *karaṇa*, a word denoting a *dravya* (including the *guṇavacana*), is a potential candidate.
- If there are two words in instrumental case, and the verb is in passive voice, then the word denoting an animate object is preferred to be a *kartṛ*.

6 Evaluation

For evaluating the disambiguation rules thus framed, we chose `Srīmadbhagvadgītā`. This text is manually analysed at various levels such as morphological analysis and *kāraka* analysis. The current parser can not handle sentences with co-ordinate conjunction properly. Hence we selected only those verses which do not have the use of conjunctive particles. A verse with more than one finite verbs[12] were split. Each input sentence had only one finite verb, and the order of the words was the same as in the original verse. Since the implementation focuses on reduction of Type-2 error, we wanted to make sure that the recall is high. The recall for all the relations was found to be 100%. That is, each of the sentences produced one or more solutions and one of them was found to be correct. Table 2 shows the performance of the parser on sentences with ablative, dative and instrumental case. We note that in almost 80% of the times, the first solution is correct. And the parser could parse 93% of the sentences correctly. The failures were due to un-availability of morphological analysis for at least one word in the sentence.

relation	Sentences	Parsed	Failed	rank of correct solution		
				1	2-9	>9
apādāna	18	18 (100%)	0	13 (72.2%)	1	4
hetu(5)	20	18 (90%)	2 (10%)	10 (55%)	6	2
vibhakta	19	17 (90%)	2 (10%)	10 (60%)	4	3
sampradāna	26	23 (88.5%)	3 (11.5%)	16 (69.6%)	4	3
prayojana	25	23 (92%)	2 (8%)	22 (95.6%)	0	1
karaṇa	91	84 (92.3%)	7 (7.7%)	71 (84.5%)	11	2
hetu(3)	22	22 (100%)	0	13 (59%)	5	4
All	221	205 (92.8%)	16 (7.2%)	155 (78.9%)	31	19

Table 2: Performance of the parser

Analysis of the sentences where the correct solution was not at the top revealed that the sentence contains words with more than one possible morphological analysis. And the top solution displayed makes sense, if it is situated in an appropriate context. For example, consider the following feet of a verse
{m, sg, dat} Skt: tat te padaṃ saṅgraheṇa pravakṣye ahaṃ (41) (BhG 8.11)
Gloss: that{n, sg, acc} you{m, sg, dat} goal{n, sg, acc} briefly{m, sg, inst} tell{f, sg, 1p} I{m, sg, nom}
Eng: I will tell you that goal briefly.

Here the word *te* is ambiguous between a dative and a genitive case suffix of the second person pronoun *yuṣmad*. So it can be interpreted as either related to *padaṃ* by a possessive relation or related to the verb as a beneficiary. In this particular context, the second reading is more appropriate. A simple rule which checks if all the desired expectancies of the verb are fullfilled or not would push the correct solution to the top. But this rule can be used only if we always deal with complete sentences. If elliptical sentences are allowed, then this rule breaks down.

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[12] *ekatiṅ vākyam*

Another observation is, if the word order is changed to

Skt: ahaṃ tat padaṃ te saṅgraheṇa pravakṣye (42) (BhG 8.11)
Gloss: I{m, sg, nom} that{n, sg, acc} goal{n, sg, acc} you{m, sg, dat} briefly{m, sg, inst} tell{f, sg, 1p}
Eng: I will tell you that goal briefly.

then the parser produces the intended solution as the first solution. Most of the cases of *sampradāna kāraka* where the solutions were pushed down were due to such ambiguities.

In the case of instrumental case, the cases where the solution was pushed down were due to the ambiguity between a *kartṛ* and *karaṇa* having the same instrumental case marker in passive voice. When there is an ellipsis of one of them, then the sentence can be parsed in more than one ways. Only the context helps you in deciding which one is the correct. For example,

Skt: indriyaiḥ sṛjyate yat. (43)
Gloss: organs{m, pl, inst} produce{pr, sg, 3p, passive} which{n, sg, nom}
Eng: which is produced by organs

This phrase can be interpreted in two different ways: with *indriya* as either a *kartṛ* or a *karaṇa*. And it is only the context that helps in selecting the correct one.

7 Conclusion

In this paper we have discussed the problems in disambiguation of three case suffixes ablative, dative and instrumental. There is always a trade-off between precision and recall. Since our aim is to provide complete access to the original text and not merely a translation system, recall is more important for us. This implies, we need to consider both the primary and the secondary meanings of the words for checking the meaning congruity for establishing the relations. The mīmāṁsā texts very clearly advocate the use of primary meaning first, and only in the absence of any appropriate primary meaning, they advocate the use of secondary meaning. However, since the task of framing rules for meaning congruity is a gigantic task, and our aim is to increase the recall, we decided to use *yogyatā* as an absence of non-congruity. This reduces the precision, but helps in using some simple ontological properties to rule out the non-players. With the help of only two classes viz *dravya* and *guṇa*, and occasionally words denoting *śabda*, and animacy, we could get satisfactory results.

We are aware of the fact that the sample on which the parser was tested is very small, and belongs to a specific domain. In order to test it on better corpus, we still do not have annotated corpus of large size.

Improving the performance of this parser would help in its use for building a tree bank for Sanskrit semi-automatically, at the same time making it useful for those who would like to access the original text with the help of these tools.

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A Tagset of Dependency Relations

- **Kāraka-sambandhāḥ**
  - kartā
    * prayojaka-kartā
    * prayojya-kartā
  - karma
    * mukhya-karma
    * gauṇa-karma
    * vākya-karma
  - karaṇam
  - sampradānam
  - apādānam
  - adhikaraṇam
    * kāla-adhikaraṇam
    * deśa-adhikaraṇam
    * viṣaya-adhikaraṇam
- **Kāraketara-sambandhāḥ**
  - **Kriyā-kriyā-sambandhāḥ**
    * pūrva-kālaḥ
    * vartamāna-samāna-kālaḥ
    * bhaviṣyat-samāna-kālaḥ
    * bhāvalakṣaṇa-pūrva-kālaḥ
    * bhāvalakṣaṇa-vartamāna-samāna-kālaḥ
    * bhāvalakṣaṇa-anantara-kālaḥ
    * sahāyaka-kriyā
  - **Kriyā-nāma-sambandhāḥ**
    * sambodhyaḥ
    * hetuḥ
    * prayojanam
    * kartṛ-samānādhikaraṇam
    * karma-samānādhikaraṇam
    * kriyāviśeṣaṇam
    * pratiṣedhaḥ

  - **Nāma-nāma-sambandhāḥ**
    * ṣaṣṭhī-sambandhaḥ
    * aṅgavikāraḥ
    * vīpsā
    * viśeṣaṇam
    * sambodhana-sūcakam
    * vibhaktam
    * abhedaḥ
    * nirdhāraṇam
    * atyanta-saṃyogaḥ
    * apavarga-sambandhaḥ
    * vakyakarmadyotakaḥ
- **Upapada-sambandhāḥ**
  - sandarbhabinduḥ
  - tulanābinduḥ
  - viśayādhikaraṇam
  - nirdhāraṇam
  - prayojanam
  - udgāravācakaḥ
  - saha-arthaḥ
  - vinā-arthaḥ
  - svāmī
  - srotaḥ
- **Vākyetarasambandhāḥ**
  - anuyogī
  - pratiyogī
  - nitya-sambandhaḥ
- **Samuccayādisambandhāḥ**
  - samuccitaḥ
  - samuccaya-dyotakaḥ
  - anyataraḥ
  - anyatara-dyotakaḥ

Note: The bold entries are the headings and do not indicate relation labels