

Linguistically-informed Computational Approaches to Verbal Aspect

Bachelor Thesis

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Abstract

Abstract in English

Zusammenfassung

Zusammenfassung auf Deutsch

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1 Introduction

Motivation

Despite being one of the most studied areas in linguistics, I COULDNT FIND ANY statistical approaches to aspect.

Why aspect?

One may justifiably beg the question why a “computational approach” to aspect (OR INDEED TO ANY PROBLEM IN THEORETICAL LINGUISTICS) is necessary or indeed useful: in an age of LLMs

The use of such a study comes down to the purpose of computational linguistics as an area of study. Computational linguistics has changed a lot since its conception in the mid 20th century, at some points being closer to linguistics and at others (arguably including right now) being closer to computer science. However the position of the field lying at the intersection between more well-established and well-defined areas of study has led to a fruitful exchange of ideas between the disciplines.¹

One reason is of course the contribution to the linguistic community: computational approaches to language have SPURRED ON LOTS OF PROGRESS (cf Chomsky!!!). A

In the true nature of the interdisciplinarity of the field I wish to WORK AT BOTH AIMS IN PARALLEL and show how they complement each other.

Importance on engineering side:

- Zero-shot performance of ChatGPT comparable with BERT [Zhong et al., 2023]
- I also experienced poor (?) performance with own experiments
- but fine-tuning lead to large improvements

1 Just to name a few examples: formal languages, artificial neural networks and SOMETHING ELSE!!!!!!

The fact that fine-tuning can lead the model to

Therefore the purpose of this study is two-fold: firstly to further explore the phenomenology of aspect using methods from computational linguistics such as neural embeddings, and secondly to look at how current state-of-the-art approaches deal with this phenomenon and investigate how this could be improved.

Main contributions

- First in-depth study using computational approaches to study the phenomenology of aspect
- First probing of neural models applied to the task
- SOMETHING ELSE

Structure of this thesis

2 Aspectology: an introduction

Aspect is one of the most studied areas of linguistics [Sasse, 2002], particularly Slavic linguistics (for reasons I will discuss later), and hence a thorough theoretical discussion of the linguistic phenomenon which does full justice to the work on the field is not possible within the constraints of this thesis. Nevertheless, in order to make a productive contribution to the area I will touch on some of the main findings in the area of aspectology.

2.1 A (short) phenomenology of aspect

The Concise Oxford Dictionary of Linguistics [Matthews, 2014] defines aspect thus:

General term, originally of specialists in Slavic languages, for verbal categories that distinguish the status of events, etc. in relation to specific periods of time, as opposed to their simple location in the present, past, or future.

As noted, one distinction which must be made right away is that between *aspect*, and another temporal phenomenon *tense*. Many works recall Bernard Comrie's differentiation in his book *Aspect* [Comrie, 1976] between the deictic nature of *tense* and the focus on the "internal temporal constituency of a situation" of *aspect*. In other words: "tense¹ relates the time of the situation referred to to some other time, usually to the moment of speaking", and thus by relating the time of the situation to the time of the utterance it is deictic [Comrie, 1976]. Aspect on the other hand gives a *situation-internal* description of the events in that situation, such how they relate to each other temporally or how an individual event is temporally characterised. This brings us to another important distinction: that between lexical and grammatical aspect.

1 In many of the world's languages this is grammaticalised as past, present and future; in others such as English by some accounts [Jespersen, 1933] it is a binary distinction such as past and non-past, whereas Some languages such as Greenlandic (Kalaallisut) which some linguists have even argued to be tenseless Bittner [2005]. See also the contentious debate about Hopi time Whorf [2012], Malotki [1983].

