Heim's ambiguity and the lexical content of attitude predicates

University of Maryland Colloquium

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Concealed questions

Baker 1968; Grimshaw 1979; Heim 1979; Romero 2005; Frana 2006; Nathan 2006; Schwager 2007; Aloni 2008; Roelofsen and Aloni 2008; Frana 2010; Percus 2010 etc.

(1) Miles knows *the price of milk*.

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Paraphrase of blue DPs: "what the price of milk is"

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Two currently central questions in this literature:

- What do concealed question DPs denote?
- What are the characteristics of verbs that take concealed question DPs as arguments?

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What do concealed question DPs denote?

- Questions? (Baker, Grimshaw, Aloni/Roelofsen, Percus)
- Propositions? (Nathan)
- Individual Concepts (type $\langle se \rangle$)? Heim, Romero, Frana)
- Properties? (Frana 2006, Schwager)

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What are the defining characteristics of CQ-taking predicates?

- Q-embedding verbs?
- Proposition-embedding verbs?
- Verbs with special individual concept-taking entries?
- Verbs involving *de re* attitude ascriptions?
- Something else?

A third question

Are "concealed questions" a uniform phenomenon?

Underlying assumption in the literature: yes.

Our answers

What do concealed question DPs denote?

- Hybrid account: Non-rigid individual concepts or individuals that can be type-shifted into questions.
- Necessary to account for "Heim's ambiguity" – complex CQs with relative clauses and embedded CQ-predicates.

What is the nature of CQ-taking predicates?

- Varied: attitude verbs can take questions, ICs, and sometimes individuals.
- New data: *Unconditionals* involve purely question-denoting CQs.

Are concealed questions a uniform phenomenon?

- No! Multiple paths to apparently similar readings.
- New data: variation across different CQ-taking predicates.

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The individual concept analysis of simple CQs

Two pieces: (Heim 1979; Romero 2005; Frana 2010)

- Concealed question DPs ("the price of the iPhone") denote individual concepts (ICs), type $\langle se \rangle$.
- Attitude verbs have an extra entry that takes ICs.

Heim/Romero: Individual concepts for descriptions

Generating concepts, the simple case: Intensionalize the standard (Fregean) account of descriptions.

- Value at different worlds varies – e.g. represent (epistemic) uncertainty.

(4) $[\![\text{the price of the iPhone}]\!]^{w,c} =$
$\lambda w^*.\iota x.x$ is the price of the iPhone in w^*

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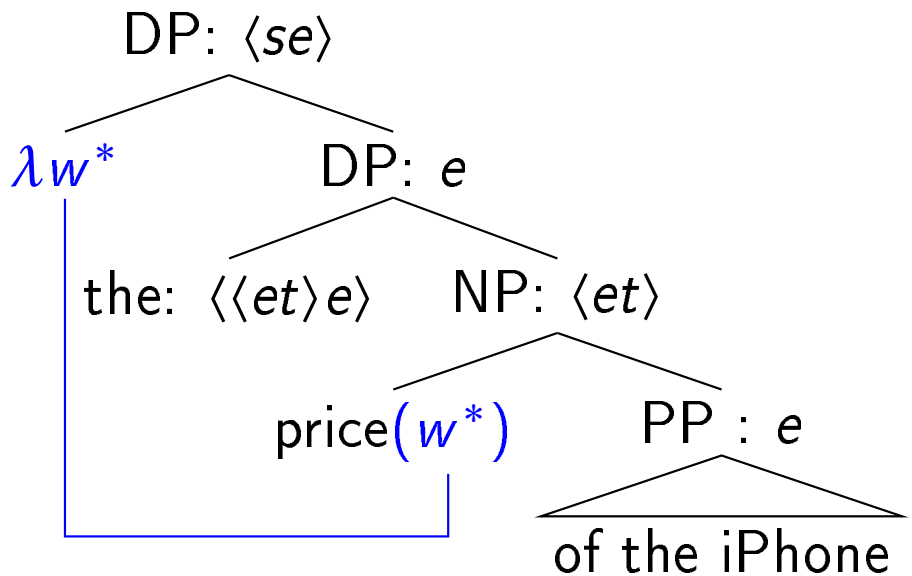

Heim/Romero: A concept-taking entry for "know"

(5) $[\![\text{know}_{\text{ic}}]\!]^w = \lambda f_{\langle se \rangle} . \lambda x_e . \forall w' \in \text{Dox}_w(x) : f(w) = f(w')$

"The value of the concept at x's doxastic alternatives is the same as its value at the evaluation world."

The IC-taking entry, example

Suppose:

- $f = [\![\text{the price of the iPhone}]\!] = \begin{bmatrix} w_1 \rightarrow & \$300 \\ w_2 \rightarrow & \$350 \\ w_3 \rightarrow & \$400 \\ w_4 \rightarrow & \$350 \end{bmatrix}$
- $w^@ = w_2$

Formula ("Miles knows the price of the iPhone"):

$$\forall w' \in \text{Dox}_{w^@}(\text{Miles}) : f(w^@) = f(w')$$

- $\text{Dox}_{w^@}(\text{Miles}) = \{w_1, w_2\}$: false
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Independent arguments for concepts and their predicates

Romero 2007: we already need predicates of ICs already. (Cf. Montague, Gupta, Lasersohn, ...)

(6) The price of milk increased.

Heim-like ambiguities:

(7) The price that doesn't usually change changed.
$\rightsquigarrow$ the value of some particular price (the price of milk) that is normally stable, changed.
$\rightsquigarrow$ the price of milk suddenly became unstable, and some other price became the stable one.

Relative clause "that doesn't usually change" – trace is type $\langle se \rangle$?
Interaction with "know":

(8) Miles knows the price that changed.

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Simple CQs: summary

The individual concept analysis accounts for interpretation of simple CQs without having to say anything very special about CQ-DPs.

- Extra complexity introduced in the attitude predicate itself.
- What happens with more complicated examples?

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Heim's ambiguity: the "what-value" reading

(9) Scenario: We are trying to figure out the prices of several new apple products, and we know that Clara and Miles have the same information.

A: Clara knows the price that Miles knows (so we can ask her instead of Miles).

Paraphrase: Clara knows the price of the same product that Miles does.

"What-value" / A reading

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(10) (Scenario: We are trying to figure out the price of the new iPhone, which (among several other products) will soon be announced. We know Miles has some inside information but aren't sure whether it is about the iPhone, and are discussing whether it is worth approaching him. Asking him what he knows will be calling in a major favor so we don't want to do it lightly. We also know that Clara has been keeping track of who knows what, though she hasn't manage to actually figure out any of the prices either.)

