Graduate Seminar: ***What If*** Questions

Johns Hopkins University, Fall 2016

Course Information

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Office Hours	by appt only
Class Code	AS.150.657
Class Time	F 10:00am-12:00pm
Class Location	Gilman 288

Course Description

This seminar is based on ongoing research with Kyle Rawlins (CogSci) on "what if" questions. The goal of this research is to develop a uniform analysis of these questions that can explain their various uses and distribution facts. This might strike you as a rather narrow quest. But "what if" questions lie at the intersection of two thriving streams of linguistics research, *viz.*, the semantics+pragmatics of questions and conditionality. Getting clearer about "what if" questions will also require us to investigate the general structure of discourse, especially the nature of conversational goals.

Schedule

In the first session, I will present our target data. In the second, we will discuss some earlier work by Kyle on "what if" questions and its limitations. After that, the schedule is open and we will let our evolving interests guide our discussions.

Requirements

The only requirement for this seminar is a less than 30 page double-spaced course-related paper. It needn't be on "what if" questions.

Tour of the Data

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1 Licit uses

We can distinguish between different kinds of "what if" questions based on the asker's motivation, the content of their "if"-clauses, and the functional role of these questions in discourse. The following categories are not meant to be mutually exclusive.

- **Exploratory uses**

  One can ask a "what if" question in order to explore or speculate about what the world might be like, or might have been like, under a restricted set of circumstances.

  (1) What if the moon were made of cheese?
  (out of the blue "stoner question")

  (2) What if Adolf Hitler's paintings had been acclaimed, rather than met with faint praise, and he had gone into art instead of politics?

  (3) What if JFK had survived his assassination attempt and been elected to a second term?

  (4) What if nobody had invented the airplane?[1]

  (5) What if Dimitri isn't who he says he is?
  (not in subjunctive)

  (6) A: Alfonso is coming to the party.
  B: Oh no, what if Joanna is there?

- **Suggestion uses**

  "What if" questions can also be used to tentatively answer a question under discussion. The primary motivation is now just to put a certain possibility into play, and the speaker needn't be all that interested in investigating further what things are like if this possibility is actual (in such cases, the speaker is often more interested in *whether* this possibility is actual).

  (7) What if I have cancer?
  (animated by fear rather than curiosity)

  (8) A: How could the butler have done it?
  B: What if he lied about where he was at 10am?

  (9) A: Why did John leave, do you know?
  B: (Not sure, but) What if he had an emergency?

  (10) A: Where are my keys?
  B: What if you left them in the car?

  Relatedly, "what if" questions can be used to tentatively suggest that a presupposition of a question is not met:

  (11) A: Do you know how John got here so fast?
  B: What if he was already here?

  (12) A: Who is coming to the party?
  B: What if it was canceled?

- **Planning uses**

  In practical settings, suggestive and exploratory "what if" questions can be used to propose or explore plans of action.

  (13) A: How can we get to the party?
  B: What if we borrow Alfonso's car?

  (14) cf. Franke and de Jager [2010]
  A: I was going to bake a cake but I haven't got any eggs.
  B: What if you make shortbread instead?

  (15) What if we blow this taco stand and go to the movies?

  (16) What if I just leave in the middle of the night when everyone is sleeping? Will they miss me?

  (17) A: We don't have a speaker for our next colloquium yet.
  B: What if we invite Professor Plum?

- **Test uses**

  When "what if" questions are used to test the addressee's knowledge, they are exploratory but only for the addressee not the questioner who already knows the answer.

  (18) Context: Parent teaching their child basic arithmetic.

[1] Questions (2)-(4) from *Aeon* "What if?" essay.

What if we subtract 13 from 54?

- **Resistance moves** (Bledin and Rawlins [2016])

  "What if" questions can be used to resist outstanding proposals to update the discourse context. In each of the following exchanges, the resister thinks that the resistee might be overlooking a relevant possibility that bears on her proposal to update.

  Following assertion, both discourse-initial and re-raising:

  (19) A: Alfonso is coming over later.
  B: What if Joanna is still here?

  (20) A: Is Alfonso coming to the party?
  B: Yes.
  A: (Are you sure?) What if Joanna is there?

  Compare B's responses in (6) and (20). These can be paraphrased respectively as follows:

  (21) B: If Joanna is at the party (along with Alfonso), then what will happen?
  B: Will Alfonso still come if Joanna is there?

  The resistance moves prolong a proposal+confirm/reject sequence in an existing stream of inquiry. The resister is stalling the resistee's attempt to update with the content of her assertion.

  Following biased or rhetorical question:

  (22) A: Why would anyone ever talk to Larry?
  B: What if he has something interesting to say?

  Following some non-rhetorical questions (rare):

  (23) A: How can we get to the party?
  B: What if there's a cover charge? Are you sure you want to go?

  Following imperatives in their various uses (only some listed here):

  (24) A: Open the window. (command)
  B: What if it's still raining?

  (25) A: Please order me a burrito. (request)
  B: What if they put cilantro in it?

  (26) A: Come over for dinner later. (invitation)
  B: What if I bring Joanna?

Again, these categories are not meant to be exclusive. Consider:

(27) A: How can we get to the party? We're going to be late.
B: What if we borrow Alfonso's car? Then can we make it on time?

With his "what if" question, B simultaneously resists A's claim that they are going to be late to the party and tentatively responds to A's initial question by offering up a new travel option. B also wants to explore the expected duration of this option.[2]

2 Illicit uses

Something you cannot do:

- "What if" questions are often infelicitous post question:

  (28) A: Who is coming to the party?
  B: # What if Alfonso is coming?
  B′: (Well,) Is Alfonso coming?

  (29) A: Is Alfonso coming to the party?
  B: # What if Joanna is coming?
  B′: (Well,) Is Joanna coming?

Post-questioning restriction is not absolute. Some exceptions:

[2]"What if" questions are not the only linguistic constructions available for making tentative suggestions, resisting assertions, etc. Various other kinds of conditional-ish questions and epistemic modalized sentences would also work.

(i) A: How can we get to the party? We're going to be late.
B: What if we borrow Alfonso's car?
B′: Even if we borrow Alfonso's car?
B″: What about Alfonso's car?
B‴: We might borrow Alfonso's car.
B⁗: Maybe we can borrow Alfonso's car.
(Thanks to Karen Clothier for suggesting this last datapoint.)

- suggestions like (8)-(13). Another interesting case from Sadhwi Srinivas:

(30) A: Who is coming to the party?
B: What if nobody comes?
B': ? What if everybody comes?

- resisting biased/rhetorical questions as in (22)
- resisting non-rhetorical questions as in (23)
- when the first and second speaker are the same

(31) Is Alfonso coming to the party? What if Joanna is there?

3 The Structure of "What If" Questions

Proposal: "what if" questions are sentential idioms with a compositionally interpreted "if"-clause.

Supporting facts:

- Order of "what" and "if"-clause fixed:

(32) # If Alfonso comes to the party, what?[3]

- Limited intervening elements:

(33) # What {only/even} if Alfonso comes to the party?

- Inability of "what" to combine with *slack regulators* (Lasersohn [1999]).

(34) {Exactly/Roughly} what will happen when we turn on the particle accelerator?

(35) # {Exactly/Roughly} what if we turn on the accelerator?

- Inability of "what" to participate in normal "wh"-modification (these tests are due to Baker [1968], [1970]; see also Gawron [2001], Rawlins [2008]).

(36) Who on earth is coming to the party?

(37) Who else is coming to the party?

(38) # What on earth if the moon is made of cheese?

(39) # What else if the moon is made of cheese?

- Restriction to "what".

(40) # Who/how/when/where/which if the moon were made of cheese?

Theatrical exceptions: "who if not us?", "how if not thus?, "when if not now?", "where if not here?".

- Can intervene with "about" in some resistance uses but not in purely exploratory ones, and "about" can follow only "what" and "how".

(41) A: We're going to be late to the party.
B: What/how about if we borrow Alfonso's car?
B': # Who/when/where/which about if we borrow Alfonso's car?

(42) # What about if the moon were made of cheese?

Data suggests that the "what" in "what if" questions (and "how" in (41)) is not present with its normal meaning/properties. By contrast, internals of "if"-clause seem entirely normal.

Some more data:

- "What if" questions unembeddable (except on quotative readings).

(43) # Alfonso knows what if Joanna comes to the party.

(44) Alfonso knows what would happen if Joanna comes to the party.

