

Constructing English Conditionals: Building Mental Spaces in ECG

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Abstract

The recent book by Dancygier and Sweetser [1] analyzes roughly four categories of English conditionals: Predictive Conditionals, Generic Conditionals, Epistemic Conditionals, Speech-Act Conditionals, using mental-space theory [2]. The purpose of this paper is to introduce a formalization of these findings in Embodied Construction Grammar (ECG) [3], demonstrate the range of data this formalization can handle, raise attention to the computational issues, and offer insights into further analysis of conditionals.

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1. Introduction

Dancygier and Sweetser, in their recent book, discuss four major types of conditionals in English, and their variations. The four types of conditionals are: (i) predictive conditionals (ii) generic conditionals (iii) epistemic conditionals, and (iv) speech-act conditionals. We extracted the basic characteristics of each type of conditionals, and based the rest of our analysis on these assumptions. Following the *if P, Q* notation,

- (i) predictive conditionals are sentences like

If I tie my handkerchief around it [your wounded knee], it will stick.

They are space-builders, setting up a primary space and an alternative space. On the form side, the if-clause is characterized by tense-backshifting. On the meaning side, P and Q are related by some causal relationship (including direct causal and enablement).

- (ii) generic conditionals are sentences like

If you heat water to 100 degrees, it boils.

They are not space-builders but rather knowledge in the base space. P and Q share the same tense, are related by a generic causal relationship.

- (iii) epistemic conditionals are sentences like

If he typed her thesis, he loves her.

They are space-builders, setting up a primary but not always an alternative space. P and Q follows a reasoning pattern, which often manifests as a reverse-causal relationship. Since reasoning can go forward or backward in time, there is no tense restriction on either clause.

- (iv) speech-act conditionals are sentences like

If you need any help, my name is Ann.

They are space-builders in that the P clause sets up the frame in which Q is supposed to be understood. There is no alternative space, and the speech-act exists in both the new space and the base space, and cannot be retracted once said. The content of Q can hold true both in the speech-act space and the base space.

For a discussion of the different variations of these conditionals, please refer to Appendix A.

2. ECG Representation

The rest of this paper describes a set of spaces, schemas and constructions written in ECG that, we argue, capture the different types of conditionals discussed in the previous section. The constructions are designed to allow the most number of variations in an elegant way. We will first introduce the representation of mental spaces, then build up the constructions gradually. As such, the mental spaces, schemas and constructions are arranged in an inheritance hierarchy. As a general guide, we will start from the most general schemas and spaces, and introduce the specializations or subtypes when the constructions require them.

2.1 Mental Space

Following ECG convention, we have a schematic version (i.e. a Compressed-Mental-Space) and an uncompressed version of mental space (i.e. Mental-Space). Risking dangerously oversimplifying mental space theory, a compressed mental space is just a piece of knowledge in the base space about a different space, and grants one access to the full uncompressed space should one choose to expand it. An uncompressed mental space, in this formalism, is the set of parameters needed to build the space. In most cases, these parameters are set up along with the compressed mental space. However, the actual space (along with the simulation mechanism) is not built until an explicit EXPAND directive is used¹.

Without further ado, here are the Compressed-Mental-Space schema and its uncompressed counterpart:

<p>SCHEMA Compressed-Mental-Space</p> <p>ROLES</p> <p>ums: Mental-Space</p> <p>parent-space: Mental-Space</p> <p>status</p> <p>CONSTRAINTS</p> <p>self <--> ums.cms</p>	<p>SPACE Mental-Space</p> <p>ROLES</p> <p>cms: Compressed-Mental-Space</p> <p>parent: Mental-Space</p> <p>alternatives: Mental-Space</p> <p>local-content</p> <p>CONSTRAINTS</p> <p>parent <--> cms.parent-space</p>
--	---

In the Compressed-Mental-Space schema, ums is a pointer to the uncompressed Mental-Space, and parent-space is a pointer to the parent of this space (often the Base-Space). The status can be either default, exception, or unmarked.

Mental-Space corresponds to the kinds of spaces often shown in the style of Fig. 1. In the ECG notation, cms is a pointer back to the compressed version of this space, and parent-space points to the parent of this space (which has to be identical to the parent that the compressed version points at). Unique to the uncompressed mental space are the list of alternatives and the local-content. Alternatives are scenarios that are different and cannot co-exist, for example, different activities that one can be performing at noon tomorrow. Local-content provides the local semantics of mental spaces, maintaining a list of predications that are true in this space, *ceteris paribus*.

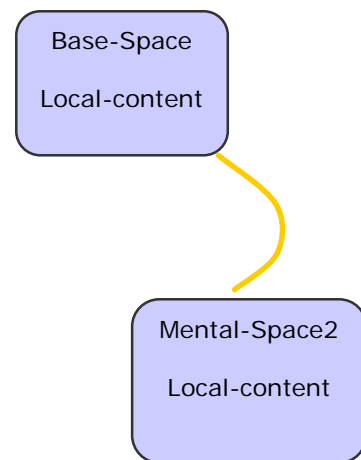


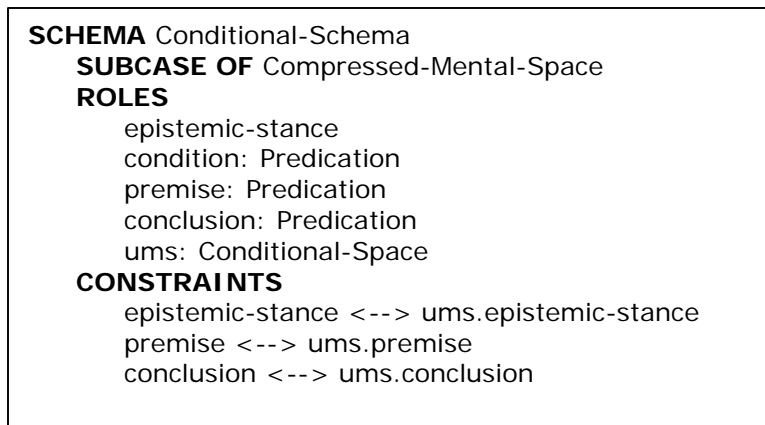
Fig. 1. Mental Space

¹ The EXPAND keyword is a temporary term we invented for the purpose of explicitly building a space. The term may or may not be incorporated into the ECG formalism.

2.2 Conditions

Conditions, often preceding the conclusion in a conditional statement, set up or locate the space in which the conclusion is to be placed, regardless of whether the entire conditional statement is a content-level conditional (predictive or generic), epistemic conditional, or speech-act conditional. Therefore the Conditional-Schema is a subcase of the Compressed-Mental-Space.

In addition to the inherited roles, the Conditional-Schema has roles for epistemic-stance, which is roughly how likely the speaker believes that the condition will happen, a condition, a premise, and a conclusion. condition stands for the condition P as expressed, and premise can be P or $\sim P$, as will be shown in the next example.



The uncompressed space in the Conditional-Schema is further restricted to be a Conditional-Space, which is shown below. The Conditional-Space contains much of the same information as the schematic version, and the premise and conclusion are appended to the local-content of the space. It is important at this point to stress that the local-content is merely a list of facts that hold true in the space. More specific relations between these facts will be appended to the local-content when the specialized constructions find them necessary.