A: Clara knows the price that Miles knows, so we can talk to her first.

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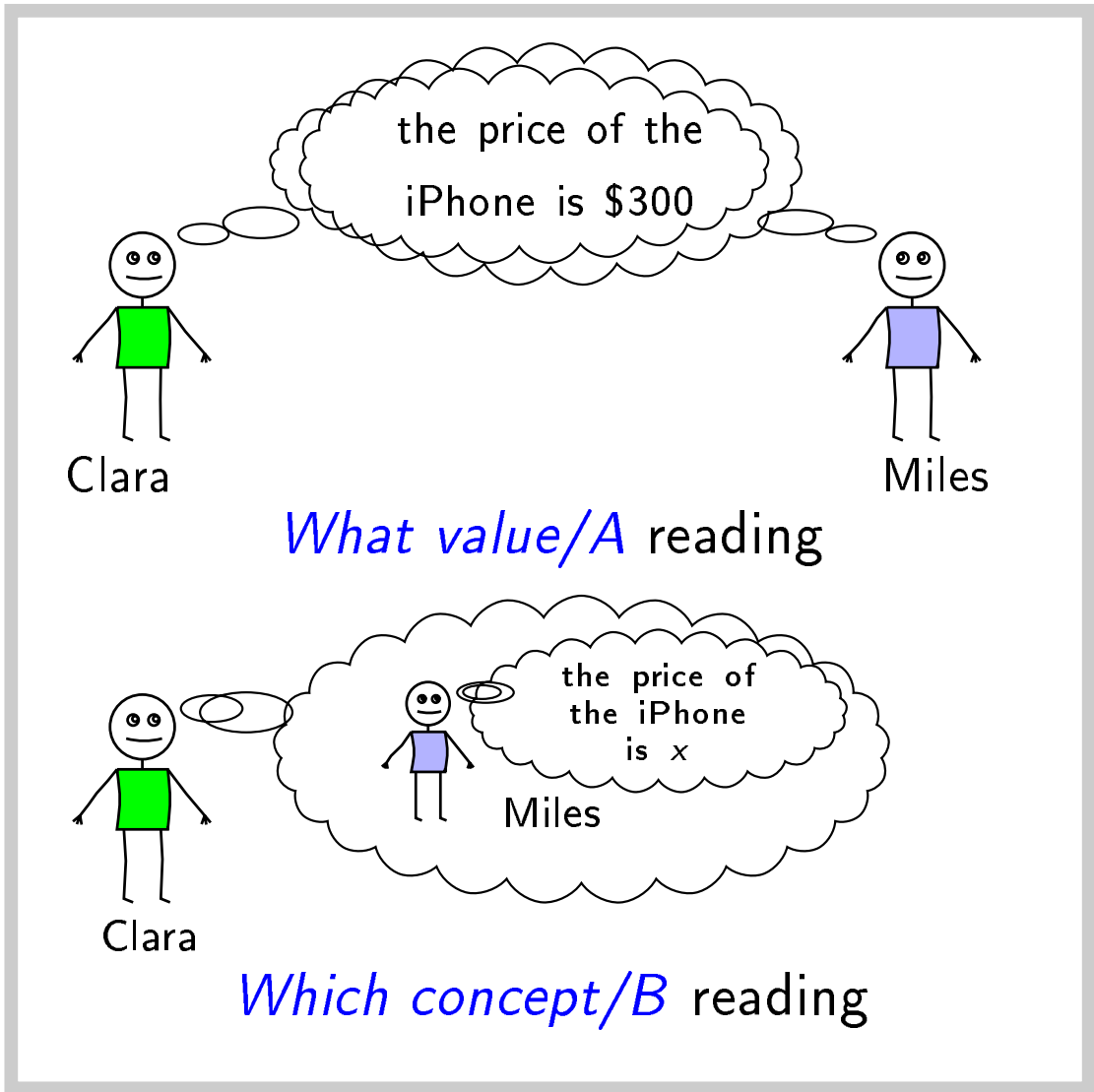

The Heim/Romero solution

Two interrelated factors behind ambiguity (see also Frana 2010):

- Ambiguous "know" – takes argument of type ⟨se⟩ or ⟨s⟨se⟩⟩.
- Ambiguous DP (/relative clause) – what binds the world variable in the relative clause?

The Heim/Romero solution: attitude verbs

The existing IC-taking entry for "know":

(12) $[\![\text{know}_{\langle se\rangle}]\!]^w = \lambda f_{\langle se\rangle} . \lambda x_e . \forall w' \in \text{Dox}_w(x) : f(w) = f(w')$
"The value of the concept at x's doxastic alternatives is the same as its value at the evaluation world."

To this we add:

(13) $[\![\text{know}_{\langle s\langle se\rangle\rangle}]\!]^w = \lambda f_{\langle s\langle se\rangle\rangle} . \lambda x_e . \forall w' \in \text{Dox}_w(x) : f(w) = f(w')$
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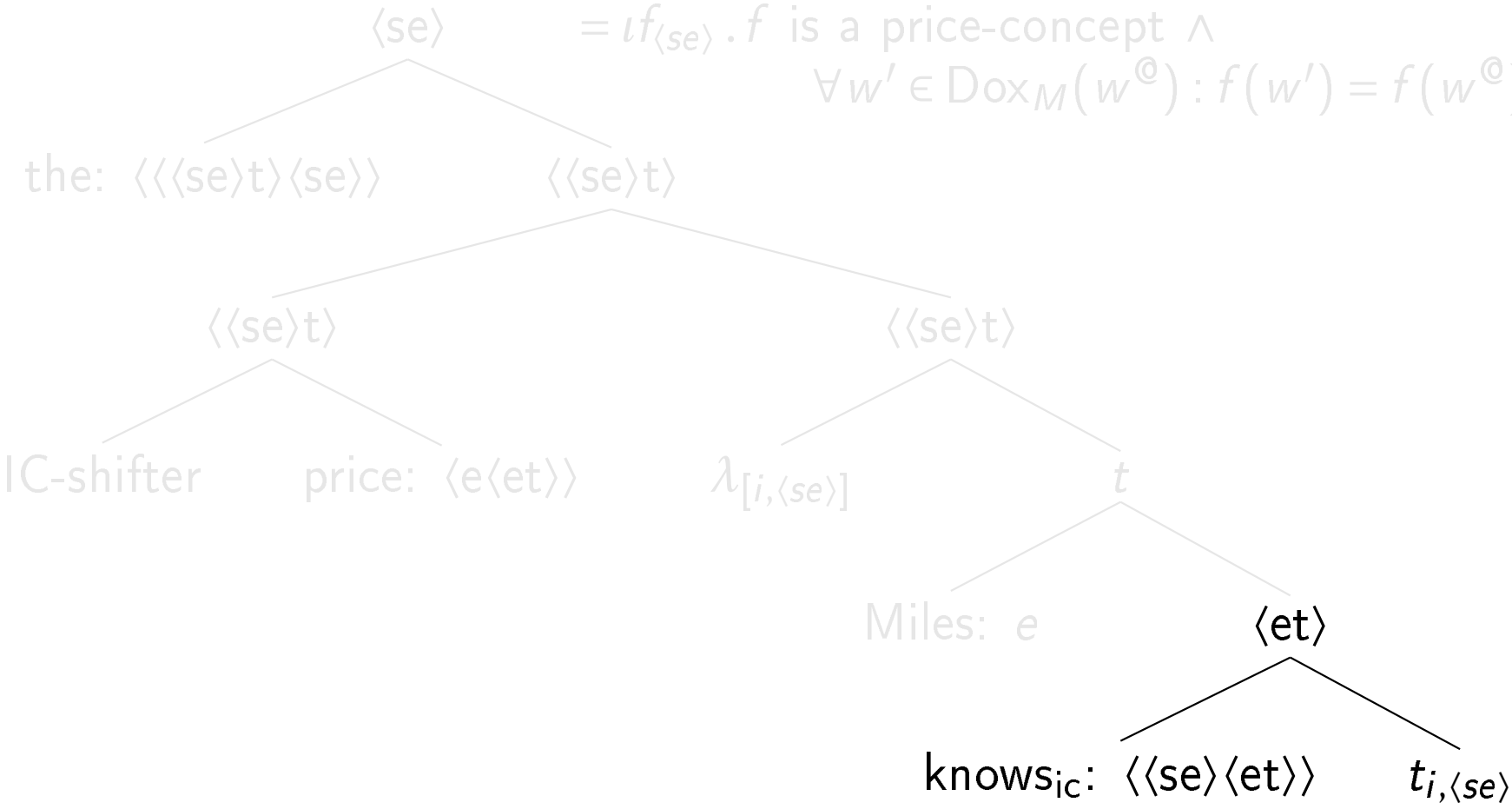
(14) [$_{DP}$ the price that Miles knows t] (what-value reading)



(15) $[\![\mathrm{IC}(\text{price})]\!]^w = \lambda f_{\langle se\rangle} . \exists x_e : \forall w' : f(w')$ is the price of x at w'
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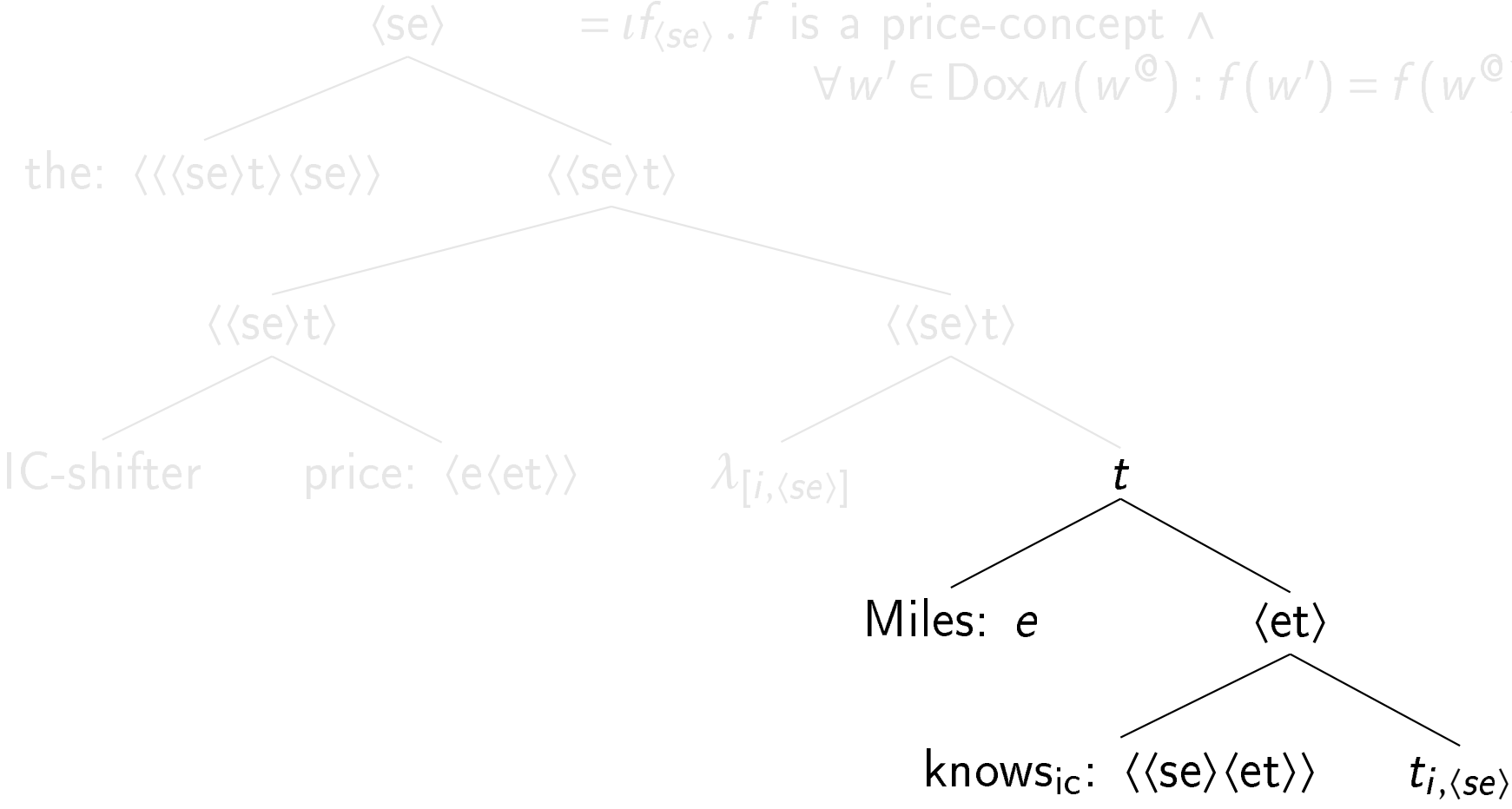