- Distribution of adverbs: can be modified by speaker-oriented adverbs, (maybe) by epistemic modifiers, no lower classes. (Cinque [1999], Ernst [2002])

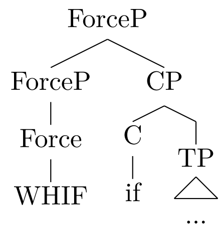
(45) Seriously, what if Joanna comes to the party?

(46) ? Maybe what if we borrow Alfonso's car?

Rudimentary proposal (cf. Krifka 2012):[4]

[3] The consequents "then what?" and "what then?" sound fine, but these are arguably sentential idioms as well. Note that they both work well as stand-alone clauses.

[4] An obvious complication is the complete unembeddability of "what if". It is a natural assumption that ForceP should not be embeddable, but there is a long line of work challenging this in one way or another; see e.g. Krifka [1999], Haegeman [2003], [2006], McCloskey [2006], and Coniglio [2007].



WHIF pronunciation: “what”

Importantly, this is only a working hypothesis. Given the data presented in this section, we feel warranted in analyzing “what if” questions on their own terms using the new force operator WHIF; we will not require that our account of this operator conform with standard treatments of “what”. However, we want to leave open the possibility that something like our account will ultimately work for both “what if” and unconditional “what” questions alike.

A Few Theories of Questions

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1 Building Blocks

(1) **Language**
Start with a standard language for monadic predicate logic and add the question operator $?\vec{x}$. Applying $?\vec{x}$ to a declarative wff $\varphi(\vec{x})$ forms the interrogative sentence $?\vec{x}\varphi(\vec{x})$ that queries the possible values of the variables in the (possibly empty) sequence $\vec{x}$ that satisfy the embedded $\varphi(\vec{x})$.

If $\vec{x}$ is an empty variable sequence, we have a *polar (yes/no) question* $?\varphi$; otherwise, we have a *constituent question*.

(2) Who went to the party?
$?xPx$ (constituent)

(3) Did anybody come to the party?
$?\exists xPx$ (polar)

(4) **Models**
A (constant domain) model is a triple $\mathcal{M} = \langle \mathcal{W}, \mathcal{D}, \mathcal{I} \rangle$ where $\mathcal{W}$ is a nonempty set of worlds, $\mathcal{D}$ is a nonempty domain of individuals, and $\mathcal{I}$ interprets the constants and predicates in our language at each world $w \in \mathcal{W}$ as per standard.

A compositional semantics lifts $\mathcal{I}$ to the full interpretation function $[\![\cdot]\!]_{\mathcal{M}}$ for $\mathcal{M}$ mapping each declarative wff φ, world w, and variable assignment g (sending each variable in our language to an individual in $\mathcal{D}$) to a truth value. For ease of exposition, I ignore free variables in what follows so we do not need to talk about variable assignments.

(5) **Truth in a model**
$[\![\varphi]\!]^w_{\mathcal{M}} = T$ designates that the declarative sentence φ is true at w in $\mathcal{M}$. (I omit the $\mathcal{M}$ subscript going forward.)

(6) **Propositions**
The *proposition* expressed by sentence φ is $\lambda w[[\![\varphi]\!]^w = T]$.

2 Proposition Set Theory

Hamblin [1973] presents one of the earliest formal treatments of questions. On his account, the meaning of a question is its *answerhood conditions* spelled out as the set of possible propositional answers to a question.

(7) **Hamblin semantics**
$$[\![?xPx]\!]^H = \{\lambda v[[\![Pd]\!]^v = T] : w \in \mathcal{W} \wedge d \in \mathcal{I}(P)(w)\}$$

Example: $[\![?xPx]\!]^H = \{\lambda v[[\![Pa]\!]^v = T], \lambda v[[\![Pb]\!]^v = T]\}$.

Karttunen [1977]: shouldn't we be interested only in the *true* possible propositional answers to a question?

3 Partition Semantics

Another influential account is the partition theory of Groenendijk and Stokhof [1984] (also Higginbotham and May [1981], Higginbotham [1996]). Question denotations are still sets of answers but these are now *complete exhaustive answers* that partition logical space into mutually exclusive cells.

(8) **Groenendijk and Stokhof semantics**
$$\begin{aligned}[\![?xPx]\!]^{GS} &= \lambda w\lambda v[\lambda x[[\![Px]\!]^w = T] = \lambda x[[\![Px]\!]^v = T]] \\ &= \{\lambda v[\lambda x[[\![Px]\!]^w = T] = \lambda x[[\![Px]\!]^v = T] : w \in \mathcal{W}\}\end{aligned}$$

Example: $[\![?xPx]\!]^{GS} = \{\lambda v[[\![Pa \wedge Pb]\!]^v = T], \lambda v[[\![Pa \wedge \neg Pb]\!]^v = T], \text{etc.}\}$.

N.B. The proposition $\lambda v[[\![Pa]\!]^v = T]$ is not a full, proper answer to this question. It is only a *partial* answer.

Some claimed advantages:

- Affords a simple set-theoretic analysis of conjunction of questions (intersection of equivalence) and question entailment; for e.g., the constituent question (9) entails the polar question (10) since any (full proper) answer to the former entails an answer to the latter.

  (9) Who called?

  (10) Did Alfonso call?

- Semantics of unembedded interrogatives directly applies to embeddings under attitude verbs.

  (11) Beth knows who came to the party.

(12) Carlos wonders who came to the party.

What does Beth know in (11)? Arguably, for each member of a domain of relevant individuals, Beth knows whether he or she came to the party (i.e., an exhaustive answer). What is Carlos wondering in (12)? Arguably, he is wondering whether each member of a domain of relevant individuals came to the party. (Recent experiments show that the data is more complicated.)

One reason to worry about partitions is the availability of *mention-some* (as opposed to *mention-all*) readings:

(13) Who has got a light?

(14) Where can I buy an Italian newspaper?

These examples seem to favor the earlier Hamblin (or Karttunen) analysis. The question arises: are questions even univocal or are they ambiguous?

4 Dynamicized

Inspired by Stalnaker's work on assertion and presupposition in the 1970s, dynamic semanticists take the meaning of each expression in a language to be an instruction or program for updating discourse contexts—its *context change potential* (CCP).

In Stalnaker's original [1978] theory, a context is modeled with the set of worlds $c \in \mathcal{W}$ that are compatible with the speakers' presuppositions (the *context set*). So CCPs are often spelled out as functions from sets of worlds to sets of worlds.

Notation: $c[\![\varphi]\!] = c'$ or $c + \varphi = c'$. Terminology: c is the *prior context* and c' is the *posterior context.*

For the declarative fragment of our language, a dynamic semantics would deliver $c[\![\varphi]\!] \subseteq c$ for any φ. Intuitively, CCPs correspond to information growth in discourse: updating with φ prunes the space of open possibilities.

What about questions? Roberts [1996], Ginzburg [1996], Hulstijn [1997] a.m.o. argue that questions must also be incorporated into our models of discourse structure. A representative quote from Dekker, Aloni, and Groenendijk [2016]:

> At any point in a discourse or dialogue several questions may be 'alive' because they are explicitly or implicitly raised, or assumed to be relevant. In order to account for such a state in discourse, we therefore cannot simply do with the set of possibilities compatible with the information assumed and exchanged so far. It should also indicate the relevant differences between possibilities which the interlocutors wish to distinguish, or the (discourse) goals they wish to establish. (p. 691)

Dynamicizing the partition theory, a context can be identified not with a set of worlds $c \subseteq \mathcal{W}$ but rather with an equivalence relation over a set of worlds $c \subseteq \mathcal{W} \times \mathcal{W}$ (sometimes called an *indifference relation*). Updating this discourse context with $?xPx$ serves to disconnect possibilities rather than exclude them:

$$c + ?xPx = c \cap \{\langle w, v\rangle : \lambda x[[\![Px]\!]^w = T] = \lambda x[[\![Px]\!]^v = T]\}$$

The ways in which the disconnected possibilities differ is now at issue in the posterior context.

5 Inquisitive Semantics

Ciardelli, Groenendijk, and Roelofsen [2012], [2013], [2015] have developed a new general theory of declarative and interrogative sentences, *inquisitive semantics*, in which discourse contexts are modeled as issues.

(15) **Issues**
An *issue* i over a state s (or proposition s, in the old sense) is a non-empty set of substates of s s.t.
i. i is *downward closed*: if $t \in i$ and $t' \subseteq t$ then $t' \in i$
ii. i is a *cover* of s: $\bigcup i = s$

(16) The *contextual information* in c is $info(c) = \bigcup c$.

(17) A context is *inquisitive* iff $info(c) \notin c$.

(18) A context is *informed* iff $info(c) \neq \mathcal{W}$.