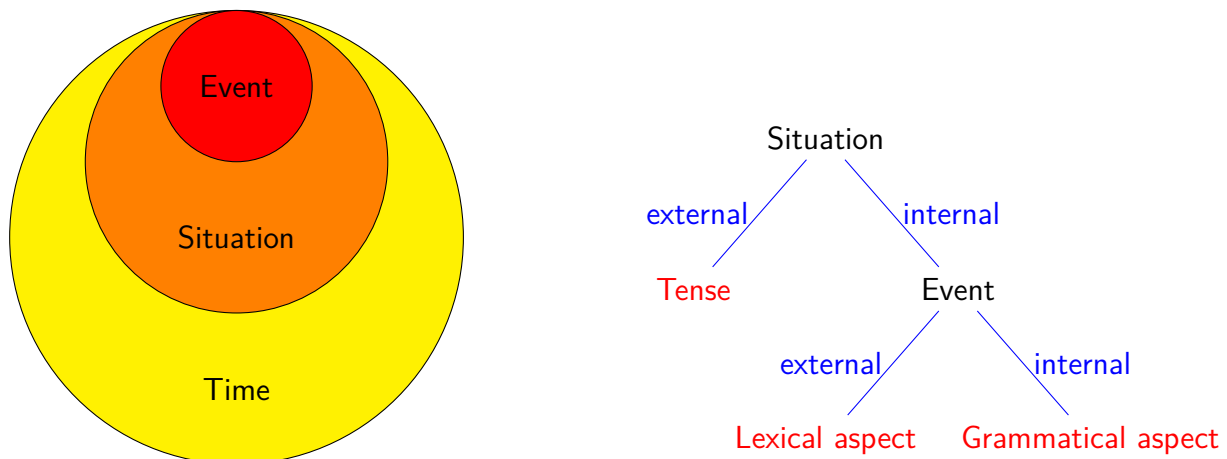


Figure 1: A set-theoretical representation of the relationship between time, situation and event (left) along with the categorisation of the three tempora phenomena discussed (right).

2.1.1 Lexical vs grammatical aspect

The polysemy of the term “aspect” in the linguistic community is unfortunate. In an area of language which seems to have surprisingly far-reaching interactions with other parts of linguistic systems these ambiguities are particularly unhelpful.² As already mentioned, aspect³ is a term often used to refer to both lexical and grammatical aspect. Lexical aspect (also referred to as *Aktionsart*, *situation aspect* or *inner aspect*) is the inherent property of a verb or verb phrase which “characterizes the temporal profile of event descriptions” [van Hout, 2016]. For example, to “crack open an egg” is inherently a short event describing the change of one state (the egg being whole) to another (the egg being cracked). Grammatical aspect (or *viewpoint aspect*, *outer aspect*), on the other hand, describes the “internal temporal constituency” [Comrie, 1976] of an event, such as its habituality or ongoing nature and can be seen more as an external lens imposed on a verbal phrase. In English, one example of this lens is the progressive, which is formed by the verb *be* + gerund, as in the phrase “Sue was running”. Figure 1 shows a taxonomy of tense, and grammatical and lexical aspect.

The concrete linguistic realisation of these categories is very often unclear or non-existent and exhibits a relatively wide variety of encodings throughout the world’s languages [Dahl, 1985]. It therefore proves tricky to uphold this distinction in empirical studies “in the real world”. Nevertheless

² Among other things, aspect is also intertwined with case, mood and voice [Franks, 2005, Kiparsky, 2004].

³ Boogaart uses the term *aspectuality* to remove the aforementioned ambiguity [Boogaart, 2004]. However, I will stick with the term *aspect* due to its prevalence in the literature, further specifying where necessary.

the theoretical differentiation of these two interrelated subdomains is an important one to make, and each describes a variety of concepts which will be useful later.

2.1.2 Lexical aspect

Telicity

A fundamental distinction of lexical aspect is that of telicity (from Ancient Greek *télos* meaning “end”). Telicity describes whether an event has an inherent goal or end-point after which the event can be regarded as completed: for example "go climbing" would be atelic whereas "climb the mountain" is telic (since it involves the agent reaching the summit of a mountain). A classic test for telicity⁴ is whether the verb phrase admits a completing adverb such as "in an hour" and does not admit a durative adverb such as "for an hour" [Krifka, 1998].