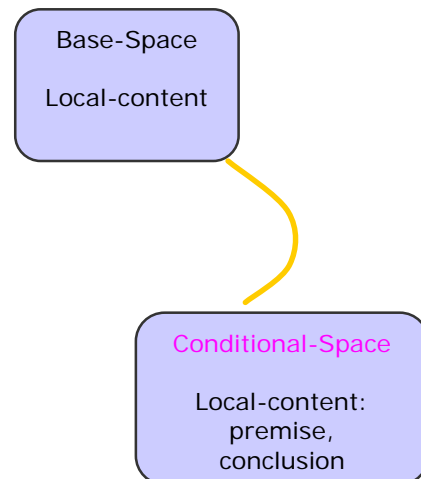
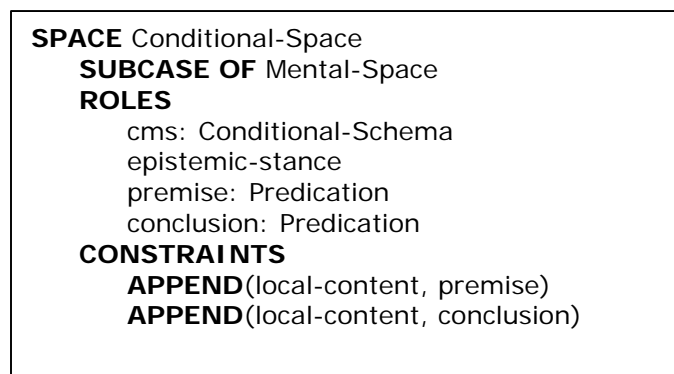


Fig. 2. Conditional Space

2.2.1 The If construction

The abstract construction Conditional-Conjunction is a supertype of lexical constructions If and Unless. A Conditional-Conjunction does not have meaning on its own, but **EVOKES** two copies of the Conditional-Schema, one as primary and one as alternative. Notice that evoking both schemas does not mean that both Conditional-Spaces will be built, or even parameterized. We only postulate that these conjunctions make the hearer expect a conditional statement and the alternative scenarios that may arise. This point will be further discussed in the next two sections.

abstract **CONSTRUCTION** Conditional-Conjunction

MEANING

EVOKES Conditional-Schema AS cs

EVOKES Conditional-Schema AS alt

Given the Conditional-Conjunction and the Conditional-Schemas it evokes, the If construction only needs to hook up the correct premise and set the epistemic-stance to neutral. The condition itself does not get filled in until a larger construction uses the Conditional-Conjunction as a constituent. Notice that the If construction only gives information about the primary space and does not set up an alternative. This is in line with the speech-act use of *if*.

lexical **CONSTRUCTION** If

SUBCASE OF Conditional-Conjunction

FORM: Word

self.f.orth <- "if"

MEANING

cs.premise <--> cs.condition

cs.epistemic-stance <-- neutral

2.2.2 The Unless Construction

The Unless construction is comparatively a bit more complicated. The main difference is that *unless* sets up both the primary and alternative spaces by providing a piece of information for each space. In *Unless P, Q*, a default space is set up with Q as the conclusion (where $\sim P$ is the premise, which we later fill in), and an exception space is set up with P as the premise (where $\sim Q$ is the conclusion, which we again later fill in). The epistemic-stance on the primary space is still neutral.

lexical **CONSTRUCTION** Unless

SUBCASE OF Conditional-Conjunction

FORM: Word

self.f.orth <- "unless"

MEANING

alt.premise <--> cs.condition

cs.epistemic-stance <-- neutral

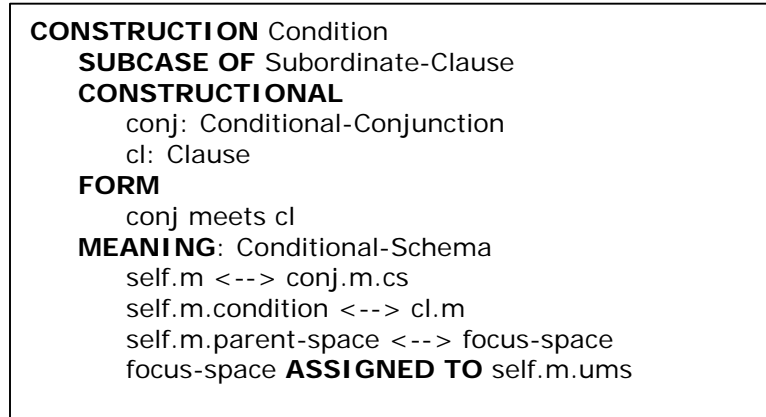
cs.status <-- default

alt.status <-- exception

2.2.3 The Condition Construction

The Condition construction forms a Subordinate-Clause from a Conditional-Conjunction and a Clause. The most important aspect of this construction is that it identifies its meaning pole (a Conditional-Schema) with the Conditional-Schema that is evoked by the Conditional-Conjunction, thereby preserving all the constraints on the premise, epistemic-stance and status that If and Unless set up.

In addition, it also fills in the actual content of the condition with the meaning of the Clause. It sets the parent-space to the current Focus-Space, then assigns the Focus-Space to itself. This will be illustrated in the next two examples.



2.2.4 Examples

(i) *If it rains tomorrow*

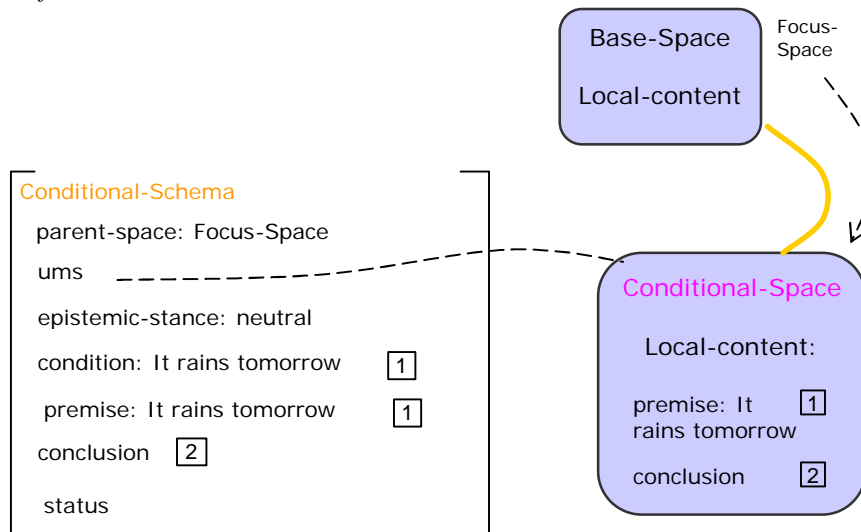


Fig. 3. Mental spaces set up by an *if*-conditional

The If construction sets the epistemic-stance to neutral, and binds the premise to the condition P. The Conditional-Schema automatically appends both the premise and conclusion to the local-content of the space, therefore the premise, now filled in, appears there. The Focus-Space is assigned to the new space as a result of this Condition construction. An alternative Conditional-Schema is evoked by the Conditional-Conjunction, but never filled out by If, so it does not appear in this diagram.

(ii) *unless it clears up tomorrow*

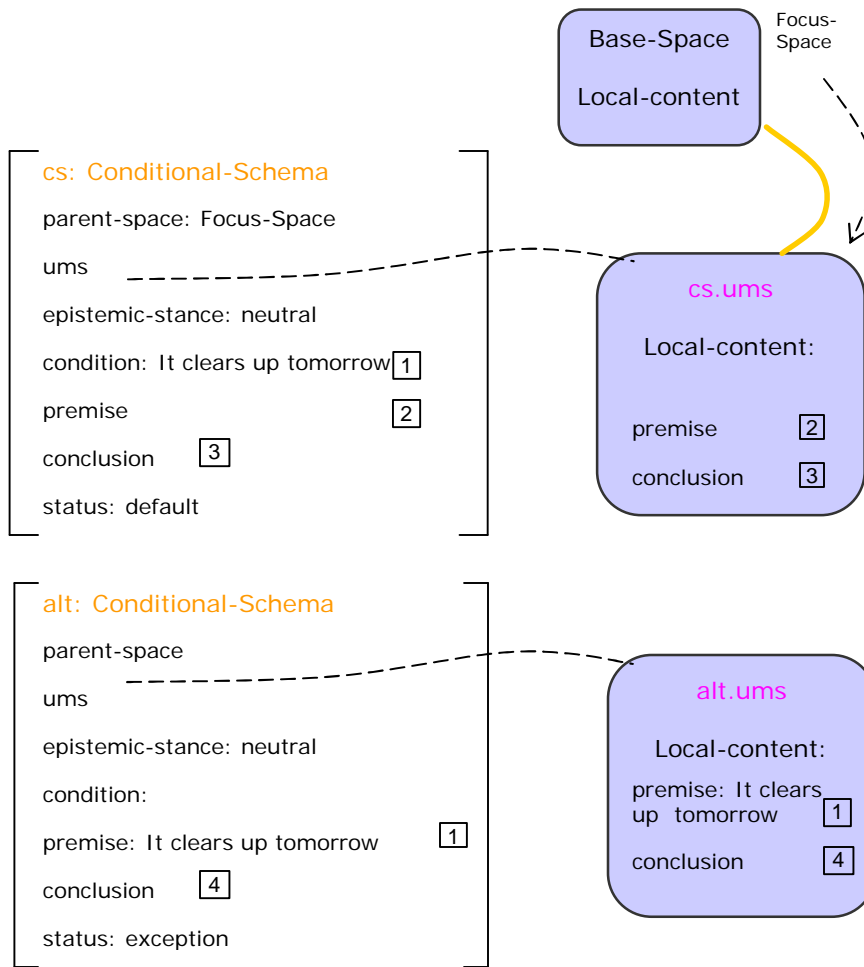


Fig. 4. Mental spaces set up by an *unless*-conditional

Figure 4 deserves a bit more explanation. The Unless construction sets up two Conditional-Schemas, and therefore parameterizes two Conditional-Spaces. It sets the premise of the alternative space to be the condition P. It denotes the primary space as default, and the alternative space as exception.