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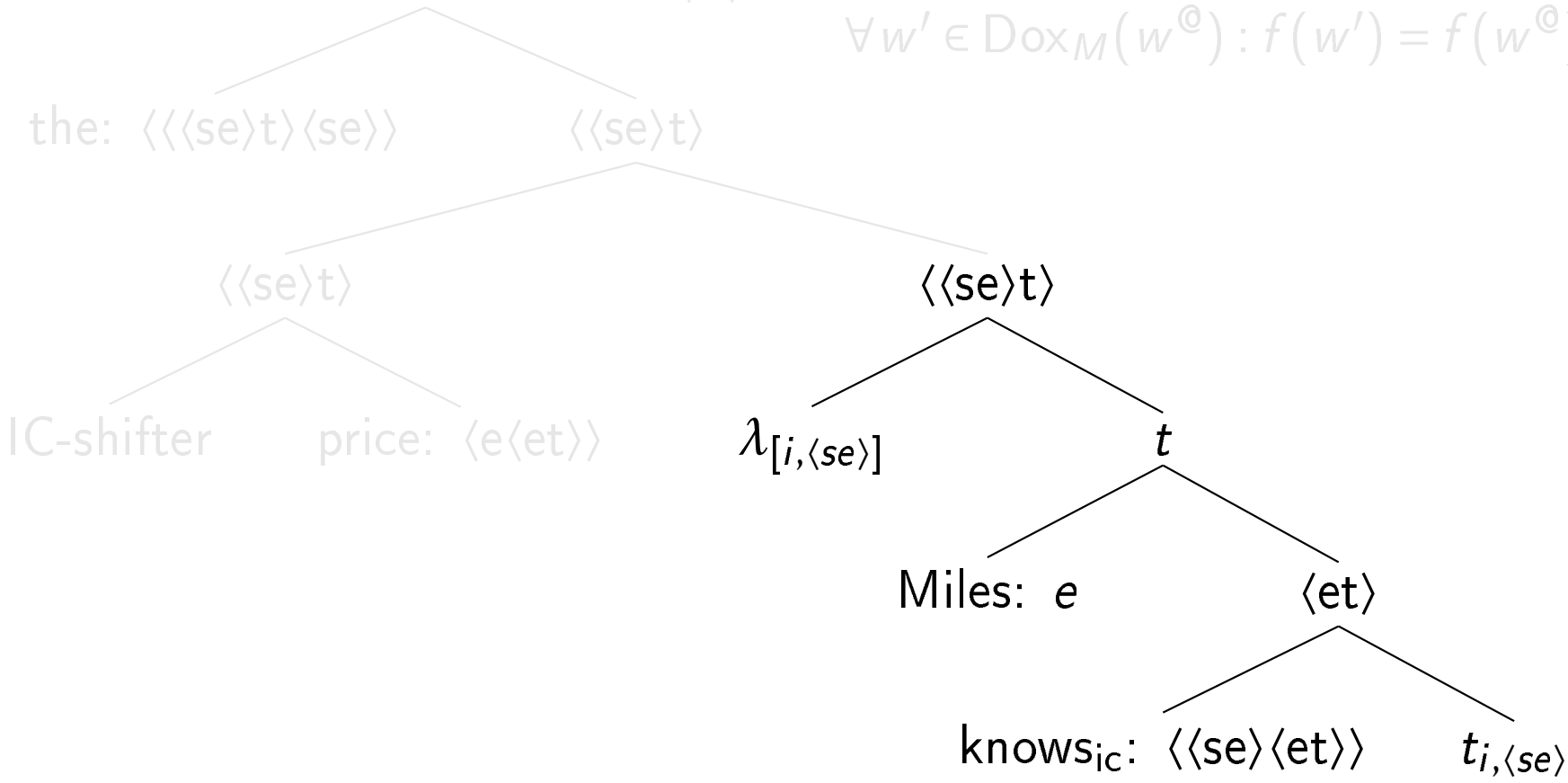

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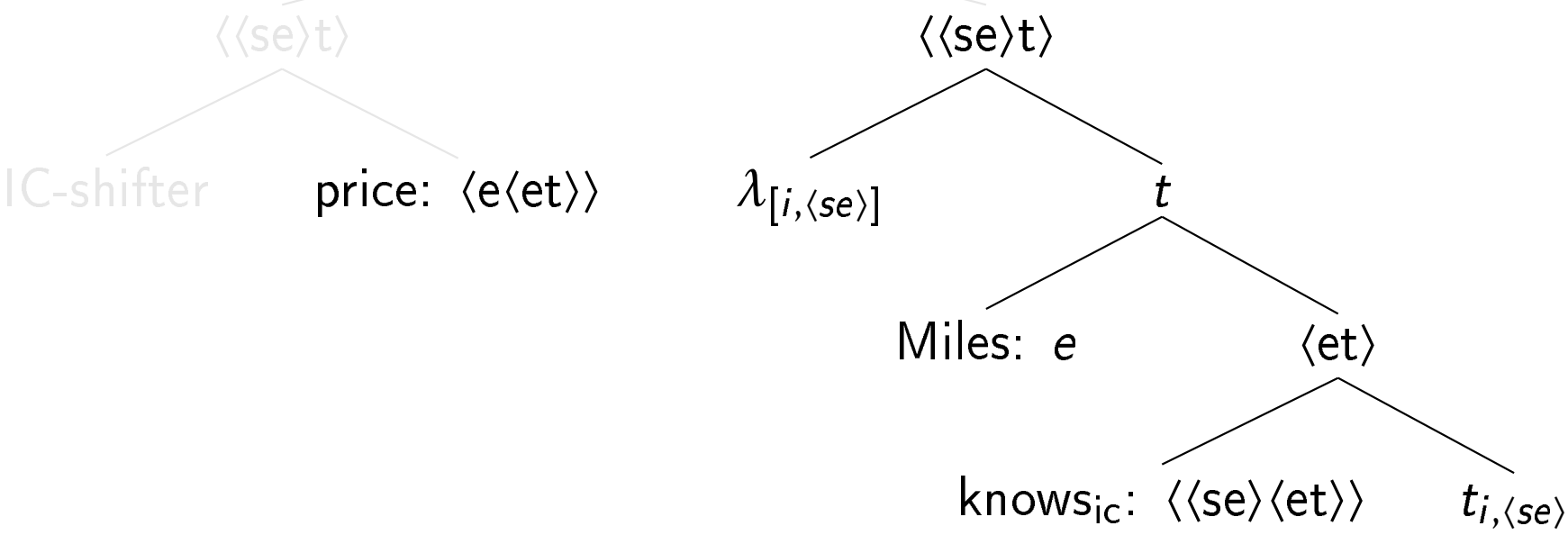