Dahl misleadingly defines telicity as "involv[ing] the presence of a boundary or the attainment of a specific result-state" [Östen Dahl, 2015], which, however can lead to confusion with the term *(un)boundedness*.

Boundedness

(Un)boundedness refers to the existence (or lack of) a *temporal* boundary marking the end of an action. Boundedness must be distinguished from telicity⁵ in order to avoid the so-called 'Imperfective Paradox' highlighted by Linguistics et al. [2005], here verbalised by Zucchi [2020]:

How is it possible that a statement of the form *x was F-ing* is true and yet there is no time at which *x was F-ed* is true?

More concretely, it asks the question why (1) entails (2) but (3) doesn't entail (4) in the examples below:

⁴ Though Xiao and Mcenery [2006] note that this test is flawed and propose an alternative test scheme.

⁵ Friedrich et al. [2023] seem to mistakenly conflate the two, stating that "[t]elicity is also sometimes referred to as boundedness (e.g., by Loáiciga and Grisot, 2016)" referring to the 2016 paper Loáiciga and Grisot [2016], which, however, clearly distinguishes between the two notions.

- (1) The man was running.
- (2) The man ran.
- (3) The man was building a house.
- (4) The man built a house.

Depraetere [1995] shows that this apparent "paradox" can be resolved by distinguishing between these two concepts of telicity and boundedness,⁶ and this further serves to show the dangers of misuse of terminology. Table 2.1.2 visualises the relationship between the reference time (temporal boundaries) and the run-time (the inherent "time schema" of the verb phrase). This allows for a clearer definition of boundedness, namely whether the right-hand side of the run-time boundary lies within the reference time or not (IS THIS TRUE?).

Stativity

Another parameter of lexical aspect I would like to discuss is stativity, which describes a state of being such as "know", "love" or "be", rather than an action [Binnick, 1991]. A classic test for stativity in English is non-admittance of the progressive or the imperative [McIntosh, 1975].⁷ Consider the following examples:

- (5) She resembles her grandmother.
- (6) * She is resembling her grandmother.

Durativity

Durativity denotes whether an event takes time (i.e. has duration) or happens in an instant, and this can be checked in English by the compatibility of durative adverbs such as *for an hour* [Wilhelm, 2007]. For example:

-
- 6 By definition of telicity as whether an even has an inherent end-point, and boundedness as whether it has a temporal boundary (separate from its intended end-point) we can distinguish between whether an event has reached its termination or whether it was ended before reaching this end-point. Therefore while it the case that the both (1) and (2) are bounded, only (3) and (4) contain telic events, and it seems to be the case that the progressive's focus on temporal boundary nullifies the end-point inherent in the verb phrase "build a house". This serves as an interesting example of the interaction between grammatical and lexical aspect.
 - 7 Interestingly, however, Granath and Wherrity [2013] find that, assuming a functional-semantic definition of stativity, the usage of stative verbs with the progressive is much higher in spoken language, than in written language.

Sentence	Representation	Telicity	Boundedness
The man was running.	<p>The diagram shows a horizontal timeline with an arrow pointing to the right. A bracket above the timeline is labeled 'Reference time' and spans a continuous, unbounded interval. A bracket below the timeline is labeled 'Run-time' and also spans a continuous, unbounded interval.</p>	atelic	unbounded
The man ran.	<p>The diagram shows a horizontal timeline with an arrow pointing to the right. A bracket above the timeline is labeled 'Reference time' and spans a bounded interval. A bracket below the timeline is labeled 'Run-time' and also spans a bounded interval.</p>	atelic	bounded
The man was building a house.	<p>The diagram shows a horizontal timeline with an arrow pointing to the right. A bracket above the timeline is labeled 'Reference time' and spans a continuous, unbounded interval. A bracket below the timeline is labeled 'Run-time' and spans a continuous, unbounded interval. A vertical line segment at the end of the run-time interval is labeled 'Goal'.</p>	telic	unbounded
The man built a house.	<p>The diagram shows a horizontal timeline with an arrow pointing to the right. A bracket above the timeline is labeled 'Reference time' and spans a bounded interval. A bracket below the timeline is labeled 'Run-time' and spans a bounded interval. A vertical line segment at the end of the run-time interval is labeled 'Goal'.</p>	telic	bounded

Table 1: Representation of (1),(2),(3) and (4) with regards to the reference time referred to by the utterance and inherent run-time of the event. Concept adapted from van Hout [2016].

