

Semantic Representation of Causality

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Abstract—This is an attempt to study the semantic relation of Causality or Cause-Effect, how it is marked in Tamil, how the causal markers in Tamil manifest in texts, their syntactic and semantic properties and how this information can be represented so as to handle causal information and reasoning.

Keywords- causality; Tami; semantic relation; cause-effect.

I. INTRODUCTION

Causality or Cause-Effect relation is a complex semantic relation. It refers to the relation between two events. If an event E2 is caused by another event E1, then a causative relation exists between event E1 and event E2. E1 is the cause of E2 and E2 is the consequence of E1.

I bought a new pen because I lost the old one. - (1)

Here the event E1 is “I lost the old one” and the event E2 is “I bought a new pen”. The causality marker “because” connects the two events E1 and E2, thus establishing a Cause-Effect relationship between the two events.

I bought a new pen after I lost the old one. - (2)

In example (2), the events remain the same. But the marker “after” simply specifies a temporal relationship between the two events. Here, there is no Cause-Effect relation. Also, it may be noted that the relationship is asymmetric, i.e, E1 causes E2 does not imply E2 causes E1.

An attempt has been made to study this Cause-Effect relation in Tamil and the various markers which serve to express this semantic relation. The Attribute Value Matrix (henceforth AVM) representations for some of the markers have been drawn for some examples of expressions of cause. This has given an insight into the causal markers in Tamil.

II. PREVIOUS WORK

Several philosophers have studied the semantic relation of causality like (Ehring 1997), Mellor (1995), Owens (1992) and Sosa and Tooley (1993). Though extensive work has been done in the analysis of causality in English, there has not been much work done on causality in Tamil.

From a natural language understanding(NLP) perspective, Khoo (1995) analyzed the verb entries in the Longman Dictionary of Contemporary English (1987) and came up with a total of 2082 causative verbs (verbs with a causal component in their meaning). In subsequent works (Khoo et al, 2001, Khoo and Myaeng, 2002 and Khoo et al 2002), attempts at automatic recognition of cause-effect relations have been made for information retrieval purposes. Nazarenko-Perrin (1993) has attempted to represent causality using conceptual graphs. Girju (2003) has also attempted the automatic recognition of causal relation in English texts. But, there has not been any attempt to study causal relation in Tamil, especially from a computational perspective.

III. ANALYSIS OF CAUSALITY IN TAMIL

Causality or the semantic relation of Cause-Effect in Tamil is expressed in many ways. It can be syntactic (a suffix) or lexical. It can be within a clause, inter-clausal or inter-sentential. The various causal markers and their features are studied and discussed below.

A. Arguments of the Causal marker

The semantic relation of cause holds between two arguments – the cause or the reason and the effect. Consider the following example.

He died of drowning.	- (3)
He drowned due to heavy flood.	- (4)
He died due to heavy flood.	- (5)

In example (3), it may be noted that the Cause is “drowning” and the Effect is “he died”.

In example (4), the Cause is “heavy flood” and the Effect is “he drowned”.

In example (5), the Cause is “heavy flood”, but the effect is “he died”.

In other words, “he died because of drowning due to heavy flood”. Here we see that the Cause-Effect event chain. Hence we see that for a particular result or effect, we have two causes – a direct Cause and an indirect Cause. Similarly, for a particular cause, we have two effects – an intermediate Effect and an ultimate Effect.

In the above examples, “heavy flood” is the indirect Cause and “he drowned” is the intermediate effect and the direct Cause. The ultimate Effect is “he died”.

B. The Markers of Causality

The causal markers in Tamil may be divided into two categories – those markers which have a noun as their Cause argument and those which take a verb as their Cause Arguments.

1) -aal

The predominantly used marker of cause is -aal. When it takes a noun as the cause, it manifests as below.

avar maaraTaipp-aal kaalamaanaar.
he heartattack-CAUSE expired.
“He died of heart attack.”

But this marker is polysemous. Sometimes, it denotes instrumentality, as below.

avan katti-y-aal kutt-in-aan.
he knife--INS stab-PST-3SM
“He stabbed with a knife.”

This marker may add to the verbal stems in the past or future tense to denote cause. But, it is to be noted that the verbal stem is first nominalized with *atu* and then this marker is added with or without the euphonic markers *an* or *in*.

kaaRRu aTi-tt-a-at-aal mazai pey-t-atu.
Wind blow-PST-RP-3SN-CAUSE rain rain-PST-3SN
“It rained because of the wind.”

takka neerattil maruttuvamanai-kku ce-nR-a-at-an-aal
avar uyir pizai-tt-aar.
correct time hospital-DAT go-PST-RP-3SN--
CAUSE he life save-PST-3SH
“His life was saved because he went to the hospital at the right time.”