Intuitively, think of an issue as the set of states that *settle* or *resolve* it (note the shift from *answerhood* to *resolution*). If the discourse participants enter one of these states, then this issue is no longer *at issue.*

In inquisitive semantics, the propositional contents of *both* declarative and interrogative sentences are issues. To utter a sentence with content i is to propose that the discourse participants jointly cooperate in establishing an update of the current context c that takes them into a new context c' where $info(c') \in i$.

Previous Work and Its Limitations

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"What if" questions have been underexplored. This is somewhat surprising since they lie at the intersection of two thriving streams of linguistics research: the semantics+pragmatics of questions and conditionality.[1]

Exception (lone linguistic account?): Rawlins [2010] who focuses mainly on re-raising uses of "what if" questions (he also discusses related "what about if", "even if", "and if", "what about" constructions):

(1) A: Is Alfonso coming to the party?
B: Yes.
A: What if Joanna is there?
A′: What about if Joanna is there?
A″: Even if Joanna is there?
A‴: And if Joanna is there?
A⁗: What about Joanna?
≈ If Joanna comes to the party, will Alfonso really come?

On Rawlins' analysis, a "what if" question is a conditional question where the "if"-clause restricts the domain of a question under discussion (QUD) supplied anaphorically by context. So first, let's talk a bit about QUDs.

1 Roberts on QUDs

Questions under discussion were first introduced by Roberts [1996], [1998] (reissued in [2012]) and Ginzburg [1996] (see also Hulstijn [1997], Büring [2003], Beaver and Clark [2008], a.m.o.). Here is Roberts [2012] on the QUD concept:

> If a question is accepted by the interlocutors, this commits them to a common goal, finding the answer; like the commitment to a goal in Planning Theory, this is a particularly strong type of commitment, one which persists until the goal is satisfied or shown to be unsatisfiable. The accepted question becomes the immediate topic of discussion, which I will also call the *immediate question under discussion*, often abbreviated as the *question under discussion*. (p. 5)

It is tempting, I think, to read this in such a way that the QUD account is insufficiently general: a question is asked by a speaker who does not yet know its answer and this question launches a kind of collaborative or joint inquiry with the aim of resolving it. Exam questions, interrogative questions, combative questions, rhetorical questions, etc., do not (always) fit this mold (Lauer and Condoravdi).

A more plausible line is this: if a question is accepted by interlocutors, this commits them to the common goal of reaching a later discourse state where the answer to this question is incorporated into the common ground. While everybody might already know the answer to an exam or interrogative question, the aim of such questions is to make this public.

Roberts does seem to see things in this latter way:

> On the present view, it is the common ground, not the speaker, that's "informed," and it is mutual-belief behavior, and not knowledge, that's sought. This permits a generalization over rhetorical questions, quiz questions, etc., which are problems for more solipsistic views of information in discourse. (n. 7)

> If accepted, an imperative commits the hearer to trying to make the corresponding assertion true; i.e., it commits the hearer to a certain domain goal [more on "domain goals" below]. If accepted, a question commits the hearer to trying to add its answer to the common ground; i.e., it commits the hearer to a certain discourse goal. (p. 26)

Now, according to Roberts, the primary goal of discourse is to answer the "Big Question": what is the way things are? I.e., the goal is to reduce the context set to a singleton set containing the actual world.[2] But QUDs are typically coarser-grained. On the one hand, speakers often adopt *strategies of inquiry* and ask "subquestions" in the service of addressing an active "superquestion" that *entails* them (in the sense of Groenendijk and Stokhof

[1]Will Starr has a paper entitled "What 'If'?" [2014] but this is about only the "if" in "what if". XKCD comics also has a "what if" blog (and a book) with many colorful examples, but, unfortunately, it does not provide a linguistic analysis of such constructions.

[2]What about hypothetical and counterfactual talk? Roberts might say that the goals of such talk are derivative on the primary discourse goal of answering the Big Question.

[1984]). On the other hand, our non-conversational goals dictate which subquestions of the Big Question we take up:

> Besides the discourse goal of inquiry in its most general sense, we usually have goals in the real world, things we want to achieve quite apart from inquiry, *domain goals*. And our domain goals, in the form of deontic priorities, generally direct the type of inquiry which we conduct in conversation, the way we approach the question of how things are. We are, naturally, most likely to inquire first about those matters that directly concern the achievement of our domain goals. (p. 7)

Formally, Roberts assumes that each question denotes a *q-alternative set* (Hamblin-style; these alternatives can overlap). She then defines partial and complete answers in terms of this q-alternative set where the set of complete answers forms a partition (G&S-style). The details aren't too important for present purposes. More important is how Roberts embeds question denotations into a broader model of discourse context (extending the classic model in Stalnaker [1984]).

(2) **Information structure**
The *information structure* for discourse $\mathcal{D}$ is the tuple $\text{InfoStr}_{\mathfrak{D}} = \langle M, Q, A, <, Acc, \text{CG}, \text{QUD}\rangle$ where:

- M is the set of (explicit+implicit) moves in $\mathcal{D}$
- Q is the set of questions in M (question=set of propositions)
- A is the set of assertions in M (assertion=proposition)
- $<$ is the precedence relation on M (total order)
- Acc is the set of accepted moves in M
- CG is a function mapping each move $m \in M$ to the set of propositions CG(m) constituting the common ground just prior to m (requirements: CG grows monotonically; accepted assertions are added to CG; CG registers moves and whether they are accepted; CG contains its own history and history of the QUD)
- QUD is the *question-under-discussion stack*, a function mapping each move $m \in M$ to a totally ordered set of accepted questions QUD(m) that are unsettled by CG(m) and have not been determined to be practically unanswerable (constraint: for $q, q' \in \text{QUD}(m)$, if $q < q'$ then the complete answer to q' contextually entails a partial answer to q)

A bit more on the QUD stack:

> The set of questions under discussion at a given point in a discourse is modelled using a push-down store, which I call QUD, the *questions-under-discussion stack*. Intuitively, QUD yields the ordered set of all as-yet unanswered but answerable, accepted questions in Q at the time of utterance of q. When we accept a question, we add it to the top of the stack. Its relationship to any question previously on top will be guaranteed by a combination of Relevance, entailing a commitment to answering prior questions, and logical constraints on the way that the stack is composed. If we decide to pursue an accepted question by asking a subquestion, we may add the subquestion to the stack, so that the stack reflects (part of) a strategy of questions. When a question is answered or determined to be practically unanswerable, it is popped off the stack, revealing any below it.[3] At any point in discourse, the question on top of the stack is the (immediate) question under discussion. (p. 15-6)

The richer structure in (2) affords a precise account of how discourse goals, manifested as QUDs, constrain the felicitous flow of discourse. Roberts spells this out as follows:

(3) **Strategies of inquiry**
The *strategy of inquiry* Strat(q) which aims at answering q is the ordered pair $\langle q, S\rangle$ where:

- If there is no q' s.t. $\text{QUD}(q') = \langle ...q\rangle$, then $S = \emptyset$
- else, $\text{QUD}(q') = \langle ...q\rangle$ iff $\text{Strat}(q') \in S$

(4) **Relevance**
A move m is *Relevant* to *top*(QUD(m)) iff m is an assertion that partially answers *top*(QUD(m)) or m is a question that is part of a strategy for answering this superquestion $(\text{Strat}(top(\text{QUD}(m))) = \langle top(\text{QUD}(m)), \{\text{Strat}(m), ...\}\rangle$.

One might worry about the exact details of this account. But to her credit, Roberts shows how we can make the Gricean maxim 'Be relevant' more precise.[4]

[3] As Roberts later points out, a question might also be popped off the stack if another question lower down is answered since answering this lower question can relieve us of our commitment to answer the higher question.

[4] One concern with Roberts' criterion of Relevance is that it does not seem to work for epistemic modal claims (cf. Franke and de Jager [2010]).