- (7) Andrea was painting a picture for an hour.
(8) * Andrea was reaching the summit for an hour.

2.1.2.1 Some attempts at event classification

Vendler [1957]

It was the seminal work *Verbs and Times* [Vendler, 1957] of philosopher Zeno Vendler which initiated the discussion on inner aspect in the linguistic tradition.⁸ Vendler begins his discussion with the following premise:

Indeed, as I intend to show, if we focus our attention primarily upon the time schemata presupposed by various verbs, we are able to throw light on some of the obscurities which still remain in these matters. [...] There are a few such schemata of very wide application. Once they have been discovered in some typical examples, they may be used as models of comparison in exploring and clarifying the behaviour of any verb whatever.⁹

That is to say, the "time schema" of any verb can be described through comparison with a set of prototypical classes (see 2.1.2.1), which can be easily identified. In order to arrive at these prototypical "schemata" he uses an analytical method consisting of classifying verbs according to their behaviour regarding certain elements of English grammar, as was also used to outline the aspectual parameters above.¹⁰ For example, the first distinction he makes is between English verbs that permit the progressive and those that don't. This signals the first class of events known as 'states'. The article then goes on to outline the other three Vendlerian classes *activity*, *accomplishment* and *achievement*, and their character is summarised thus:

- **State** - non-dynamic, static and durative situation

⁸ A similar classification was also developed independently by Anthony Kenny in *Action, Emotion and Will* [Kenny, 1963], however combining Achievement and Accomplishment into one single class [Mourelatos, 1978]. Hence it is sometimes referred to as the Vendler-Kenny scheme of verb-types.

⁹ Vendler [1957]

¹⁰ The issue of Anglocentrism is one which has plagued many a linguistic theory throughout the years, with work from Chomsky's generative grammar [Levisen, 2019] to Abstract Meaning Representation [Damonte and Cohen, 2018] being criticised for their too heavy focus on English.

	Static	Durative	Telic
State	+	+	-
Activity	-	+	-
Accomplishment	-	+	+
Achievement	-	-	+

Table 2: Classification of Vendlerian event types by binary aspectual parameters [Smith, 1991]

State	Activity	Accomplishment	Achievement
know	running	paint a picture	reach the summit
understand	pushing	build a house	spot the plane
love	smoking	deliver a sermon	recognise

Table 3: Some of the example verb phrases given in Vendler [1957] for the classification of events.

- **Activity** - open-ended, dynamic and durative processes without an end-point
- **Accomplishment** - dynamic and durative processes with a natural end-point
- **Achievement** - instantaneous or near-instantaneous events (such as semelfactives)

Or to use the parameters of lexical aspect introduced above:

Vendler states in his introduction that verbs "presuppose" certain time schemata and hence assigns a category to each verb (as in 2.1.2.1). However it must also be stated that the true profile of a verb phrase such as those listed in 2.1.2.1 depends heavily on the context. Hence a typical semelfactive such as "sneeze" could also be used reinterpreted as a process when combined with a progressive auxiliary as in "Harry was sneezing" [Moens and Steedman, 1988]. Thus the verbs (or verb phrases) mentioned by Vendler as belonging to a certain category are ones that typically lend themselves to one class or another.

Moens and Steedman [1988]

2.1.3 Grammatical aspect

The second

Perfective vs. Imperfective

Progressive

Iterative

2.2 Aspect in Slavic languages

The Slavic language group has a special place on the study of aspectology due to its overt encoding of aspectual phenomena.