Only the primary Conditional-Schema is bound to the meaning pole of the Condition Construction, but notice that we can still have a handle on the alternative space through the Conditional-Conjunction. The primary Conditional-Schema has very little filled in at this point, because the conclusion will be filled in only when the entire conditional statement is seen, and the premise will be set in a larger construction.

The Focus-Space, again, is assigned to the primary space as a result of the Condition construction.

2.3 Predictions

We will now introduce our formalization of unconditional predictions, which are basically speculated facts about the future. In this formalization, predictions are not space builders in and of themselves. Instead, they are events that are marked as future, and the general treatment of events and time within the ECG framework is responsible for recognizing the future marker and performing the correct type of simulation.

This way of thinking is consistent with how we think that past events should be treated. Certain events in the past are known, while some are uncertain (hence detective novels and crime-solving in general). Both past and future events are stored in the base space in a schematic form, accessible as facts with qualifications, and if necessary, the simulation mechanism can take these schemas and expand them in a generic way.

```
SCHEMA Prediction-Schema
EVOKES Event AS e
ROLES
  predicted-event: Predication
  likelihood-of-predicted-event
  basis-of-prediction
CONSTRAINTS
  predicted-event.category <--> e
  predicted-event.time-location <-- future
```

```
SCHEMA Event //minimal
EVOKES Cause-Effect AS ce1
EVOKES Cause-Effect AS ce2
ROLES
  time-extent
  time-location
  participants
  action
  setting: Scene
CONSTRAINTS
  ce1.effect <--> self
  ce2.cause <--> self
```

Therefore, as shown above, Prediction-Schema is not a subcase of Compressed-Mental-Space. It includes a predicted-event, which is a predication of category Event (denoted through the EVOKES statement and the binding), a likelihood-of-predicted-event, which is some scalar value, and a basis-of-prediction, which is not utilized at the moment.

The Event schema is provided here for reference, but we make no claim that this is the complete representation of an event. At the minimum we need certain representation of time, participants, the action, and setting, as well as the cause of the event and the consequence of the event. We shall see that the cause of the predicted-event get set in a Conditional-Prediction statement.

2.3.1 The Prediction Construction

The Prediction construction, then, is a Clause that evokes a Prediction-Schema in its meaning. The meaning pole of a Clause is a Predication. By identifying the meaning pole of the Prediction construction with the predicted-event, the Prediction is required to be an Event, possibly through construal (e.g. states).

CONSTRUCTION Prediction SUBCASE OF Clause CONSTRUCTIONAL time-reference <-- relative-future(Viewpoint-Space) MEANING: EVOKES Prediction-Schema AS ps ps.predicted-event <--> self.m

The nature of prediction requires that the time reference be future with respect to the Viewpoint-Space. However, this requirement admits a number of subtypes of the Prediction construction that flesh out the distinction between *will*, *shall*, *gonna*, present-for-future, imperfectives, and other modal constructions.

2.3.2 Example

The game will be cancelled.

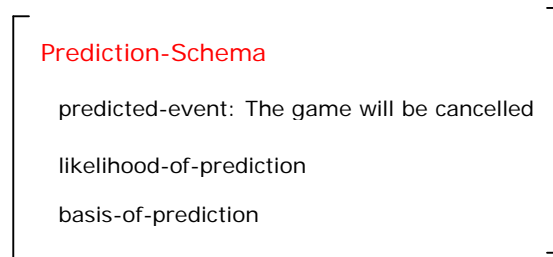


Fig. 5. The Prediction-Schema filled by a prediction

This very simple example shows that the basic job that the Prediction construction performs is to fill in the predicted-event with the actual prediction, i.e. game cancellation tomorrow.

2.4 Conditional Statements

Conditional-Statement is a very general construction that puts a Condition and a Clause together, in whichever order². This construction is designed to be a supertype of all four types of conditionals that were discussed in the introduction of this paper.

The most important thing to notice is that this larger construction finally fills in the conclusion of the Condition with the meaning pole of the statement.

CONSTRUCTION Conditional-Statement
CONSTRUCTIONAL
cond: Condition
statement: Clause
MEANING
cond.conclusion <--> statement.m

2.5 Predictive Conditionals

To a first approximation, a Conditional-Prediction is just a special case of the Conditional-Statement where the statement has to be a Prediction. However, extra care has to be taken to ensure that the alternativity and cause-effect relation between P and Q are set up correctly.

Recall that the Conditional-Conjunction EVOKES two Conditional-Schemas, which are either partially filled in or not filled in at all. Intuitively, the goal of this construction is to completely fill out these two schemas (and their respective spaces), and put a Cause-Effect relation between the premise and conclusion in the local-content of each space.

The Conditional-Prediction construction is shown on the next page, followed by two examples of how this construction interacts with the If construction and the Unless construction. It may be worthwhile at this point to skip over to see the examples before reading the constraints in ECG notation.

² This construction, should the analyzer allow it, would also accept inserting the condition in the middle of the statement, for sentences like *Technically, if you can get technical about such things, maybe I did hold it [the kiss] for a couple of seconds too long.*

2.5.1 The Conditional-Prediction Construction

```
CONSTRUCTION Conditional-Prediction
SUBCASE OF Conditional-Assertion
CONSTRUCTIONAL
  statement: Prediction
  statement.time-reference <-- relative-future(condition.time-reference)
MEANING:
  EVOKES Cause-Effect AS ce-primary
  EVOKES Cause-Effect AS ce-alternative

  alt: Conditional-Schema
  alt <--> cond.conj.alt
  alt.premise <--> not(cond.premise)
  alt.conclusion <--> not(cond.conclusion)
  alt.epistemic-stance <-- opposite(cond.epistemic-stance)

  ce-primary.cause <--> cond.premise
  ce-primary.effect <--> cond.conclusion
  APPEND(cond.msp, ce-primary)
  APPEND(cond.msp.alternatives, alt.msp)

  ce-alternative.cause <--> not(cond.premise)
  ce-alternative.effect <--> not(cond.conclusion)
  APPEND(alt.msp, ce-alternative)
  APPEND(alt.msp.alternatives, cond.msp)

  ce-primary <--> assertion.ps.predicted-event.ce1
```

A role alt is created with type Conditional-Schema to capture the fact that there is an alternative space parameterized by this construction. alt is then identified with the alternative Conditional-Schema evoked in the Conditional-Conjunction. This has the effect of "bringing in" all the constraints that have been set by the Unless construction, or filling out the unused alternative Conditional-Schema in the If construction.

The complete filling out of both Conditional-Schemas are done by identifying the premise in the alternative schema with the negation of the premise in the primary schema, and like-wise for the conclusion. The epistemic-stance of the alternative schema is set to the opposite of that in the primary. For example, the opposite of a neutral stance remains neutral, and the opposite of a negative stance becomes a positive stance.

So far, the only things floating in the local-content of both spaces are the premise and conclusion, which are just predications without any relations between them. The next two sections assert a Cause-Effect relation between the respective premise and conclusion, and placing that in the local-content. It also adds the other space to its list of alternatives.