2 Rawlins on "What If"

Rawlins [2010] works with a generalization of the QUD stack:

(5) **Contexts**
A *context* involving participants X, Y is an n-tuple
$\mathcal{C} = \langle T, a, cs_X, cs_Y, ...\rangle$ where:

- T is a *table* $\langle A, Q\rangle$ consisting both of an *assertion slot* A and *question slot* Q for discourse moves in purgatory (cf. Farkas and Bruce [2010])[5]
- a is a temporary *assumption slot* that restricts the *view* of the context to the worlds inside it
- cs_X, cs_Y are the *public commitment sets* of X, Y respectively (Gunlogson [2001], [2008], drawing on Hamblin [1971])

With this representation of context in hand, Rawlins follows Isaacs and Rawlins [2008] and implements conditional questions (CQs) in a dynamic semantics (cf. Heim [1982], [1983], Veltman [1996], Beaver [2001], a.m.o.):

(6) $\mathcal{C}$ + "if φ, ψ?" = ($\mathcal{C}$ + ASSUME φ) + $?\psi$

Updating a context with a conditional question "if φ, ψ?" involves the following two steps:

1. Temporarily assuming that its antecedent φ holds (Ramsey [1929]), thereby restricting the domain of possibilities under consideration. In Isaacs and Rawlins [2008], this is implemented by modeling context as a stack of "context sets" (Kaufmann [2000], Isaacs [2007]) and having ASSUME push a temporarily restricted context set onto the top of this stack. In Rawlins [2010], the ASSUME procedure rather enters the content of the supposition directly into the assumption slot in a 'flat' context from (5).

   (7) **Assuming**
   $\mathcal{C}$ + ASSUME $\varphi = \langle T^{\mathcal{C}}, a^{\mathcal{C}} \cap [\![\varphi]\!], cs_X^{\mathcal{C}}, cs_Y^{\mathcal{C}}, ...\rangle$

2. Asking the consequent $?\psi$ of the conditional question in the derived subordinate context. Following Groenendijk [1999] (who builds on Hamblin [1958], Groenendijk and Stokhof [1984], a.m.o.), this serves to partition the subordinate context into alternatives corresponding to the possible answers to this question.

   (8) **Questioning update**
   $\mathcal{C} + ?\psi = \langle\langle A^{\mathcal{C}}, [\![?\psi]\!]\rangle, a^{\mathcal{C}}, cs_X^{\mathcal{C}}, cs_Y^{\mathcal{C}}, ...\rangle$

   (9) The *GS-context* $g^{\mathcal{C}}$ of a context $\mathcal{C}$ is:
   $\{\langle w, v\rangle : w, v \in cs_X^{\mathcal{C}} \cap cs_Y^{\mathcal{C}} \cap a^{\mathcal{C}}$ and $\forall p \in Q^{\mathcal{C}}(w \in p \equiv v \in p)\}$

"What if" questions work the same way, but the question posed inside the hypothetical context is the QUD:

(10) $\mathcal{C}$ + "what if φ" = ($\mathcal{C}$ + ASSUME φ) + WHIF
$\mathcal{C}$ + WHIF = $\mathcal{C}$ + ?QUD$^{\mathcal{C}}$

(Rawlins also argues that "what if" questions used for resistance trigger *conversational backoff*: a kind of restricted acceptance where the resister accepts the resisted claim limited to those possibilities not explicitly raised by the resistance move. While I think this is on the right track, I'm pretty skeptical about how backoff is implemented in Rawlins' theory given cases of *repeated resistance*, but I will not discuss this here; see Bledin and Rawlins [2016] for some discussion.)

Observe that the Rawlins account delivers nice results for the re-raising cases like (1) that it was explicitly designed to explain. In such exchanges, a "what if" questioner does seem to be continuing the line of questioning initiated by a prior question. In (1) there is an explicit QUD provided by the overt question 'Is Alfonso coming to the party?' and A is presumably re-asking this QUD over the restricted domain in which Joanna is coming:

(11) A: What if Joanna is there?
$\approx$ If Joanna is at the party, is Alfonso coming?

What about cases where a QUD is not supplied directly by prior discourse? Rawlins: discourse-initiality is possible as long as there is an implicit QUD that can be recovered.

(12) Context: We show up for a seminar and find the room locked. Alicia, the departmental administrative coordinator, has a master key that can open the seminar room.
A: What if Alicia has already gone to lunch?

(i) A: What's the weather like outside?
B: It might be raining.

[5] Rawlins allows for only limited storage space: A is filled with a single proposition or empty, Q is filled with a single (Hamblin) set of propositions or empty. For certain purposes, we want A, Q to be *stacks*; see Bledin and Rawlins [2016].

≈ If Alicia has already gone to lunch, then how can we get into the seminar room?
(implicit ?QUD$^{\mathcal{C}}$ = "How can we get into the room?")

3 Some Worries

However, I have some worries with Rawlins' account. Perhaps none of these are fatal, but they point to some limitations of his analysis.

First worry: In some cases, it is not clear that there is even an implicit QUD available for a "what if" question to grab hold of.

Example: out of the blue 'stoner questions'.

(13) What if the moon were made of cheese?

Plausibly, there is a repair strategy at play here that allows the "what if" question to reflexively introduce a new QUD all on its own.[6] On this line, hearers accommodate (13) by first introducing the Counterfactual Big Question 'What is the way things could be?' and then interpreting the "what if" question against it.[7]

Another example: resisting imperatives.

(14) A: Open the window.
B: What if it's still raining?

Unless imperatives introduce QUDs, it seems that we must again allow for repair. But with (14) the relevant QUD is not the Counterfactual Big Question but rather something like 'Does A want B to open the window?' or 'What is the best way to achieve our goal of cooling down?'. A repair account would need to be more nuanced to derive this.

Second worry: In cases where a "what if" question is used to suggest a complete answer to a QUD, a flat-footed application of Rawlins' analysis interprets the "what if" question as a trivial "question" with only a single complete answer.

(15) A: Where are my keys?
B: What if they're in the car?
≈ # If the keys are in the car, then where are they?

(16) A: How can we get to the party?
B: What if we drive Alfonso's car?
≈ # If we drive Alfonso's car, then how can we get to the party?

If B is re-asking A's discourse-initial question in (15) restricted to the set of possibilities in which the keys are in the car, then the "what if" question has one complete answer: its entire domain.[8] Likewise in (16).

Relatedly, Rawlins' analysis seems to predict that a "what if" question used to suggest that a presupposition of a QUD does not hold is degenerate since it is not even well-formed over the "if"-clause restriction.

(17) A: When did Henry stop beating his donkey?
B: What if he never beat it?
≈ # If Henry never beat his donkey, then when did he stop beating it?

Now, these predications are odd. But they are arguably correct. After all, the "what if" questions in (15)-(17) are used not to inquire into what things are like if the possibilities raised by their "if"-clauses hold, but rather just to float these possibilities for consideration. Still, we then want to know how such trivial and degenerate questioning fits into a more general pragmatics of questions. We also want an explanation of why the corresponding explicit CQs sound bad.

Alternatively, one might hold that B's "what if" questions in (15)-(17) are not actually restricted versions of A's discourse-initial questions.

On the one hand, one could say that the "what if" questions are not anaphoric to the discourse-initial QUDs but instead target other questions lower down in the stack, or introduce new QUDs all on their own. But then we need some new story about what is going on, a story that can explain why explicit QUDs available from immediately preceding discourse serve as the antecedents of "what if" questions in re-asking cases like (1) but not in cases like (15)-(17).

On the other hand, one might appeal to the context-sensitivity of questions and argue that the "what if" questions are more fine-grained (restricted) forms of the discourse-initial questions. But consider:

[6] Roberts seems to allow for this kind of QUD-accommodation; see her seafood example on pp. 19-20.

[7] Drew Reisinger conjecture: the "what about" form of (13) is infelicitous because it has a minimal salience requirement that precludes this kind of QUD-accommodation. (The literature on "hard"/"soft" presupposition triggers might be helpful here.)

[8] I.e., B's "what if" question is a kind of *rhetorical question* in that A is automatically committed to believing that the keys are in the car *conditional on the keys being in the car* (cf. Lauer and Condoravdi).

(18) A: How can we get to the party?
B: What if we drive Alfonso's car?
A: # Well, I'll first open the door to his car; then I'll get into the driver's seat and lower the emergency brake; next I'll step on the gas; etc.

It is also not clear how this response helps with cases like (17).

Third worry: No explanation of limited post-question distribution.

van Rooy on DPs

AS.150.657 *What If* Questions
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1 Context Dependence of Resolvedness

van Rooy [2003] argues for the following two theses:

(T1) Whether an answer to a *wh*-question is resolving/appropriate or not depends on the decision problem (DP) the questioner faces.

(T2) DPs help resolve the underspecified meaning of interrogatives.

Part of the first thesis (T1) is pretty easy to establish with examples, *viz.*, that the appropriateness of answers to questions depends on context in some way (it is slightly less obvious that the relevant feature of context on which resolvedness hangs is the decision problem of the questioner).

In the following examples, the appropriateness of answers seems to depend on a required *method of identification* supplied by the discourse context (Böer and Lycan [1975], Hintikka [1976], Grewendorf [1981], Gerbrandy [1997], Aloni [2001]).