WE CAN SEE THE DIACHRONICAL DEVELOPMENT FROM LEXICAL ASPECT TO GRAMMATICAL ASPECT

2.2.1 Perfective-Imperfective

Show that imf and perf different to telicity/boundedness

2.3 Formal models of aspect (or put this in related work?)

I would like to outline some of formal logical approaches that have been made to this area

3 Related Work

3.1 Previous computational approaches to modeling aspect

Aspect has received comparatively very little attention from the computational linguistics community[Friedrich et al., 2023], especially from the Natural Language Processing (NLP) part of the field.¹ However there have been some works in recent years looking at this area:

title

¹ As opposed to those with more emphasis on the *linguistics* part of computational linguistics.

4 Methods

This is the description of the methods.

4.1 Which aspect types do I use?

One inherent drawback of computational methods is exactly their one unifying characteristic: their computability. Sadly, the requirement for computability means, in many cases, sacrificing the nuance that comes with more qualitative approaches. In this concrete case this means settling for a single aspect classification system. A consequence of the glut of literature in the field is a glut of classification systems to go with it, each with their own idiosyncrasies and each having their own advantages and drawbacks. I will attempt to discuss what I see as the main candidates before deciding on one system and explaining this decision - NO - this was done in aspectology already!!!!SEE ABOVE

reason is of course the contribution to the linguistic community: computational approaches to language have SPURRED ON LOTS OF PROGRESS (cf Chomsky!!!).

The framework I decided on was Uniform Meanign Representation (UMR) [Van Gysel et al., 2021].

4.1.1 UMR

UMR [Van Gysel et al., 2021] was introduced in order to expand and further generalise the attempt to design an abstract semantic representation, as was most successfully pioneered by Banarescu et al. [2013] with Abstract Meaning Representation (AMR). In contrast to AMR, UMR aims to be a typologically-informed abstraction away from English structures, making it more suitable for other similar languages, or, in their own words, making it "a practical and cross-linguistically valid meaning representation designed to meet the needs of a wide range of NLP applications" [Van Gysel et al., 2021].