Finally, the last statement identifies the primary cause-effect with ce1 of the predicted-event (in the Event schema), thereby filling in the cause of the predicted-event.

2.5.2 Examples

(i) *If it rains tomorrow, the game will be cancelled.*

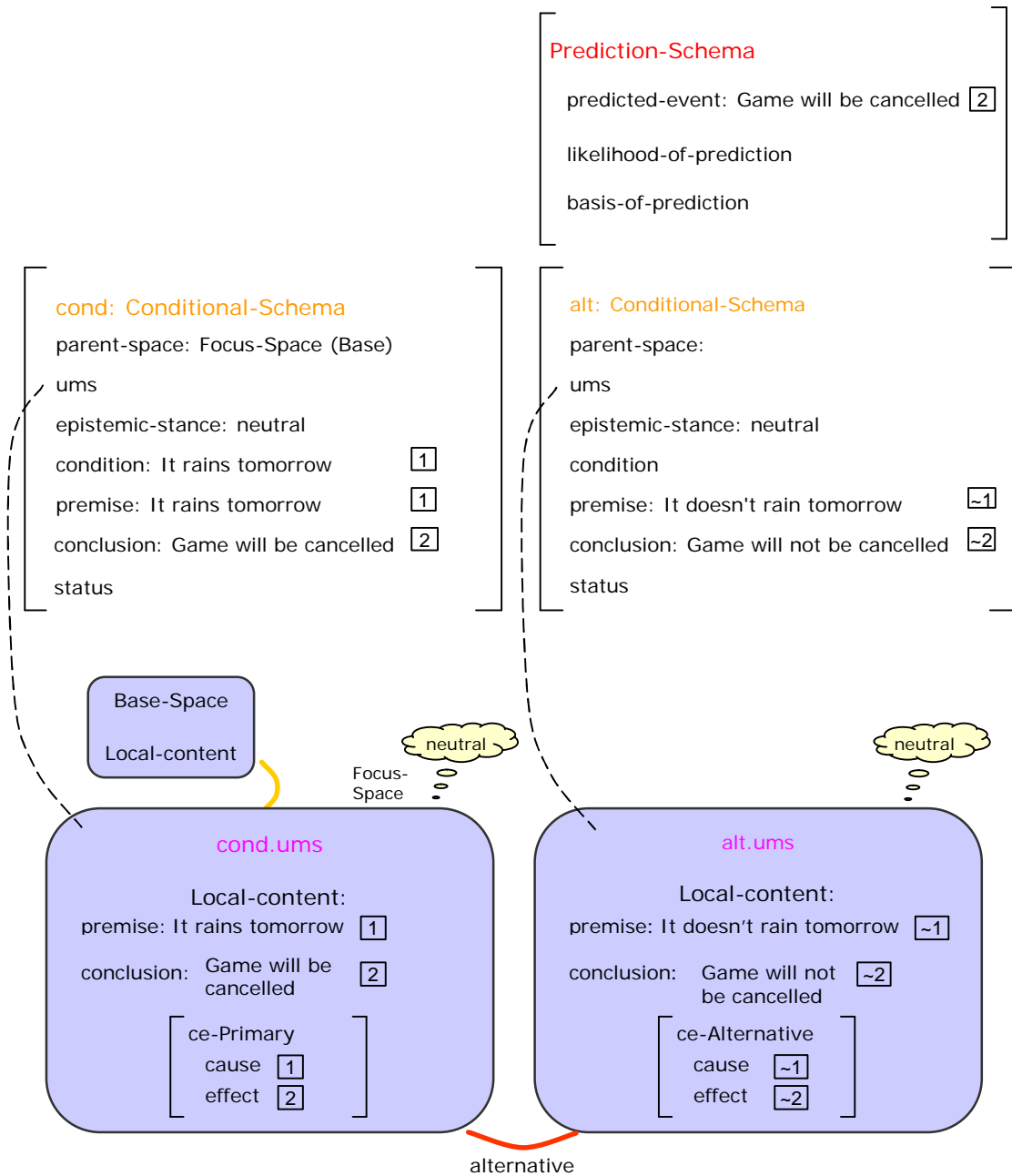


Fig. 6. Mental Spaces filled-in by Conditional-Prediction with *if*

Given a Condition with *if* (Fig. 3) and a Prediction (Fig. 5), the Conditional-Prediction construction completes this picture. The predicted-event is filled into the conclusion in the primary Conditional-Schema. The alternative Conditional-Schema, previously untouched by *If*, now gets the negated premise and conclusion. A primary Cause-Effect (ce-Primary) is evoked and placed into the local-content of the primary Conditional-Space, and likewise for the alternative space. The two spaces are linked as alternatives.

(ii) *The game will be cancelled unless it clears up tomorrow.*

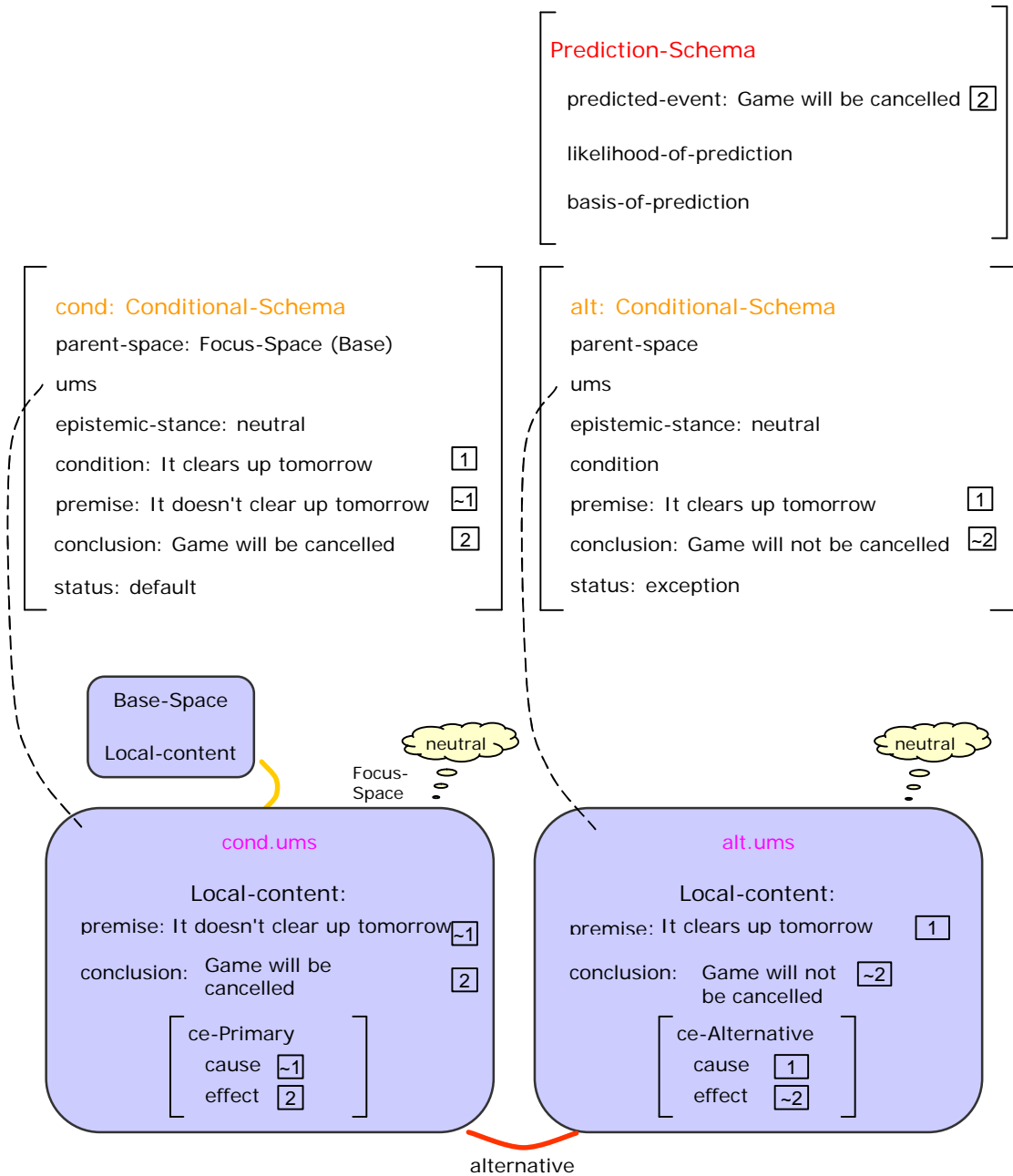


Fig. 7. Mental Spaces filled-in by Conditional-Prediction with *unless*

Given a Condition with *unless* (Fig. 4) and a Prediction (Fig. 5), the Conditional-Prediction construction completes this picture. Again, the predicted-event is filled into the conclusion in the primary Conditional-Schema. In this case, however, the primary and the alternative Conditional-Schemas are already partially filled in to start with, and they just need to be completed. The primary schema gets its premise filled in with the negated premise of the alternative. The alternative schema gets its conclusion filled in with the negated conclusion of the primary. Finally, a primary Cause-Effect (ce-Primary) is evoked and placed into the local-content of the primary Conditional-Space, and likewise for the alternative space. The two spaces are linked as alternatives.