It may be noted that the marker -aal attaches to verbal roots without nominalization to form the conditional form and this is different from Causality.

avan paTi-tt-aal veRRi peRu-v-aan.
he study--COND success get-FUT-3SM
“If he studies, he will succeed”.

2) kaaraNattaal

This marker literally means “because of the reason”. We may note that the causal marker -aal is present in this marker.

avan paTikk-aat-a kaaraNattaal tooRRaan.
He study-NEG-RP CAUSE fail-PST-3SM.

“He failed because he did not study.”

3) kaaraNamaaka

This marker also literally means “because of the reason”. *kaaraNam* means reason.

iRaiccal-in kaaraNamaaka enakku onRumee keeTkavillai.
Noise-GEN CAUSE I-DAT anything hear-INF-
NEG
“I cannot hear anything because of the noise”.

4) kaaraNam

This marker means “reason”. The peculiarity of this marker is that this is the only marker where the Cause follows and the Effect precedes the causal marker.

ivvaLavvu piraccinaikaL-ukk-um kaaraNam un aRiyaamai.
these-many problems-DAT-INC reason your ignorance.
“Your ignorance is the reason for all these problems.”

5) toTarntu

This marker literally means “following which”. So, this marker denotes consequence/cause.

*uuraTaṅku uttarav-ai toTarntu terukkaL veRiccooTi iru-
nt-ana.*
Curfew order-ACC CAUSE streets empty be-
PST-3PN.
“The streets were empty following the curfew order.”

But this marker is polysemous. It can mean “regularly” or “continuously” or even “follow”.

mantiravaati puuṅkuzaliyai toTarntu oot-in-aan.
Sorcerer Poonkulali-ACC follow-VBP run-PST-3SM.
“The sorcerer ran behind Poonkulali, following her”

6) *atanaal/itanaal/aanapatiyaal/aakaiyaal/aatalaal*
These markers are inter-clausal or inter-sentential markers meaning “so”. They literally mean “because of that/this”. Though they directly denote consequence, cause can be inferred.

*ciRuvan tavaRu cey-t-aan. atanaal ammaa koopam-
uR-R-aalL.*
boy mistake do-PST-3SM. so mother anger-get-
PST-3SF.
“The boy did a mistake. So, the mother got angry”.

*ciRuvan tavaRu cey-t-aan. itanaal ammaa
avan-ai aTi-tt-aalL.*
Boy mistake do-PST-3SM. because-of-this mother he-
ACC beat-PST-3SF
“The boy did a mistake. So the mother beat him.”

naaṅkaL pattirikkaṭai vaaṅkuvatt-illai. aanaṭaiyaal inta ceyti enakuṭṭu teri-yaa-tu.
we newspaper buy-NEG. so this news
I-DAT know-NEG-3SN.
“We don't buy newspapers. So, I don't know of this news.”

en tantai-kku tamiz teri-yum. aakaiyaal avar-iṭamiruntu tamiz kaṛ-kalaam.
my father-DAT Tamil know-3SN. so he-ABL
Tamil learn-PERF
“My father knows Tamil. So, one can learn Tamil from him.”

en aluvalaka neeram kaalai 11 maNi. aatalaal naan coompeeri aaneen.
my office time morning 11o'clock. so I
lazy become-PST-1S.
“My office time is at 11 a.m. So, I became lazy.”

7) Verb in infinitive

This is a particular case of unmarked expressions of cause which is quite frequently found. The verb in the infinitive(morphologically) is used to chain a sequence of events, thus implicitly showing cause.

ciRuvan tavaRu cey-ya ammaa koopam-uṛ-R-aaL.
boy mistake do-INF mother anger-get-PAST-3SF.
“As the boy did a mistake, the mother got angry”.

8) Verbs that denote cause

The following verbs may denote a causal relation in the sentence - *eeṛpaṭu, uṇṭaaku, viLai*.

cuuRaavaLi-y-aal peṛum naacam viLai-nt-atu.
storm--CAUSE big damage lead-PST-3SN.
“The storm led to heavy damages.”

9) Causative verbs

The causative verbs are a special class of verbs, where the additions of a marker (-*vi, -pi*) or an auxiliary verb (*vai, cey, aṭi*) to the main verb produces another verb with the meaning “make to/cause to” added to the original meaning. The following examples show the use of auxiliary verbs to include causative meaning in the verb.

naan anta ceyti-y-ai aṛi-nt-eeen.
I that news--ACC know-PST-1S.
“I knew that news.”

naan anta ceyti-y-ai aṛivi-tt-eeen.
I that news--ACC make know-PST-1S.
“I announced that news.”

Here the causal interpretation is that “I am the cause for the news to be known.”

naan anta paaṭatt-ai avan-ukku puriya-vai-tt-eeen.
I that lesson-ACC he-DAT understand-make-PST-1S.
“I made him understand the lesson.”

naan avan-ai caak-aṭi-tt-eeen.
I he-ACC die-make-PST-1S.
“I caused him to die.”

naan avaLai paaṭa-c-cey-t-eeen.
I she-ACC sing--make-PST-1S.
“I made her sing.”