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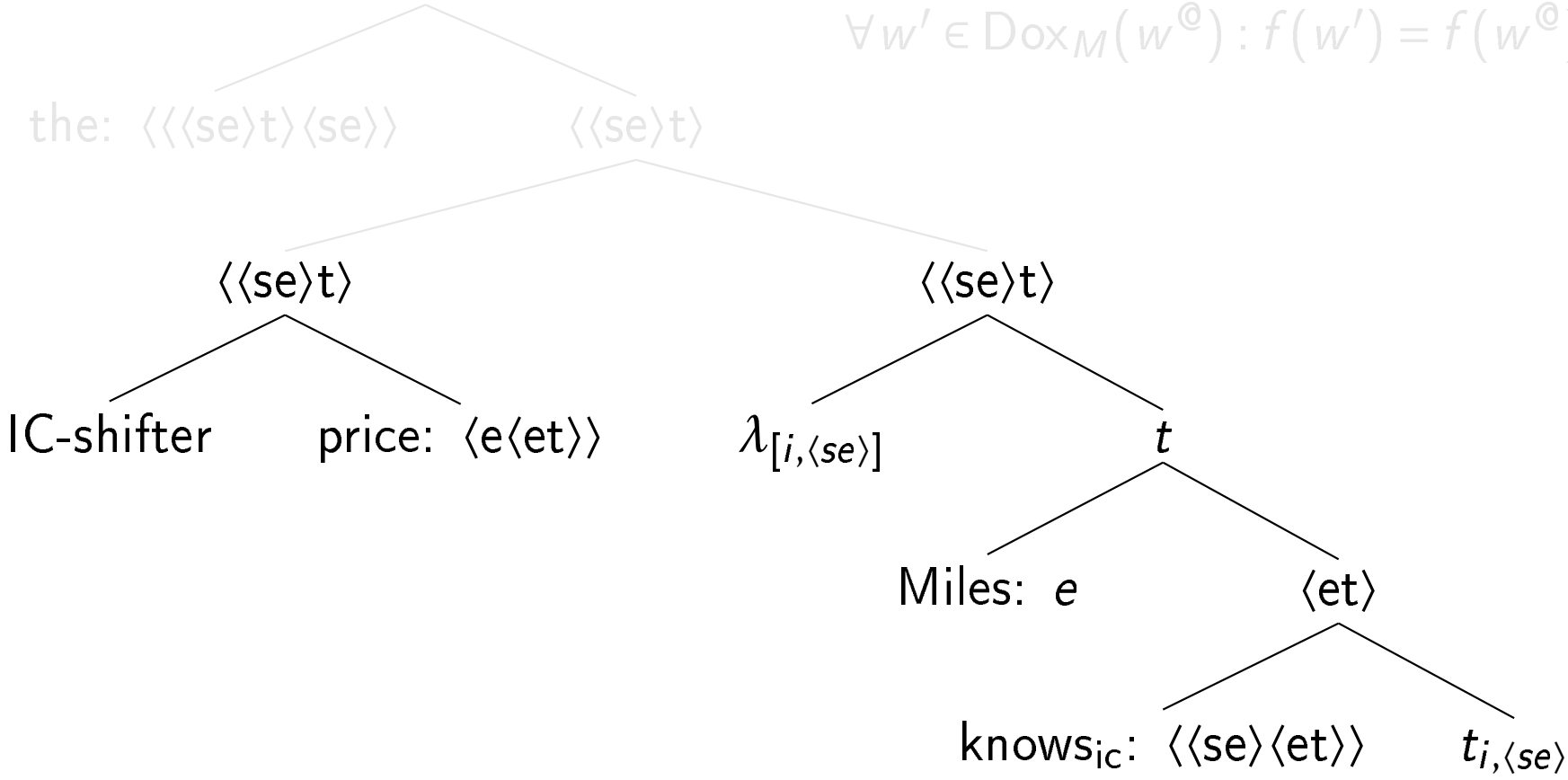