2.5.3 Distanced Forms

These two sections deal with variations in the Condition construction. The first variation is representing negative epistemic stance when a distanced form is used. An example of a conditional with a distanced verb form is:

If he decided to file the suit, the hospital's lawyers would be allowed to interview him for discovery.

It is worthwhile to note that there are two readings of the above example. One is a strictly past time-reference reading, and one is a present time-reference reading with a negative epistemic stance, and the correct reading is solely based on context. This inherent ambiguity is represented by competing constructions in our formalization.

Shown below is the Distanced-Condition construction. In addition to constraints inherited from the Condition construction, it requires that the tense be of distanced form, which generally means one layer of past morphology. The epistemic-stance in the Conditional-Schema in its meaning pole is set to negative. In the unification hierarchy, negative unifies with neutral to form negative.

CONSTRUCTION Distanced-Condition SUBCASE OF Condition FORM cl.tense <-- distanced MEANING self.m.epistemic-stance <-- negative

Therefore with the above example, a Condition construction will fire as well as a Distanced-Condition construction, resulting in two competing Conditional-Prediction constructions. The correct analysis will be handled at the pragmatics level, with information from the context.

2.5.4 Counterfactuals

The second variation in the Condition construction is representing counterfactuals. An example is:

If I'd've known you were coming, I'd've stayed home.

This particular example uses the special constructions *had've* / *had'of*, but in general, since English only has two layers of past morphology, the same kind of ambiguity as discussed in the last section appears. Therefore we again propose competing constructions, with the specialized Counterfactual-Condition construction requiring a very-distanced form. A very-distanced form generally means multiple-layers of past morphology, *had've*, or *were to*, etc. The epistemic-stance, in this case, is set to very-negative.

CONSTRUCTION Counterfactual-Condition SUBCASE OF Condition FORM cl.tense <-- very-distanced MEANING self.m.epistemic-stance <-- very-negative
--

2.6 Conditionals with And / Or conjunctions

The examples of conditionals with *and* or *or* as conjunctions that we encountered are all predictive conditionals, therefore only this variant is treated in our formalization. Here are two examples:

(i) *Take another step and I'll shoot!*

(ii) *Stop or I'll shoot!*

Unlike other and/or sentences, the two sides of the conjunctions in and/or conditionals do not have equal weight, therefore special constructions are written. Particularly, the clauses on the two sides must occur in a fixed order, i.e. the premise, usually a Command, must come before the conclusion.

Shown below is the And-Predictions construction. It looks just like what one expects from a Conditional-Prediction construction, with the exception of the last EXPAND statement. Since and-conditionals are often offers or threats, partially arising from the imperative aspect of the command, there is a higher level of urgency that requires immediate simulation for decision-making. Therefore, the EXPAND directive is used to require that both Conditional-Spaces be built right away.

```
CONSTRUCTION And-Prediction
CONSTRUCTIONAL
  c: Command
  p: Prediction
  and: And
FORM
  c before and before p
MEANING
EVOKES Cause-Effect AS cep
EVOKES Cause-Effect AS cea
  primary: Conditional-Schema
  alternative: Conditional-Schema

cep.cause <--> c.m
cep.effect <--> p.m
cea.cause <--> not(c.m)
cea.effect <--> not(p.m)

primary.premise <--> c.m
primary.conclusion <--> p.m
primary.epistemic-stance <-- neutral
primary.parent-space <--> focus-space
APPEND(primary.ums.local-content, cep)
APPEND(primary.ums.alternatives, alternative)

alternative.premise <--> not(c.m)
alternative.conclusion <--> not(p.m)
alternative.epistemic-stance <-- neutral
APPEND(alternative.ums.local-content, cea)
APPEND(alternative.ums.alternatives, primary)

cep <--> p.ps.predicted-event.ce1

EXPAND primary.ums
EXPAND alternative.ums
```

For completeness, the Or-Prediction construction is shown here. The only difference between this construction and the And-Prediction construction is the correct negation of one side of the conjunction to get the two Cause-Effect schemas right.

CONSTRUCTION Or-Prediction
CONSTRUCTIONAL
 c: Command
 p: Prediction
 or: Or
FORM
 c before and before p
MEANING
EVOKES Cause-Effect **AS** cep
EVOKES Cause-Effect **AS** cea
 primary: Conditional-Schema
 alternative: Conditional-Schema

cep.cause <--> c.m
 cep.effect <--> not(p.m)
 cea.cause <--> not(c.m)
 cea.effect <--> p.m

primary.premise <--> c.m
 primary.conclusion <--> not(p.m)
 primary.epistemic-stance <-- neutral
 primary.parent-space <--> focus-space
APPEND(primary.ums.local-content, cep)
APPEND(primary.ums.alternatives, alternative)

alternative.premise <--> not(c.m)
 alternative.conclusion <--> p.m
 alternative.epistemic-stance <-- neutral
APPEND(alternative.ums.local-content, cea)
APPEND(alternative.ums.alternatives, primary)

cep <--> p.ps.predicted-event.ce1

EXPAND primary.ums
EXPAND alternative.ums

Essentially, what the above construction creates is a mental-space diagram that looks like:

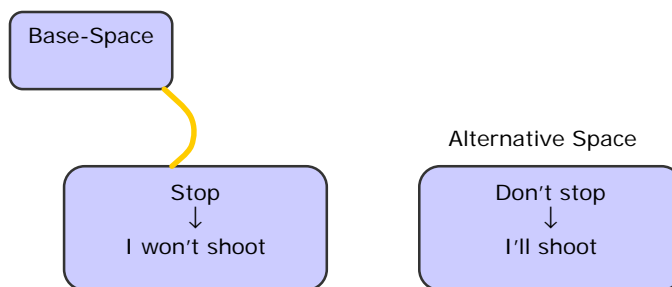
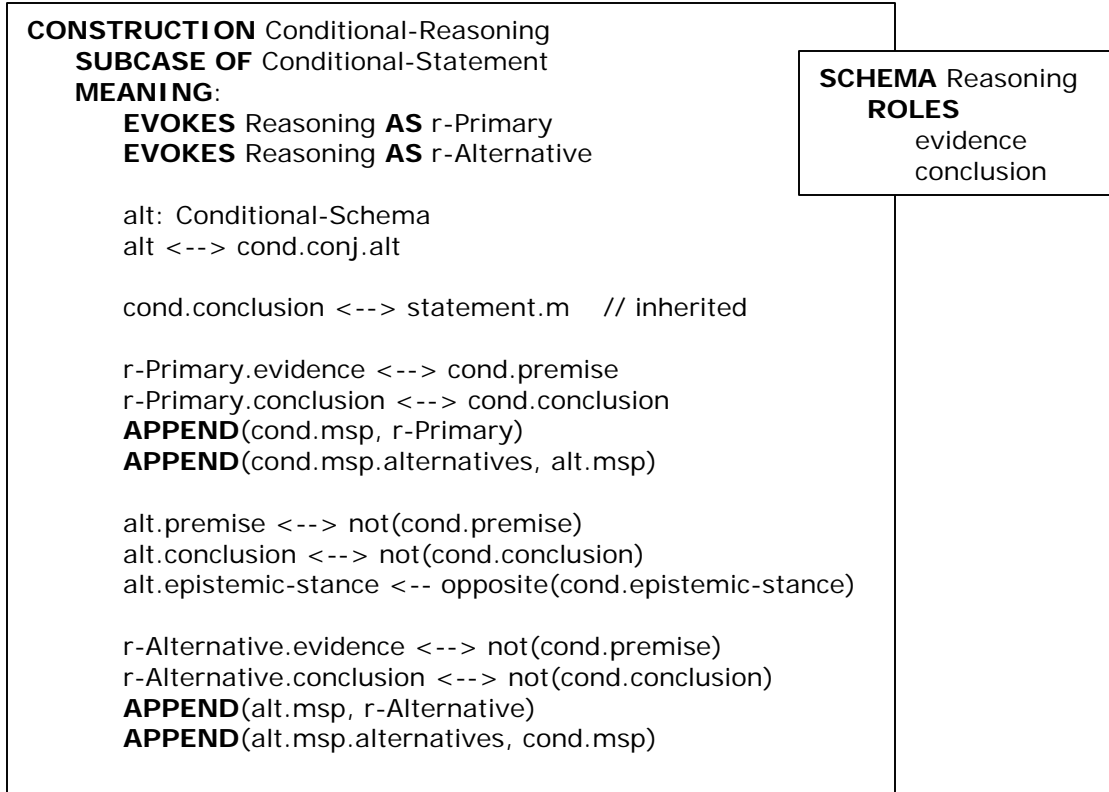