(1) Q: Who is Cassius Clay? (*identification question*)
A: Muhammed Ali.
A′: The man over there [pointing at man].
A″: The heavyweight boxing champion in the 70s.

(2) Q: Who appoints Supreme Court justices?
A: The President.
A′: George W. Bush.

The required *level of specificity* can also vary by context (Grewendorf [1981], Ginzburg [1981], [1995]):

(3) a. Politican: Who has been attending these talks?
Director: A number of linguists and psychologists.

b. Researcher: Who has been attending these talks?
Director: A number of cognitive phoneticians and Wilshaw-net experts.

(4) a. Context: Jill about to step off a plane in Helsinki.
Flight attendant: Do you know where you are?
Jill: Helsinki.
Flight attendant: Ah ok. Jill knows where she is.

b. Context: Jill about to step out of a taxi in Helsinki.
Driver: Do you know where you are?
Jill: Helsinki.
Driver: Oh dear. Jill doesn't know where she is.

Another class of examples is *mention some* vs. *mention all* cases:

(5) Where can I buy an Italian newspaper?

(6) How can I get to the train station?

The rest of thesis (T1) tells us that the appropriateness of answers in cases like (1)-(6) depends on the asker's DP. This is also fairly intuitive: the appropriateness of answers is a matter of their *usefulness* which, in turn, depends on the *goals* of the questioner

How exactly do DPs work as contextual parameters? Broadly speaking, there are two ways to go:

- We can maintain that questions have context-independent meanings but not equate these meanings with sets of resolving answers. For instance, we might still take the meaning of a question to be the set of its complete semantic answers but allow that resolving answers needn't be complete.
- We can accept (T2) and hold that the meaning of a sentence is the context-sensitive set of its resolving answers.

2 Decision Problems

The notion of a decision problem can be made precise within statistical decision theory.

(7) **Decision problems**
A *decision problem* $DP = \langle P, U, \mathcal{A} \rangle$ consists of a (discrete) probability measure $P : 2^{\mathcal{W}} \to \mathbb{R}[0,1]$ representing an agent's beliefs, a utility function $U : \mathcal{A} \times \mathcal{W} \to \mathbb{R}$ representing her desires, and a (finite) action set $\mathcal{A} = \{a_1, ..., a_n\}$.

Rational agents are assumed to maximize expected utility so we can define the utility of an entire decision problem as follows:

(8) **Expected utility of actions**
$EU(a) = \sum_{w \in \mathcal{W}} P(w) \times U(a,w)$

(9) **Utility value of decision problems**
$UV(\text{Choose now}) = \max_{a \in \mathcal{A}} EU(a)$

We can also define the utility of making an informed decision conditional on learning C as follows:

(10) **Expected utility of actions after learning**
$EU(a,C) = \sum_{w \in \mathcal{W}} P(w|C) \times U(a,w)$

(11) **Utility value of decision problems after learning**
$UV(\text{Learn } C, \text{ Choose later}) = \max_{a \in \mathcal{A}} EU(a,C)$

Using these notions, we can define the value of new information:

(12) **Utility value of information** v. 1
$UV(C) = UV(\text{Learn } C, \text{ Choose later}) - UV(\text{Learn } C, \text{ Choose } a^0)$
where $a^0 = \arg\max_{a \in \mathcal{A}} EU(a)$

This value is sometimes referred to as the *value of sample information* $VSI(C)$ (Raiffa and Schlaifer [1961]). Note that $VSI(C) \geq 0$ and we have $VSI(C) > 0$ only if learning C leads the agent to change her mind.

But can't new information also be relevant when it strengthens the choice that was already preferred?

(13) **Utility value of information** v. 2
$UV(C) = UV(\text{Learn } C, \text{ Choose later}) - UV(\text{Choose now})$

We can say that C is (positively) *relevant* if $UV(C) > 0$. We can also define the following strict ordering of information:

(14) **Ordering of information**
C is *better* than D iff $UV(C) > UV(D)$.

3 Resolving Decision Problems

Naturally, agents want to resolve their decision problems.

(15) **Resolving decision problems**
New information C *resolves* a decision problem $DP = \langle P, U, \mathcal{A} \rangle$ if one of the actions $a \in \mathcal{A}$ *dominates* in $DP + C = \langle P(\cdot|C), U, \mathcal{A} \rangle$ (i.e., a has the max utility in each world s.t. $P(w|C) > 0$).

(16) $a^* = \{w : U(a,w) \geq U(b,w) \text{ for all } b \in \mathcal{A}\}$

(17) $\mathcal{A}^* = \{a_1^*, ..., a_n^*\}$ (not generally a partition)

	w_1	w_2	w_3	w_4
a_1	1	2	2	1
a_2	2	3	3	2
a_3	2	2	1	3
a_4	3	1	1	2

In this example, $\mathcal{A}^* = \{a_1^*, a_2^*, a_3^*, a_4^*\} = \{\emptyset, \{w_2, w_3\}, \{w_4\}, \{w_1\}\}$

To simplify things for the moment, assume

- $UV(\text{Choose now}) = \max_{a \in \mathcal{A}} P(a^*)$
- $UV(\text{Learn } C, \text{ Choose later}) = \max_{a \in \mathcal{A}} P(a^*|C)$
- $\mathcal{A}^*$ forms a partition
- $P(a^*|C) = 1/|C_{\mathcal{A}^*}|$ for each $a^* \in C_{\mathcal{A}^*} = \{a^* \in \mathcal{A}^* : a^* \cap C \neq \emptyset\}$

	w_1	w_2	w_3	w_4
a_1	0	0	0	0
a_2	0	1	1	0
a_3	0	0	0	1
a_4	1	0	0	0

In this setting, C resolves DP iff $|C_{\mathcal{A}^*}| = 1$.

Moreover, C is better than D

iff $UV(C) > UV(D)$

iff $UV(\text{Learn } C, \text{ Choose later}) > UV(\text{Learn } D, \text{ Choose later})$

iff $\max_{a \in \mathcal{A}} P(a^*|C) > \max_{a \in \mathcal{A}} P(a^*|D)$

iff $1/|C_{\mathcal{A}^*}| > 1/|D_{\mathcal{A}^*}|$

iff $|D_{\mathcal{A}^*}| > |C_{\mathcal{A}^*}|$

iff C eliminates more cells in $\mathcal{A}^*$ than D

Compare Groenendijk and Stokhof's [1984] ordering between answers:

$C >_Q D$ iff either (i) $C_Q \subset D_Q$ or (ii) $C_Q = D_Q$ and $C \supset D$
(in latter case, D is overinformative and introduces extra processing costs)

4 Least Informative Resolving Answers

With decisions problems in hand, we can now be more precise about the context dependence of resolvedness.

First example.

w_1: I live in Amsterdam East
w_2: I live in Amsterdam West
w_3: I live in Utrecht East
w_4: I live in Utrecht West

a_1: take train to Amsterdam
a_2: take train to Utrecht

	w_1	w_2	w_3	w_4
a_1	1	1	0	0
a_2	0	0	1	1

Q: 'Where do you live?'

G&S: $\{\{w_1\}, \{w_2\}, \{w_3\}, \{w_4\}\}$

$\mathcal{A}^* = \{\{w_1, w_2\}, \{w_3, w_4\}\}$ (set of least informative answers)

Second example.

w_1: can buy newspaper only at station
w_2: can buy newspaper only at palace
w_3: can buy newspaper at both places

a_1: walk to station
a_2: walk to palace

	w_1	w_2	w_3
a_1	1	0	1
a_2	0	1	1

Q: 'Where can I buy a newspaper?'

G&S: $\{\{w_1\}, \{w_2\}, \{w_3\}\}$

$\mathcal{A}^* = \{\{w_1, w_3\}, \{w_2, w_3\}\}$ (set of least informative answers)

Proposal: Questions have a context-independent partition semantics but context still plays a role in determining how fine-grained answers need to be in order to resolve them.

Problem: Meaning of questions w/non-exhaustivity markers do not seem to be partitions.

(18) Who, for example, is coming to the party? (Beck and Rullmann [1999])

Problem: Embedding questions under certain attitude verbs suggests that questions have context-dependent meaning.

(19) John knows where he can buy an Italian newspaper.

Assuming that this sentence is true iff John knows a resolving answer to the embedded question (Ginzburg [1995], Krifka [1999]), the semantics of (19) depends on the context-dependence of resolving answers. Assuming compositionally, context-dependence of resolvedness is crucial to semantics of embedded questions.

Alternative proposal: The interpretation of an interrogative depends on a contextually supplied decision problem. More specifically, the hearer chooses, and is expected to do so by the questioner, the interpretation of the interrogative sentence with the highest utility.