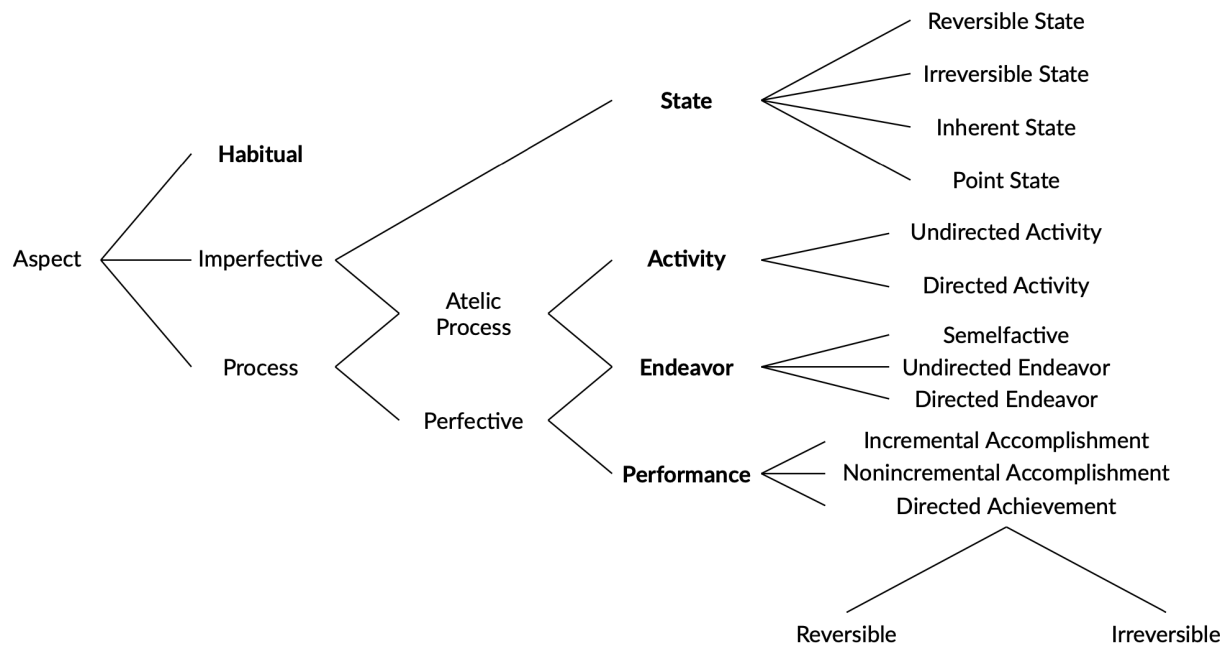


Figure 2: UMR aspect classification tree [Jens Van Gysel and Xue, 2022]

Aspect in UMR

UMR describes the following 5 coarse-grained aspect classes: (descriptions taken from Van Gysel et al. [2021]), also depicted in figure 2:

- **state** - an unspecified type of state
- **habitual** - an event that occurs regularly in the past or present, including generic statements
- **activity** - an event that has not necessarily ended and may be ongoing at Document Creation Time (DCT)
- **endeavour** - a process that ends without reaching completion (i.e., termination)
- **performance** - a process that reaches a completed result state

How these relate to other aspectual classes can be shown in table 4.

Interesting to note is that these classes conflate the distinction made earlier between lexical and grammatical aspect, most clearly in the class "habitual", which is a paradigmatic example of an outer aspect, rather than one inherent in the verb event itself. However, as can be seen in figure

Vendler [1957]	Moens and Steedman [1988]	Egg [2005]	Egg, Prepens, and Roberts [2019]		Van Gysel et al. [2021]
state	state (habitual state)	stative predicate (CHECK THIS)	stative -		state habitual
activity	process	process predicate	dynamic	unbounded	activity
accomplishment	culminated process	intergressive predicate		bounded	extended/no change endeavour
		change predicate			extended/change performance
achievement	point	intergressive predicate			punctual/no change endeavour
	culmination	change predicate			punctual/change performance

Table 4: Comparison of aspectual classes. Adapted and extended from Egg, Prepens, and Roberts [2019].

2, while classes which would usually be seen as grammatical aspect are to be found nearer the top of the tree (on the left), the leaves further down the tree are more examples of *Aktionsarten*. That Van Gysel et al. [2021] make no mention of these different types of aspect is not necessarily surprising, given one of the main design goals of UMR being scalability, itself entailing learnability for annotators. As we have seen (HAVE WE?), the theoretical distinction of inner and outer aspect is "very difficult to apply in practice" [Dahl, 1985], hence a clear separation would often be difficult - and indeed not very fruitful - for annotators. This conflation of two phenomena, however, can also be an advantage, since it shows the relationship between classes of each type (i.e. that *irreversible states* are imperfective and *directed achievements* perfective etc.), subsuming them all into *one* semantic parameter space concerning aspect. A further advantage of UMR is the flexibility of annotation levels that can be seen in figure 2. This allows for annotation both at a fine-grained level (using the classes at the bottom of the tree), but also on a more coarse-grained level if instances are unclear or annotators unsure.

4.2 Use of approximative LMs as sources of linguistic knowledge??

4.3 Where do LLMs fail?

5 Experiments

5.0.1 Language model fine-tuning

5.0.1.1 Ablation (aspectualisation and contextualisation)

5.0.1.2 Combined Rus/Eng model

5.0.2 Probing

5.0.3 Aspect latent space

5.0.3.1 Verb of motion clustering

5.0.3.2 Prefix clustering

6 Discussion

Discussing the results.

7 Conclusion

And finally a conclusion.

A Appendix

A.1 Experiments with ChatGPT

Over the last few years, Large Language Models (LLMs) such as GPT-3 [Brown et al., 2020] have achieved great amounts of success over a range of tasks in the NLP domain.

However it has been shown that models such as ChatGPT struggle with mathematical and logical reasoning.

A.1.1 Temporal reasoning

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