Fig. 8. Mental Spaces created by the Or-Prediction Construction (Simplified)

2.7 Epistemic Conditionals

The major difference between a predictive conditional and an epistemic conditional, as mentioned in the introduction, is the lack of a direct causal relationship between the premise and conclusion in an epistemic conditional. They could be related by a reverse causal relationship, but in generally they represent a line of reasoning.

To represent this difference in our formalization, we create a Conditional-Reasoning construction, which is a subcase of Conditional-Statement with the evoked Reasoning relation between the premise and conclusion filled in.



The Conditional-Reasoning construction should look to the reader exactly like the Conditional-Prediction construction, with two exceptions. First, the evoked Cause-Effect schemas are replaced by the Reasoning schemas. The Reasoning schema, as shown on the side, consists of an evidence role and a conclusion role, at the minimum. This schema asserts no content-level causal relationship between the evidence and the conclusion, and any further relation between the two have to be either supplied linguistically or obtained through inference. Second, the last statement setting the cause of the predicted-event is omitted, precisely because no content-level cause is given in this statement.

In the introduction of this paper, we mentioned that epistemic conditionals do not always construct an alternative space, particularly when the evidence is already known to be true. Here, somewhat contrary to the what we just said, the Conditional-Reasoning construction always construct both a primary and an alternative space. The reason is that, in a closer analysis, there is nothing linguistically to disallow the alternative space from being parameterized. It is the context and knowledge that may rule out one of the spaces as contrary to facts, and therefore see no reason to open up the space for simulation.

The next page shows an instance of a Conditional-Reasoning construction.

If he typed her thesis, he loves her.

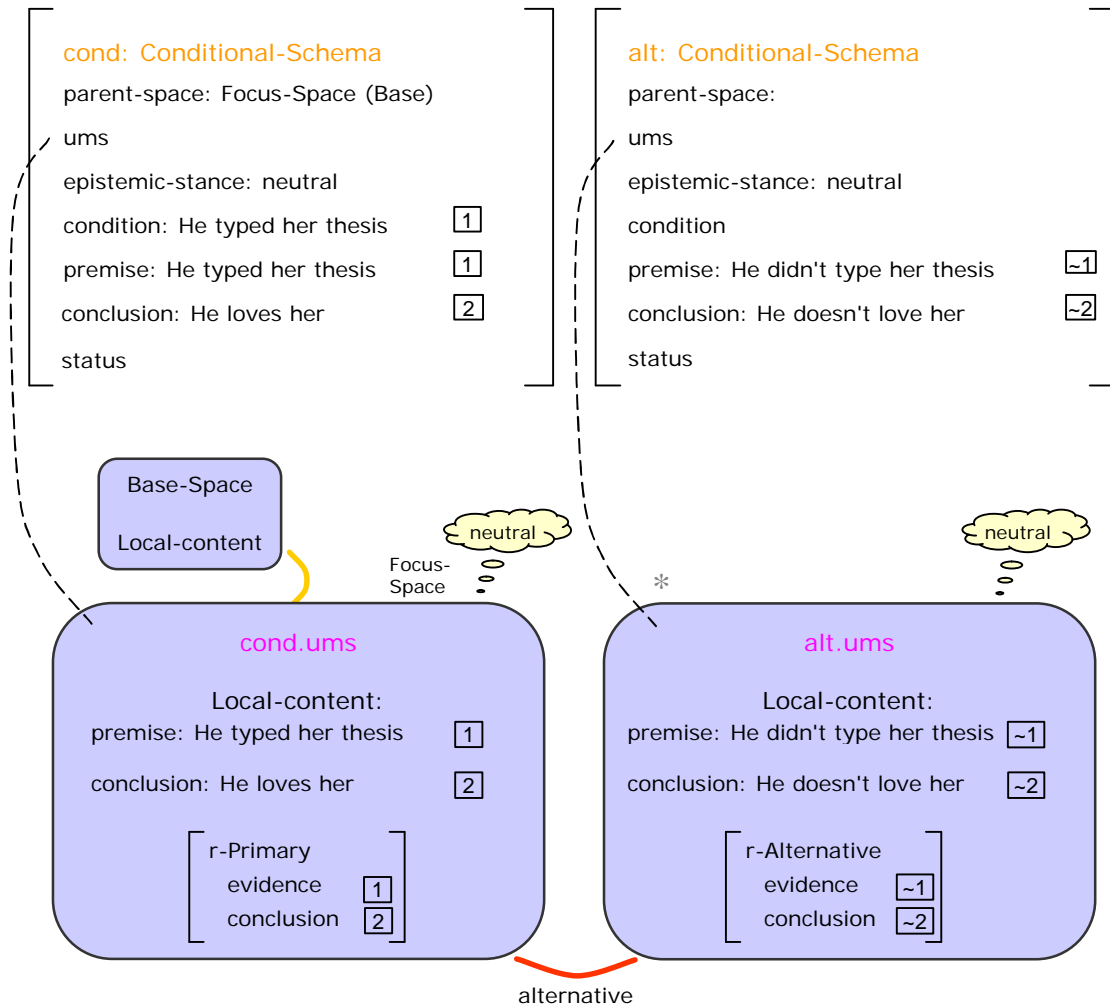


Fig. 9. Mental Spaces filled out by the Conditional-Reasoning Construction

He loves her is just a Clause whose meaning pole is the Predication itself, which gets filled into the conclusion of the Conditional-Schema. A Reasoning schema is appended to local-content of each space, with the evidence and conclusion properly filled in with the respective premise and conclusion. The alternative space is tentatively starred, as a result of pragmatics and not the construction.

3. Other types of conditionals

We discussed four major types of conditionals in the introduction. However, it is out of the scope of this paper to provide a formalization of all these categories and their variations. In particular, generic conditionals and speech-act conditionals have not been discussed. The lack of concrete treatment for these conditional constructions partially arise from a general need for knowledge representation work and treatment of pragmatics within the ECG framework.

It is nonetheless the goal of this section to propose a rough outline of how these two types of conditionals should be formalized, and discuss the trouble spots in formalizing them. We will also discuss the challenges that we faced in thinking about concessive conditionals, and propose a different way of conceptualizing conditional spaces that offers a computationally tractable solution.

3.1 Generic Conditionals

Generic conditionals are, in this formalization, a subcase of the Conditional-Statement. The statement becomes the conclusion of the condition, and the premise and conclusion are related by a Generic-Cause-Effect schema.

It is unclear if this is the best way to formalize generic conditionals. The two questions at hand are: 1. Should the Conditional-Space that the Condition construction creates be discarded or identified with the Base-Space? 2. How should past generics be handled, particularly at the knowledge representation level? Should they be represented as past events with an effective duration?