> Given that the questioner is assumed to be confronted with a certain decision problem and that she used a certain interrogative sentence whose interpretation is underspecified by its conventional meaning, the other participants of the conversation want to know what the actual interpretation of the sentence is. On the assumption that the questioner is a *relevance optimizer*, they will assume that the actual interpretation is the one that is most relevant for the questioner who is facing the assumed decision problem. (p. 744)

5 Utility of Questions

We earlier defined the utility value of assertions (information). We can also define the utility value of questions.

(20) **Utility value of questions** (N.B. assumes partition semantics)
$EUV(Q) = \sum_{q \in \mathcal{Q}} P(q) \times UV(q)$

Compare: $EVSI(Q) = \sum_{q \in \mathcal{Q}} P(q) \times VSI(q)$ (*value of experiment*)

Although $UV(q)$ and $VSI(q)$ can come apart for some answer $q \in Q$, $EUV(Q) = EVSI(Q) \geq 0$. We have $EUV(Q) = 0$ when no answer to Q would change the agent's mind, i.e., when the question is completely *irrelevant*.

Fixing a particular DP, we can now define the following strict ordering of questions:

(21) **Ordering of questions**
Q is *better* than Q' iff either of these conditions hold:

(i) $EUV(Q) > EUV(Q')$

(i) $EUV(Q) = EUV(Q')$ and $Q \sqsupset Q'$

where $Q \sqsubseteq Q'$ iff $\forall q \in Q[\exists q' \in Q'[q \subseteq q']]$. ($Q$ is finer)

I.e., we want our questions to be useful but their answers should not be overinformative.

New Analysis of *What If*

AS.150.657 *What If* Questions
Johns Hopkins University, Fall 2016

1 Goals, More Generally

So far, we have seen two different ways to formally represent goals:

- Roberts [2012] represents the common discourse goal of (publicly) addressing a question using a QUD (non-discursive *domain goals* are included in her *information structures* only in later work).
- van Rooy [2003] draws on statistical decision theory and represents domain goals as *decision problems*.

It would be nice to have a more general account subsuming both discourse and domain goals.

Here is one way to do this.

(1) **Goal structures**
A *goal structure* $G = \langle M, S, U\rangle$ over $\mathcal{W}$ consists of two partitions $M, S \subseteq 2^{\mathcal{W}}$ of subspaces of $\mathcal{W}$ into *moves* and *states* respectively, and an ordinal utility function $U : M \times S \to \mathbb{R}$ mapping move-state pairs to reals.[1]

Let me elaborate on these three ingredients in turn.

- The moves in M encode the particular ways that the agent, or agents, with goal G might go about trying to achieve it (each cell $m \in M$ corresponds to a set of worlds that agree on which move is taken).

  Moves can be simple, like performing a specific act, or complex, like performing an extended course of actions or adopting a plan and then implementing it.

  Moves needn't be entirely under one's volitional control. Besides behavioral acts, I allow for *epistemic moves* like updating or revising one's beliefs.

[1] The set $\{m \cap s : m \in M, s \in S\}$ with ordering $m \cap s \leq m' \cap s'$ iff $U(m, s) \leq U(m', s')$ is a "preference structure" as in Condoravdi and Lauer [2010].

- The exogenous states in S are the external contingencies relevant to the achievement of G. Distinctions between worlds in the same state $s \in S$ do not matter as far as G is concerned.
- The utility function U represents desires (in the case of a collective or group goal, I assume that the desires of the individual agents in the group align with respect to this goal).

  Since U is an ordinal utility function, it captures the *ordering* of an agent's preferences; it needn't capture their intensity or strength.

If we require that (i) M is a finite set of actions, (ii) S is the diagonal or identity relation on $\mathcal{W}$, and (iii) U is an interval utility function, and (iv) we supplement G with a probability measure $P : 2^{\mathcal{W}} \to \mathbb{R}[0, 1]$ representing an agent's degrees of belief or credences, then we have van Rooy's decision problems:

(2) **Decision problems**
A *decision problem* $DP = \langle A, P, U\rangle$ consists of a (finite) action set $A = \{a_1, ..., a_n\}$, a probability function $P : 2^{\mathcal{W}} \to \mathbb{R}[0, 1]$, and an interval utility function $U : \mathcal{A} \times \mathcal{W} \to \mathbb{R}$.

	can buy paper only at station	can buy paper only at palace	can buy paper at both places
walk to station	1	-1	1
walk to palace	-1	1	1
stay put	0	0	0

With the more general concept of a goal structure in hand, though, we can also think about QUDs in a novel way. Recall that in *Inquisitive Semantics* (Ciardelli, Groenendijk, and Roelofsen [2012], [2013], [2015]), each interrogative (and declarative) sentence (in context) denotes a set of (possibly overlapping) *resolving answers*, or an *issue*.

(3) **Issues**
An *issue* I over $P \subseteq \mathcal{W}$ is a non-empty set of substates of P s.t.
a. I is *downward closed*: if $i \in I$ and $i' \subseteq i$ then $i' \in I$
b. I is a *cover* of P: $\bigcup I = P$

(4) **Alternative sets, etc.**
The *alternative set* of issue I is $Alt(I) = \{i \in I : \neg\exists i' \in I[i \subset i']\}$ (i.e., $Alt(I)$ is the set of maximal elements in I).

(5) $Con(Alt(I)) = \{X \subseteq Alt(I) : \bigcap X \neq \emptyset\}$
(i.e., $Con(Alt(I))$ is the set of jointly consistent subsets of $Alt(I)$).

(6) $w \sim_{Alt(I)} v$ iff $\{i \in Alt(I) : w \in i\} = \{i \in Alt(I) : v \in i\}$.

Examples:

(7) Is it raining?

$[\![(7)]\!] = \{P : P \subseteq [R]\} \cup \{P : P \subseteq [\neg R]\}$ (notation: $[\varphi]$ is *truth set* of φ)

$Alt([\![(7)]\!]) = \{[R], [\neg R]\}$

$Con(Alt([\![(7)]\!])) = \{\{[R]\}, \{[\neg R]\}\}$

(8) Does Alfonso speak English↑, or Spanish↑?
(Roelofsen and Farkas [2015])

$[\![(8)]\!] = \{P : P \subseteq [E]\} \cup \{P : P \subseteq [S]\} \cup \{P : P \subseteq [\neg E] \cap [\neg S]\}$

$Alt([\![(8)]\!]) = \{[E], [S], [\neg E] \cap [\neg S]\}$

$Con(Alt([\![(8)]\!])) = \{\{[E]\}, \{[S]\}, \{[\neg E] \cap [\neg S]\}, \{[E], [S]\}\}$

Running with this semantics and identifying questions with issues, we can explicate the shared discourse goal of publicly resolving a question (issue) Q as follows:

(9) **Question-under-discussions**
A *question-under-discussion* (QUD) is a triple $G_Q = \langle M_Q, S_Q, U_Q \rangle$ determined by a question Q as follows:

- $M_Q = \{\{w : \text{reach } CG \text{ in } w \text{ s.t. } \{i \in Alt(I) : CG \subseteq i\} = X\} : X \in Con(Alt(I))\} \cup \{\{w : \text{fail to reach } CG \text{ in } w \text{ s.t. } \{i \in Alt(I) : CG \subseteq i\} \neq \emptyset\}\}$
- $S_Q = \bigcup Q / \sim_{Alt(I)}$
- $U_Q(m_Q, s_Q) = \begin{cases} 1 \text{ if } s_Q \subseteq \bigcap X \text{ (where } X \text{ from } m_Q) \\ 0 \text{ otherwise} \end{cases}$

N.B. In the current framework, we are distinguishing between a *question* that is under discussion (an issue Q) and a *question-under-discussion* (a goal structure G_Q).