IV. COMPUTATIONAL REPRESENTATIONS

Computationally the above markers and examples can be expressed as Attribute Value Matrix (AVM) representations, which capture the arguments and features of the markers. The AVM representations for some of the examples are given in Figure 1.

1. *avar maaraṭaiippaal kaalamaanaar.*
He died of heart attack

$$PP_{(CAUSE+aal)} Arg(2) \left[\begin{array}{l} Arg_1 \left[\begin{array}{l} NP, -living, -concrete \end{array} \right] \\ Arg_2 \left[\begin{array}{l} S \left[\begin{array}{l} V \text{ kaalamaaku } arg(1) \\ arg_1 \left[\begin{array}{l} NP, +Sub, +Nom, +human, \pm male \end{array} \right] \end{array} \right] \end{array} \right] \end{array} \right]$$

2. *kaaṛṛu aṭittataal mazai peyṭatu.*
It rained because of the wind.

$$PP_{(CAUSE+aal)} Arg(2) \left[\begin{array}{l} Arg_1 \left[\begin{array}{l} S \left[\begin{array}{l} V \text{ aṭi } arg(1) \\ arg_1 \left[\begin{array}{l} NP, +Sub, +Nom, -living, -concrete \end{array} \right] \end{array} \right] \end{array} \right] \\ Arg_2 \left[\begin{array}{l} S \left[\begin{array}{l} V \text{ pey } arg(1) \\ arg_1 \left[\begin{array}{l} NP, +Sub, +Nom, -living, +concrete \end{array} \right] \end{array} \right] \end{array} \right] \end{array} \right]$$

3. *takka neerattil maruttuvamanaikku cenṛatanaal avar uyir pizaittaar.*
He was saved because he went to the hospital at the right time.

$$PP_{(CAUSE+aal)} Arg(2) \left[\begin{array}{l} Arg_1 \left[\begin{array}{l} S \left[\begin{array}{l} V \text{ cel } arg(2) \\ arg_1 \left[\begin{array}{l} PRO, +Sub, +Nom, +living, \pm human \end{array} \right] \\ arg_2 \left[\begin{array}{l} NP, +Obj, +Dat, -living, +concrete \end{array} \right] \end{array} \right] \end{array} \right] \\ Arg_2 \left[\begin{array}{l} S \left[\begin{array}{l} V \text{ pizai } arg(2) \\ arg_1 \left[\begin{array}{l} NP, +Sub, +Nom, +human, \pm male \end{array} \right] \\ arg_2 \left[\begin{array}{l} NP, +Obj, +Nom, +part_of_body \end{array} \right] \end{array} \right] \end{array} \right] \end{array} \right]$$

4. iRaiccalin kaaraNamaaka enakku onRumeee keetkavillai
I cannot hear anything because of the noise.

$$ADV_{(CAUSE+kaaraNamaaka)} \text{ Arg}(2) \left[\begin{array}{l} \text{Arg}_1 \left[\text{NP, +Gen, -concrete} \right] \\ \text{Arg}_2 \left[\text{S} \left[\begin{array}{l} \text{V } \text{keeL arg}(1) \\ \text{arg}_1 \left[\text{NP, +Sub, +Dat, +human, } \pm \text{ male} \right] \end{array} \right] \right] \end{array} \right]$$

5. ivvaLavu piraccinaikaLukkum kaaraNam un aRiyaamai.
The reason for all these problems is your ignorance.

$$NP_{(CAUSE+kaaraNam)} \text{ Arg}(2) \left[\begin{array}{l} \text{Arg}_1 \left[\text{NP, +Sub, Dat, -concrete} \right] \\ \text{Arg}_2 \left[\text{NP, +Obj, +Nom, -concrete} \right] \end{array} \right]$$

6. uuraTanku uttaravai toTarntu terukkaL veRiccooTi iruntana.
The streets were empty following the curfew order.

$$PP_{(CAUSE+toTarntu)} \text{ Arg}(2) \left[\begin{array}{l} \text{Arg}_1 \left[\text{NP, +Acc, -concrete} \right] \\ \text{Arg}_2 \left[\text{S} \left[\begin{array}{l} \text{V } \text{iru arg}(1) \\ \text{arg}_1 \left[\text{NP, +Sub, +Nom, -living, +concrete} \right] \end{array} \right] \right] \end{array} \right]$$

Figure 1. Some example AVMs

V. CONCLUSION

This attempt at the analysis of the cause-effect semantic relation in Tamil and the AVMs can be used in automatic

identification of causal relations in text. This, in turn, would be useful in information retrieval systems and reasoning or question-answering systems.

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