3.2 Speech-Act Conditionals

Speech-act conditionals are a subcase of Conditional-Statement that obtain richer meaning through pragmatics and inference. There are no relations between the premise and conclusion derivable from the linguistic form, and the conclusion is appended to the local-content of the Conditional-Space as well as the Base-Space.

The large unresolved issue is how should speech-acts be represented and how are they recognized. On the form side, a speech-act conditional can look exactly like a true generic conditional in that both the P and Q clauses are in the present tense. Consider these two statements:

If you heat water to 100 degrees, it boils.

If you are hungry, there are biscuits on the sideboard.

None of the distinctions we have made on the form side so far can put these two sentences into two different categories of conditionals. Furthermore, the Q clauses in both sentences seem to be an informative. One way of looking at the differences between these two sentences is to delimit the speech-acts differently. In this case, the entire first sentence is a speech-act, where the content of this speech-act is informing the hearer of some generic cause-effect relations. However, in the second sentence, only the Q clause is the actual speech-act, which serves to inform the hearer of a fact, and the condition P is only giving the hearer explicit reason why the speech-act is made.

Recognizing speech acts is an issue that should not be limited to the scope of conditionals only, and would only yield fruitful answers if all types of speech-acts are considered.

3.3 Concessivity

Concessive conditionals refer to conditionals that conjure up a range of mental spaces that are alternatives of each other, arranged on a scale. The conclusion Q is true in a subset of these spaces, and $\sim Q$ is true for the remainder.³

On the constructional side, concessive conditionals are often denoted by the use of *even if*, but a concessive reading can often be obtained with *if* alone. The followings are two examples:

(i) *Even if he commits a crime, they will vote for him.*

(ii) *It would be a problem, but why would Jed need a partner? If he had ten or fifty partners, he could not stop them. There is no difference.*

The scalarity arises either explicitly from the use of *even*, or from something construable as a scalar quantity in the P clause. The scale in the first sentence is the badness of actions that the candidate can take, and the scale in the second sentence is the number of partners Jed can have. The range of mental spaces thus come from the different quantities that one can fill into that scalar value.

If we were to continue in the vein of our proposed formalization of conditionals, a large number of mental spaces (possibly infinitely many) have to be parameterized as a result of a Concessive-Condition construction. While it is perfectly reasonable to explicitly write out two alternatives for all the constructions discussed in previous sections, the mere parameterization of this many number of spaces, not to mention building them up, is not only computationally infeasible, but also cognitively implausible.

This prompts a re-thinking of how conditionals should be formalized and what the deep-semantic representations should look like. The basic idea is to collapse the range of alternative mental spaces into one simulation mechanism with a variable simulation parameter. The change in the simulation parameter would then lead to different simulation outcomes, which correspond to the different conclusions in the different mental spaces.

What this means for the first example given above, is something like this:

1. There is one cause-effect relation between badness of the candidate's action and the voters' choice.
2. The badness of the candidate's action is the variable simulation parameter.
3. The voters' choice is the simulation outcome.
4. If the badness is set to a sufficiently low level (below the threshold), the simulation outcome is that voters will vote for the candidate.
5. If the badness is set above the threshold, the simulation outcome is that voters will not vote for him.

Conditionals that are discussed in previous sections fit nicely into this framework. In those cases, there are only two alternatives. That means that the variable simulation parameter is now binary, and the threshold is either true or false.

This way of conceptualizing conditional spaces is radically different from what we described in the previous sections, but not at all incompatible. Particularly, the alternativity is preserved even though the mental spaces are collapsed into one simulation, precisely because there can only be one filler for the variable at a time. The different premises and conclusions cannot co-exist in the same space. Yet comparisons across what we previously called alternative spaces can still be made, by comparing different simulation outcomes.

³ Notice that we are intentionally vague in the above description. Due to the lack of comprehensive data, we attempt to make the scope as general as possible to accommodate variations in concessive conditionals.

This conceptualization is particularly useful in terms of resolving a somewhat unpleasant issue with the previous relation between the premise and conclusion. The issue can be better illustrated with an example. Consider this pair of sentences:

(i) *If it rains tomorrow, the game will be cancelled.*

(ii) *If it does not rain tomorrow, the game will not be cancelled.*

In the case of (i), even though the sentence strongly suggests an *iff* reading, it does not in fact put the speaker down on the book as having also said (ii). For example, if the speaker has only said (i), it is perfectly possible that the game may still be cancelled the next day due to a hail storm. However, if the speaker has said both (i) and (ii), which is the full *iff* statement of *The game will be cancelled if and only if it rains tomorrow*, he has lied if the game is cancelled the next day due to a hail storm.

This observation points out that the primary and the alternative scenarios are not on entirely equal grounds. Therefore, it may be incorrect to assert that there are two independent cause-effect relations, one in the primary space between raining and game cancellation, and one in the alternative space between not raining and no game cancellation. The most one can say is that there is a single cause-effect relation between raining and game cancellation, and the absence of the rain, given no other information about other causes, cannot cause the game to be cancelled. The local-semantics of the conditional space structures would allow us to infer the weak *iff* reading.

The elegance of this conceptualization of conditional space is that one simulation mechanism can represent an entire range of alternative spaces, given different settings of the variable simulation parameter. This is not equal to saying that all the alternative scenarios co-exist in the same mental space, because they are the results of distinctly different runs of the simulation. What this gives is a computationally compact and cognitively plausible way of representing how one can project different (but related) premises forward or backward in time and reach different conclusions.

By viewing conditional spaces this way, both concessive and non-concessive conditionals can be treated in a uniform manner. The difference only emerges in the scale that concessive conditionals evoke, which in turns allow for more fine-grain settings for the variable simulation parameter.

4. Future Work

The work in this paper is just the tip of the iceberg in formalizing conditionals and mental space theory. The three topics mentioned in the last section are a just few of the areas that need exploration.

On the computational side, a lot of questions have been swept under the carpet. There are at least two major issues that have to be resolved. The first is the mental space maps, which have been omitted from the entire discussion. How maps should be represented and how entities and events should be linked up across spaces is an open question for us. The second issue is inference, and it relates to previous concerns about presupposition floats. What information should be propagated to new spaces and what inference results should be allowed back into the base-space is another big open question. It is our hope to work on this end further, with a wider scope of not only conditionals, but other types of mental spaces as well.

5. Conclusion

In this paper, we have taken four major types of conditionals in English discussed by Dancygier and Sweetser, and proposed a framework for formalizing their analysis in Embodied Construction Grammar. These four types of conditionals are Predictive Conditionals, Generic Conditionals, Epistemic Conditionals, and Speech-Act Conditionals, and are characterized in terms of the difference in their preferred mental space structures.

Our formalization breaks up each conditional statement into two smaller constructions: the condition and the statement. The Condition-Construction, a subordinate-clause, is responsible for setting up the mental space (a Conditional-Space) in which the statement should be placed. The statement carries the content of the conclusion and other attributes which later get filled into the Conditional-Space set up by larger constructions. The way the statement is put into the Conditional-Space is dependent on what type of conditionals it is, and these are represented by different larger constructions. The Conditional-Prediction construction, for example, asserts a Cause-Effect relation between the premise and conclusion, while the Conditional-Reasoning construction asserts a Reasoning relation between the premise and conclusion. Variations in the Conditional-Conjunction, epistemic-stance and status are captured by smaller constructions within the Conditional-Construction.