Examples (cont.):

$G_{[\![(7)]\!]}$ has these components:

$$M_{[\![(7)]\!]} = \{\{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [R]\}, \{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [\neg R]\}, \{w : \text{fail to reach } CG \text{ in } w \text{ s.t. } CG \subseteq [R] \text{ or } CG \subseteq [\neg R]\}\}$$

$S_{[\![(7)]\!]} = \{[R], [\neg R]\}$

$U_{[\![(7)]\!]}(\{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [R]\}, [R]) = 1$
$U_{[\![(7)]\!]}(\{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [R]\}, [\neg R]) = 0$
$U_{[\![(7)]\!]}(\{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [\neg R]\}, [R]) = 0$
$U_{[\![(7)]\!]}(\{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [\neg R]\}, [\neg R]) = 1$
$U_{[\![(7)]\!]}(\{w : \text{fail to reach } CG \text{ in } w \text{ that settles } [\![(7)]\!]\}, [R]) = 0$
$U_{[\![(7)]\!]}(\{w : \text{fail to reach } CG \text{ in } w \text{ that settles } [\![(7)]\!]\}, [\neg R]) = 0$

$G_{[\![(8)]\!]}$ has these components:

$$M_{[\![(8)]\!]} = \{\{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [E] \cap [S]\}, \{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [E] \text{ but } CG \not\subseteq [S]\}, \{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [S] \text{ but } CG \not\subseteq [E]\}, \{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [\neg E] \cap [\neg S]\}, \{w : \text{fail to reach } CG \text{ in } w \text{ that settles } [\![(8)]\!]\}\}$$

$S_{[\![(8)]\!]} = \{[E] \cap [S], [E] \cap [\neg S], [\neg E] \cap [S], [\neg E] \cap [\neg S]\}$

$U_{[\![(8)]\!]}(\{w : \text{reach } CG \text{ in } w \text{ s.t. } CG \subseteq [E] \cap [S]\}, [E] \cap [S]) = 1$ etc.

2 Achieving One's Goals

Each goal determines an issue, *viz., what is the best move to make in pursuit of this goal?*

This can be formalized. We just saw how each question Q determines a special kind of goal structure G_Q (a structure that is active when this question is under discussion). In the other direction, every goal structure G determines the issue of how best to achieve it:

(10) **Best move sets** (cf. van Rooy [2003])
Given a goal structure $G = \langle M, S, U \rangle$, the *best move set* for G is $Q_G = \{\bigcup\{s : U(m, s) \geq U(m', s) \text{ for all } m' \in M\} : m \in M\}^*$ (where X^* is the downward closure of X).

Intuitively, if $P \in Q_G$, then someone in state P knows the best move(s) to make in pursuit of goal G.

Consider the goal G where

$M = \{\text{walk to station}, \text{walk to palace}, \text{stay put}\}$

$S = \{\text{paper at station only}, \text{paper at palace only}, \text{paper at both places}\}$

$U(\text{walk to station}, \text{paper at station only}) = 1$
$U(\text{walk to station}, \text{paper at palace only}) = -1$
$U(\text{walk to station}, \text{paper at both places}) = 1$
$U(\text{walk to palace}, \text{paper at station only}) = -1$
$U(\text{walk to palace}, \text{paper at palace only}) = 1$
$U(\text{walk to palace}, \text{paper at both places}) = 1$
$U(\text{stay put}, \text{paper at station only}) = 0$
$U(\text{stay put}, \text{paper at palace only}) = 0$
$U(\text{stay put}, \text{paper at both places}) = 0$

$$Q_G = \{\{w : \text{paper at station only or at both places in } w\}, \{w : \text{paper at palace only or at both places in } w\}\}^*$$

When it comes to QUD structures, we have the following fact:

Fact. $Q_{G_Q} = Q$.

That is, the best move set for a question-under-discussion G_Q is just the issue Q itself.

N.B. It is not always the case that $G_{Q_G} = G$ since many goal structures are not QUDs.

3 Goals in Discourse

To embed goal structures in discourse structure, we can follow Rawlins [2010] and work with a generalization of the QUD stack (in fact, we *doubly* generalize by adding both a store for assertions in purgatory and keeping track of goals more generally, not just QUDs):

(11) **Contexts**
A *context* involving participants X, Y is an n-tuple $\mathcal{C} = \langle T, a, cs_X, cs_Y, ...\rangle$ where:

- T is a *table* $\langle \mathcal{A}, \mathcal{G}\rangle$ consisting both of an *assertion stack* $\mathcal{A}$ and *goal stack* $\mathcal{G}$ (cf. Farkas and Bruce [2010]; see also Bledin and Rawlins [2016])
- a is a temporary *assumption slot* that restricts the *view* of the context to the worlds inside it
- cs_X, cs_Y are the *public commitment sets* of X, Y respectively (Gunlogson [2001], [2008], drawing on Hamblin [1971])

4 What If

Recall the original dynamic semantic analysis of "what if" questions in Rawlins [2010] (drawing on Isaacs and Rawlins [2008]):

(12) $\mathcal{C}$ + "what if φ" = ($\mathcal{C}$ + ASSUME φ) + WHIF
$\mathcal{C}$ + WHIF = $\mathcal{C}$ + ?QUD$^{\mathcal{C}}$

This analysis decomposes a "what if" update into two steps. First, the ASSUME procedure enters the content of the supposition directly into the assumption slot (cf. Ramsey [1929], Kaufmann [2000], Isaacs [2007]):

(13) **Assuming**
$\mathcal{C}$ + ASSUME $\varphi = \langle T^{\mathcal{C}}, a^{\mathcal{C}} \cap [\![\varphi]\!], cs_X^{\mathcal{C}}, cs_Y^{\mathcal{C}}, ...\rangle$

Second, the WHIF procedure poses a contextually supplied question under discussion ?QUD$^{\mathcal{C}}$ in the resulting subordinate context.

Now, I want to suggest that the Rawlins analysis was on the right track in a couple of important respects:

- "What if" questions are conditional questions whose domains are restricted by temporary assumptions introduced by their "if"-clauses.
- "What if" questions are, in a certain sense, anaphoric on the current goals of the conversational participants.

But unlike in Rawlins [2010], both discourse and domain goals are now represented with the more general goal structures and WHIF reconstructs a question from these structures. Here is the new update:

(14) $\mathcal{C}$ + "what if φ" = ($\mathcal{C}$ + ASSUME φ) + WHIF
$\mathcal{C}$ + WHIF = $\mathcal{C}$ + ?$Q_{G^{\mathcal{C}}}$

Note that whereas the earlier entry (12) requires a current question under discussion ?QUD$^{\mathcal{C}}$ for the "what" in "what if" to grab hold of, the new entry (14) requires only that there is a contextually relevant goal structure $G^{\mathcal{C}}$ in play. This structure $G^{\mathcal{C}}$ might be a QUD (defined as in (9) above) but it might not be.

5 Examples

The Rawlins analysis really shines when it comes to re-raising cases:

(15) A: Is Alfonso coming to the party?
B: Yes.
A: What if Joanna is there?

Observation: The new analysis *replicates* Rawlins' results in such cases where a "what if" question does appear to be anaphoric on a previously introduced QUD. This follows immediately from the fact that $Q_{G_Q} = Q$.

In (15), A asks

$Q_A = \{P : P \subseteq [A]\} \cup \{P : P \subseteq [\neg A]\}$

and this introduces the common goal G_{Q_A}. When A later asks her "what if" question, she asks $Q_{G_{Q_A}} = Q_A$ in the hypothetical context where it is assumed that Joanna is coming to the party—the same story as before.

But the new analysis in (14) arguably delivers better results across the full spectrum of uses. There is no need for mysterious QUD gymnastics. For example, one case that gave the earlier analysis a rough time was the use of "what if" questions to resist imperatives:

(16) A: Open the window.
B: What if it's still raining?

Unless imperatives introduce QUDs (collective goals to answer some salient question), it is not clear how to handle this case by appealing to (12).

With goal structures in the picture, though, we can tell the following story. By uttering the discourse-initial imperative, A expresses (and incurs a public commitment to having) an *effective preference* for worlds in which the window is opened (Condoravdi and Lauer [2010]). Assuming that A has authority over B in the discourse context, and B appreciates this, the imperative shifts B's own preferences in the direction of opening the window. But B's "what if" question indicates that she does not yet know what to do. Her current goal-directed state might be represented using the following structure G:

$M = \{\text{open window}, \text{keep window closed}\}$

$S = \{\text{rain + A still wants open}, \text{rain + A does not want open}, \text{no rain}\}$

$U(\text{open window}, \text{rain + A still wants open}) = 1$
$U(\text{open window}, \text{rain + A does not want open}) = 0$
$U(\text{open window}, \text{no rain}) = 1$
$U(\text{keep window closed}, \text{rain + A still wants open}) = 0$
$U(\text{keep window closed}, \text{rain + A does not want open}) = 1$
$U(\text{keep window closed}, \text{no rain}) = 0$

	rain + A still wants open	rain + A does not want open	no rain
open window	1	0	1
keep window closed	0	1	0

$Q_G = \{\{w : \text{rain + A still wants open or no rain in } w\},$
$\{w : \text{rain + A does not want open in } w\}\}^*$

B's "what if" question amounts to this:

(17) If it's still raining, do you still want the window open?