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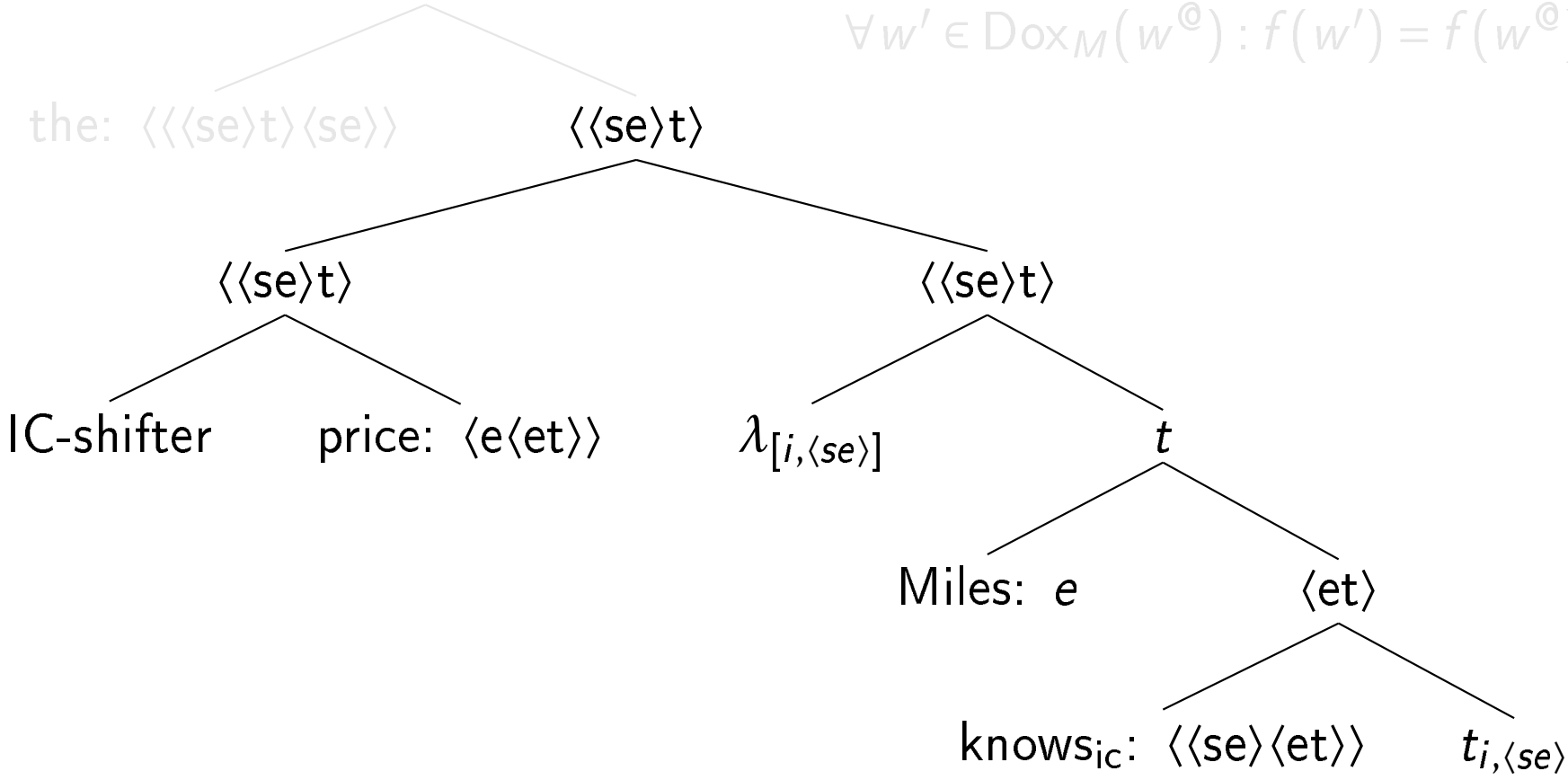

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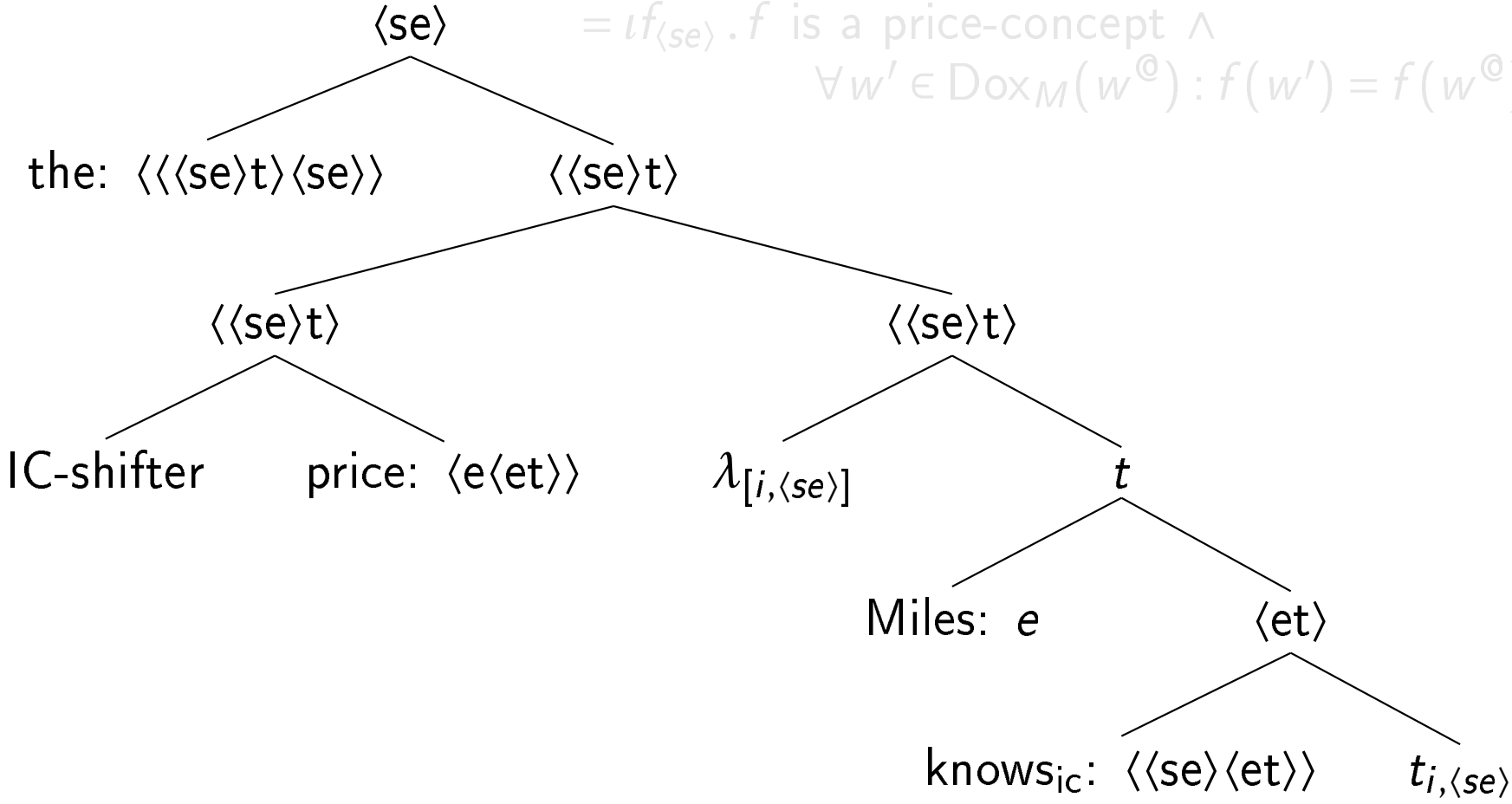