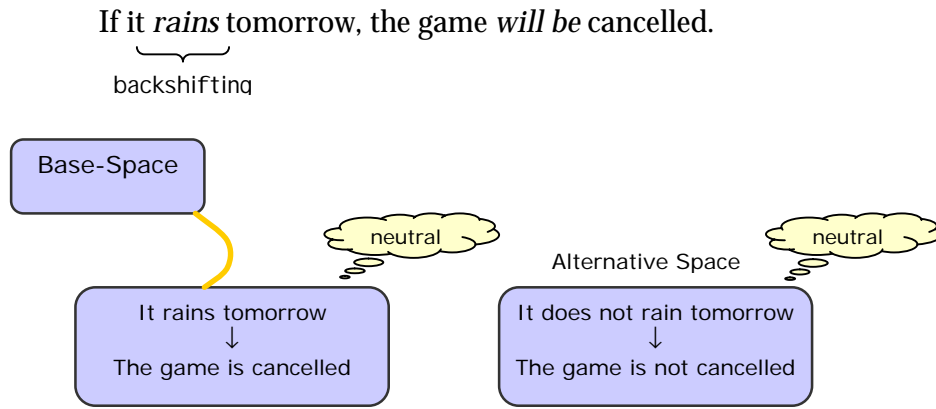
In addition, we also outlined how generic conditionals and speech-act conditionals should be handled within this framework, and proposed a different way of conceptualizing conditionals to handle concessive conditionals and non-concessive conditionals uniformly.

Reference

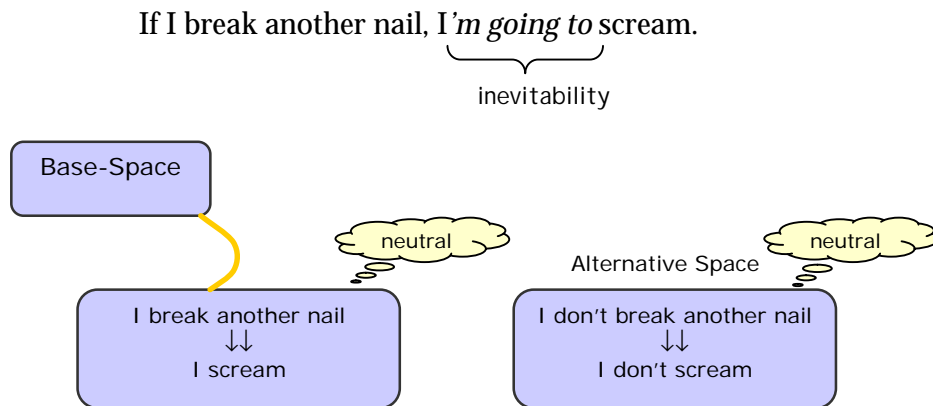
- [1] Barbara Dancygier and Eve Sweetser. Conditional Space-Building and Constructional Compositionality. Manuscript.
- [2] Gilles Fauconnier. Mental Spaces. Cambridge University Press, Cambridge, 1994.
- [3] Benjamin Bergen and Nancy Chang. Embodied Construction Grammar in Simulation-Based Learning and Understanding. Technical Report TR-02-004, ICSI, 2002.

Appendix A.

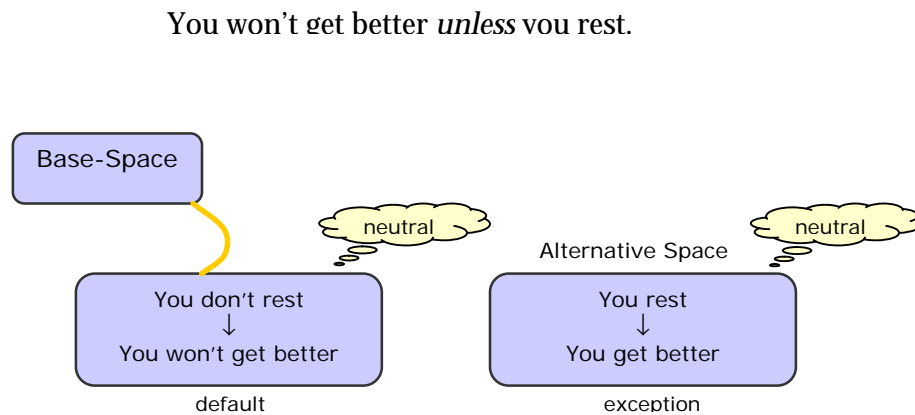
Predictive Conditionals



Predictive Conditionals with *gonna*



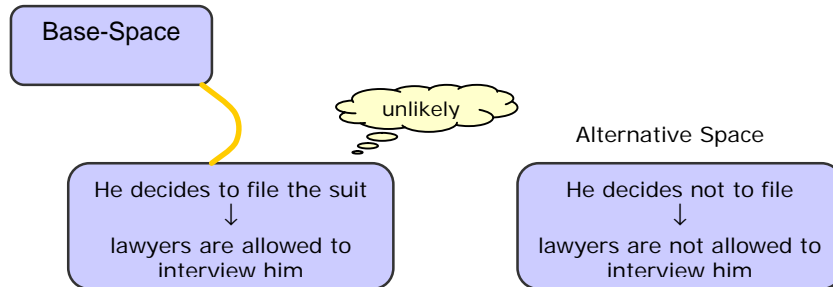
Predictive Conditionals with *unless*



Predictive Conditionals with Negative Epistemic Stance

If he *decided* to file the suit, the hospital's lawyers *would be* allowed to interview him for discovery.

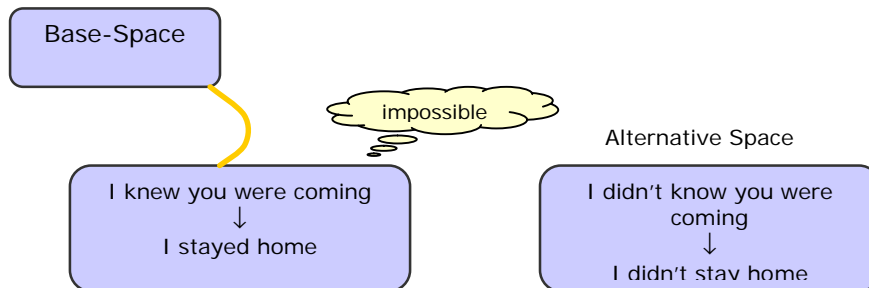
negative epistemic stance



Counterfactual Predictive Conditionals

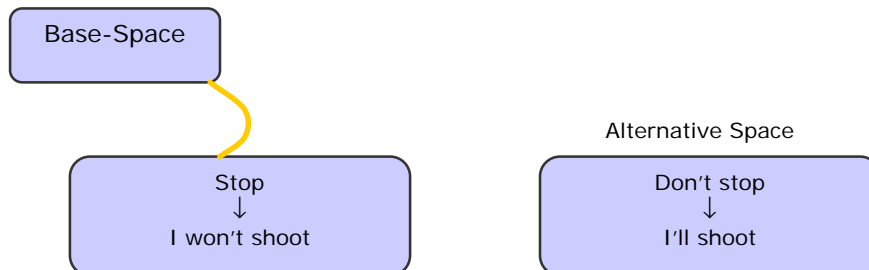
If I *d've known* you were coming, I *d've stayed* home.

counterfactual



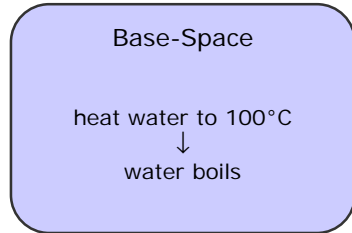
Predictive Conditionals with *And / Or* Conjunctions

Stop *or* I'll shoot!



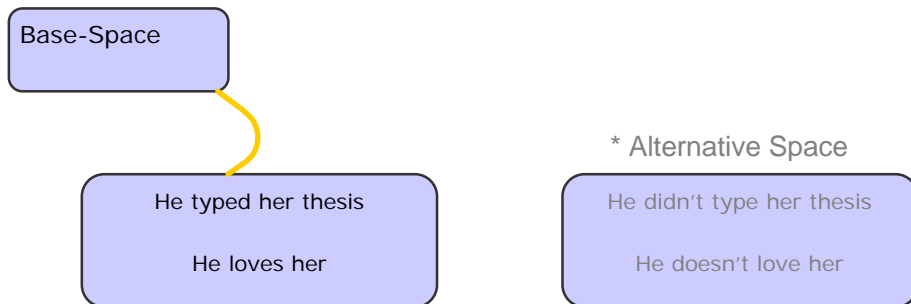
Generic Conditionals

If you heat water to 100°C, it *boils*.
present tense



Epistemic Conditionals

If he *typed* her thesis, he *loves* her.
no tense restrictions



Speech-Act Conditionals

If you need any help, my name is Ann.