Krifka on Commitment Change

AS.150.657 *What If* Questions
Johns Hopkins University, Fall 2016

1 Commitment...

What is it to make an assertion? One old and popular answer among linguists and philosophers of language is this: to assert a proposition is to undertake a *commitment* to, or to hold oneself responsible for, its truth (Peirce [1934], Searle [1969, 1979], Brandom [1983, 1994], Wright [1992], Watson [2004], MacFarlane [2003, 2005], a.m.o.).

Following Gunlogson [2001] a.o., Krifka [2012] and Cohen & Krifka [2014] adopt this idea across the board and develop a new commitment-based theory of speech acts. This theory has some striking features:

- In LFs, there is a special syntactic category Force Phrase, or ForceP, for illocutionary operators. These operators combine with TP or TPQ clauses to produce speech acts.
- The interpretation of a speech act type A is a function from input commitment states to output commitment states (what we might call its *commitment change potential*). This can be rendered as $\lambda c[c+\mathrm{A}]$.

The notion of commitment appealed to here is a bit obscure—what are these commitments *to*? Krifka [2012] does not say much about this.

> For example, in the speech act of asserting a proposition φ, the speaker takes on a commitment to be responsible for the truth of φ, and in the speech act of a promising the speaker takes on a commitment to act in a particular way in the future. Such commitments have social consequences. For example, in the case of an assertion the speaker has to present evidence for φ if asked for, and can be held liable for the truth of φ. (p. 6)

See Brandom [1983, 1994] and MacFarlane [2005] for richer discussion.

2 ...States, Spaces, and Developments

(1) **Commitment states**
A *commitment state* c is the set of public commitments that have accumulated up to a certain point in discourse.

(2) **Update on commitment states**
The *update* of c with speech act A is $c + \mathrm{A} = c \cup com_c(\mathrm{A})$ where $com_c(\mathrm{A})$ is the set of commitments introduced when A is performed in state c.

To model certain complex conversational acts like *speech act denegation* that cannot be expressed entirely at the level of commitment states, we must consider the possible developments or continuations of such states.

(3) **Commitment spaces**
A *commitment space* C is a set of commitment states with the property that $\exists c \in C[c \neq \emptyset \wedge \forall c' \in C[c \subseteq c']]$. The witness of this existential is the *root* $\sqrt{C}$ of C.

I.e., a commitment space is a *rooted* set of commitment states.

(4) **Update on commitment spaces**
The *update* of C with speech act A is $C{+}\mathrm{A} = \{c \in C : \sqrt{C}{+}A \subseteq c\}$.

(5) **Speech act denegation** (Krifka [2012])
The *denegation* of A results in the commitment space
$C + \neg\mathrm{A} = C \setminus \{c : \exists c'[c' + \mathrm{A} \subseteq c]\}$.

I.e., denegation removes all states in C that are reachable after performing A *at some point* (compare the *local* denegation in Cohen & Krifka [2014]). Since denegation does not change the root of C but only restricts future moves, Krifka calls it a "meta speech act".

See Cohen & Krifka [2014] for discussion on the composition and logic of updates on commitment spaces.

(6) **Commitment space developments**
A *commitment space development* is a sequence $\mathcal{C} = \langle C_0, C_1, ..., C_n\rangle$ where C_n is the current commitment space and $C_0, ..., C_{n-1}$ are preceding spaces (so $\mathcal{C}$ records the history of the conversation).

(7) **Update on commitment space developments**
The *update* of $\langle C_0, ..., C_n\rangle$ with speech act A is
$\langle C_0, ..., C_n\rangle + \mathrm{A} = \langle C_0, ..., C_n, C_n + \mathrm{A}\rangle$.

3 Assertions

According to Krifka, assertion involves two commitments:

- The speaker S's commitment to stand behind what is asserted. This is encoded in $[S:\varphi]$ which abbreviates 'S is liable for the truth of φ'.
- The shared commitment to treat the proposition asserted as common ground. This is encoded in $[\varphi \in CG]$ where $CG(c)$ designates the set of propositions that are common ground in c.

Krifka assumes that $[\varphi \in CG] \in c$ only if $\varphi \in CG(c)$. Accepting the commitment $[\varphi \in CG]$ then amounts to adding φ to the common ground. (What is the mechanism underlying this?)

If $S1$ utters $[_{\text{ForceP}} ASS[_{\text{TP}}\varphi]]$ to $S2$,[1] the result is the following:

(8) **Assertive update**
$\mathcal{C} + \text{ASSERT}_{S1,S2}(\varphi) = \mathcal{C} + [S:\varphi] + [\varphi \in CG]$.

Importantly, we should think of the final update with $[\varphi \in CG]$ as a *proposed* change that a hearer can accept or reject (cf. Farkas and Bruce [2010]). The following updates are defined only if the current commitment space contains an obligation imposed on S2 that does not exist in the preceding commitment space.

(9) **Acceptance**
$\mathcal{C} + \text{ACCEPT}_{S2,S1}(\varphi) = \mathcal{C}$.

(10) **Rejection**
$\langle C_0, ..., C_{n-1}, C_n\rangle + \text{REJECT}_{S2,S1}(\varphi) = \langle C_0, ..., C_n, C_{n-1} \setminus C_n\rangle$.

The kind of analysis in (10) is a bit sloppy. It suggests that φ is temporarily added to the common ground before being kicked out by the rejection.

Over and above mere acceptance, a hearer might *confirm* an assertion by indicating his or her own commitment to the proposition expressed.

(11) A: It is raining.
B: Yes. / That's right.

After A's assertion, the commitment space development $\mathcal{C}_0$ is updated with $\text{ASSERT}_{\text{A,B}}(R)$ returning $\mathcal{C}_0 + [\text{A}:R] + [R \in CG]$. The assertion also introduces R as a *propositional discourse referent* that subsequent discourse moves can retrieve. In fact, Krifka analyzes B's positive response as a re-assertion of R. The posterior commitment space development is now $\mathcal{C}_0 + [\text{A}:R] + [R \in CG] + [\text{B}:R]$. (How does the difference between acceptance and confirmation show up in discourse? Isn't a hearer publicly committed to the content of an assertion after tacitly accepting it?)

A hearer can also *deny* or *negate* an assertion.

(12) A: It is sunny.
B: No. / That's false.

According to Krifka, B's response is now an assertion of the negation of the discourse referent S. Since a CG that includes both S and $[\text{B}:\neg S]$ is *inconsistent*, A's attempt to update with $[S \in CG]$ must be rejected before $[\text{B}:\neg S]$ is added.

How to understand the flexibility of responses to assertions of negated sentences?

(13) A: There is no cloud in the sky.
B: No, there isn't.
B': Yes, there isn't.
B": No, there is!
B"': Yes, there is!

Krifka's solution: A's assertion introduces *two* discourse referents, *viz.*, C and $\neg C$. In B's agreeing responses, 'No' picks up C and 'Yes' picks up $\neg C$. In B's disagreeing responses, 'No' picks up $\neg C$ and 'Yes' picks up C.

Evidence for double referents:

(14) a. Two plus two isn't five. That would be a contradiction.
b. Two plus two isn't five. Everyone should know that.

(15) a. Bill didn't come to the party, even though everyone had expected that.
b. Bill didn't come to the party, and everyone had expected that.

4 Questions

Assuming that a question sentence radical Φ is a set of propositions (the possible "congruent" answers), $[_{\text{ForceP}} QU[_{\text{TPQ}}\Phi]]$ is interpreted as follows.

(16) **Questioning update**
$\langle C_0, ..., C_n\rangle + \text{QU}_{S1,S2}(\Phi) = \langle C_0, ..., C_n,$
$\{\sqrt{C_n}\} \cup \{c \in C_n : \exists\varphi \in \Phi[\sqrt{C_n} + [\text{S}_2:\varphi] \subseteq c]\}\rangle$.

[1] Krifka's LFs also include tonal markers but I will ignore prosody here.

The questioner restricts future continuations to those that begin with the addressee undertaking a commitment to a possible answer to the question. This is another example of a meta speech act concerned with “common ground management” (as opposed to “common ground content”).

An addressee can reject a question, e.g., by uttering ‘I don’t know’.

Krifka assumes that a polar question sans negation introduces a single propositional discourse referent (assumption: TPQ element $\{\varphi, \neg\varphi\}$ is formed from TP element φ). This can help explain ‘Yes’/‘No’ answers.

(17) A: Is it raining?
B: Yes.
B’: No.

With ‘Yes’, B asserts the discourse referent R. With ‘No’, B asserts its negation $\neg R$.