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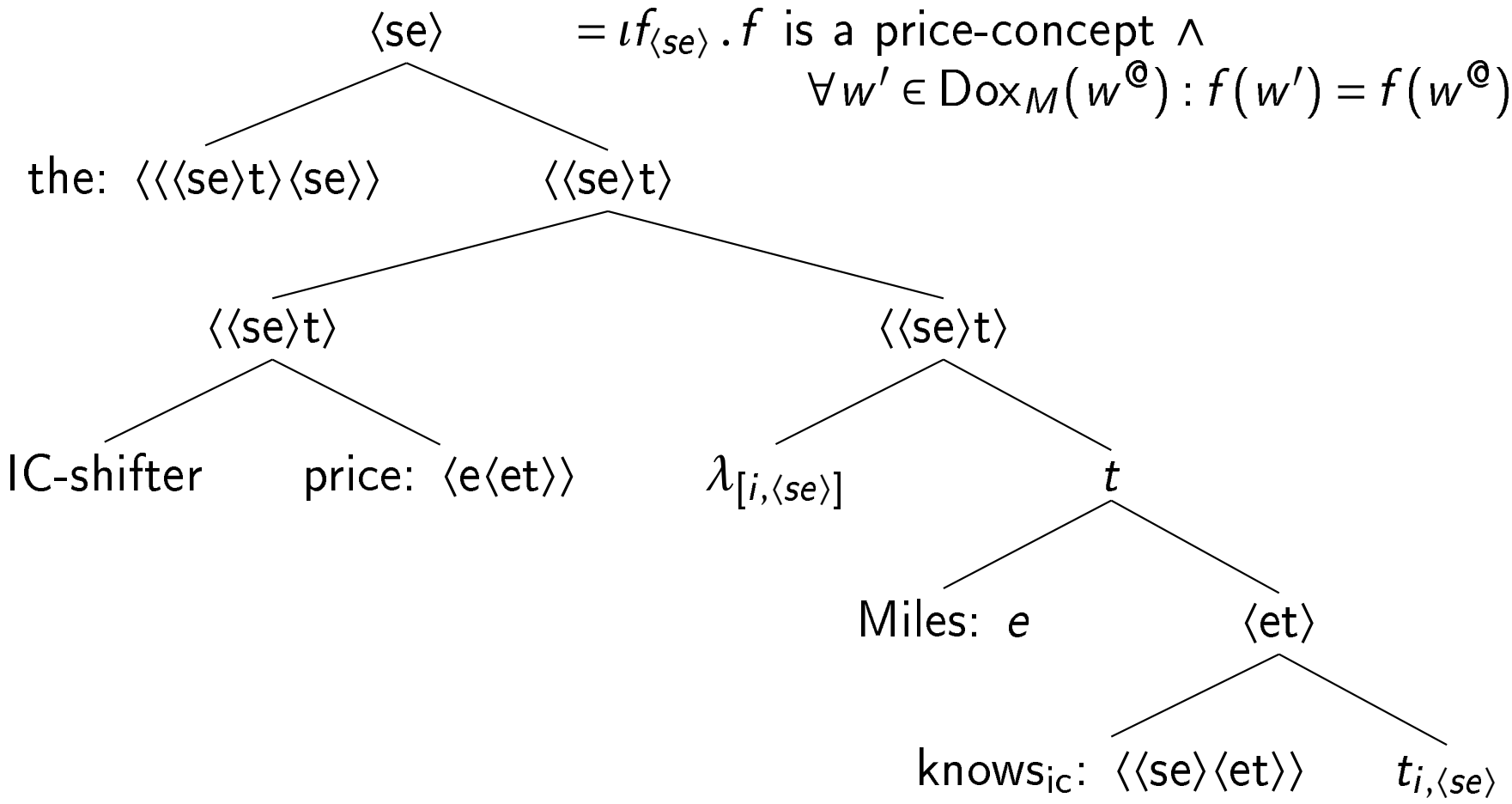

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Nathan's IC-shifter

(16) $[\![\text{IC(price)}]\!]^w = \lambda f_{\langle se \rangle} . \exists x_e : \forall w' : f(w')$ is the price of x at w' (Nathan, 2006)

- Intensional existential closure over internal argument to N.
- "f is a price-concept" = f is the result of IC(price).

Heim/Romero: what-value readings

What-value readings work like simple CQs – a DP of type $\langle se \rangle$ combines with an IC-taking attitude predicate.

So what about the which-concept readings?

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What happens when we intensionalize the function derived in what-value reading?

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becomes:

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- At any world, return the unique price-concept that Miles' doxastic alternatives fully determine at that world.
- Consequence: which world variable does "know" bind? I.e. which does it check equality at?
- Knowing: Checking value of a function ($\mathrm{know}_{\langle se \rangle}$ vs. checking identity of a concept. ($\mathrm{know}_{\langle s\langle se \rangle\rangle}$).

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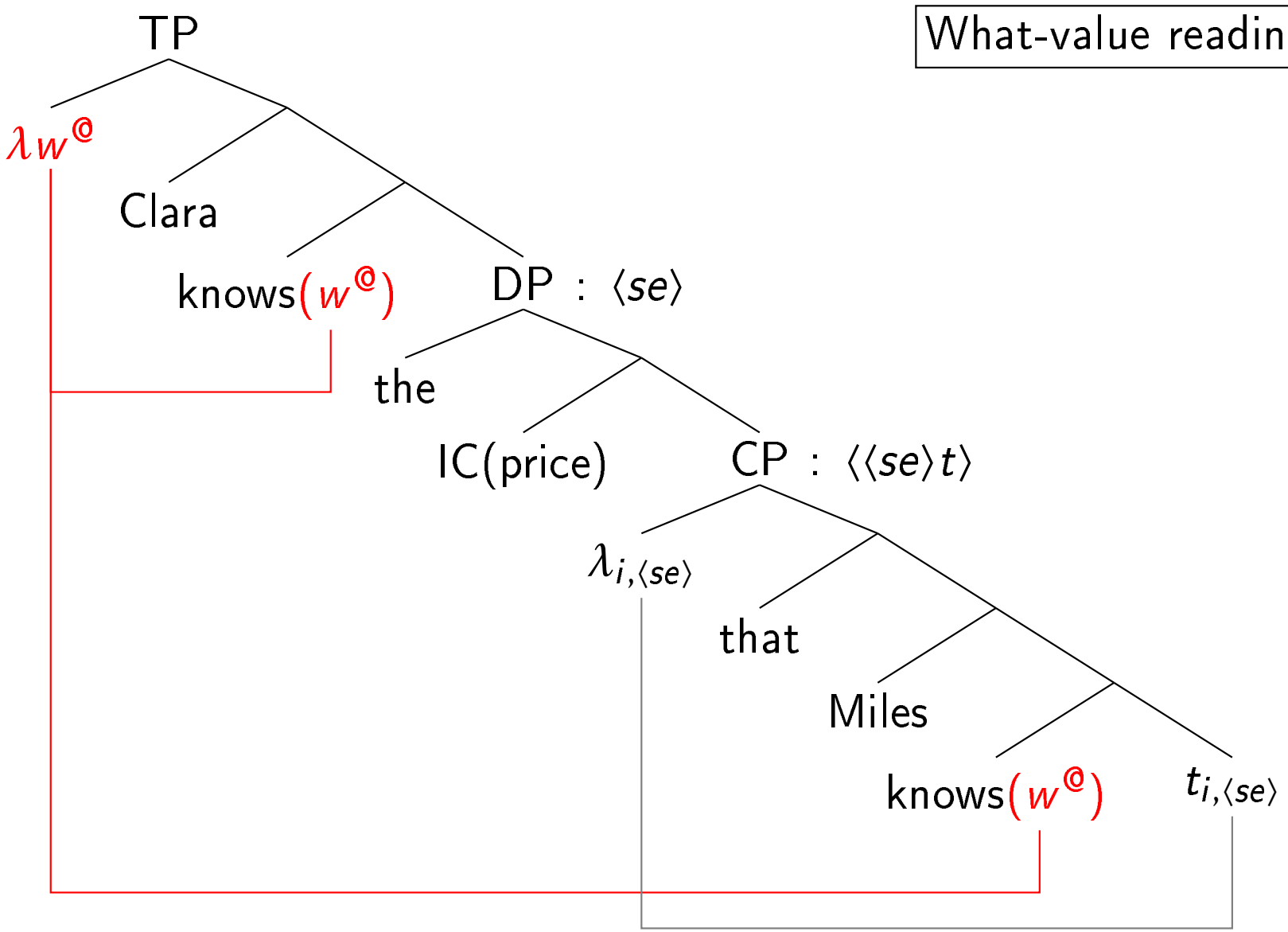
Heim/Romero: Summary in terms of world-variable binding



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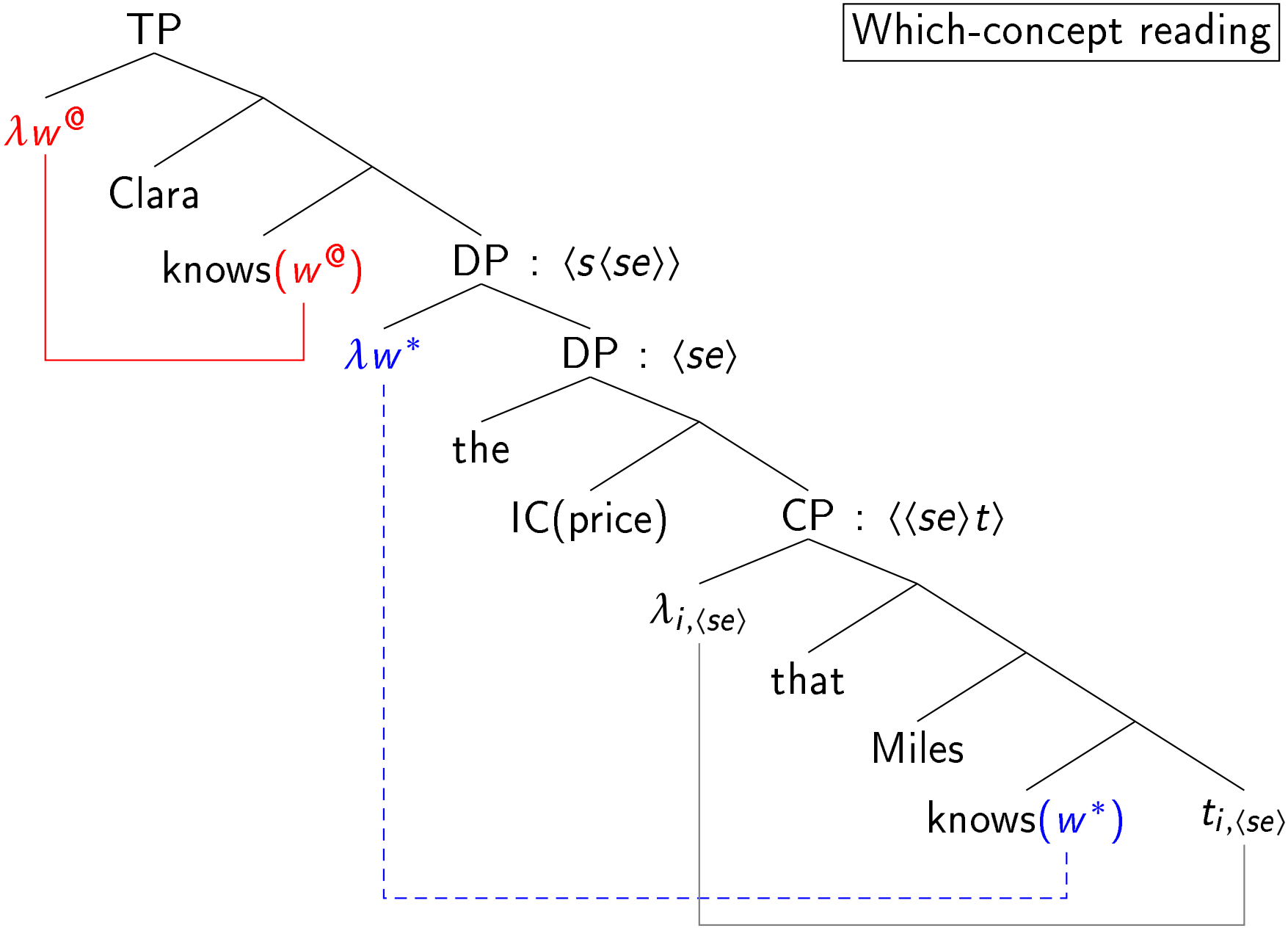

The Heim/Romero analysis: summary

(caveat: technical details slightly different in Romero's implementation)

- What-value readings: simpler type ($\langle se \rangle$).
- Which-concept readings: result from intensionalizing what-value readings.
- What-value readings = simple CQ readings.
- "Concealed Questions" are not really questions at all.
- Many benefits to this analysis!
  - Independent arguments that we need individual concepts anyways (Montague, 1973; Romero, 2006).
  - Explains (to some extent) why only identity questions.
  - Romero 2005: unified analysis with specificational subjects.

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Prediction 1: we should not expect a close selectional correlation between CQs and "true" questions. (True-ish in attitude contexts.)

Prediction 2: we don't expect a construction where simple CQs arise, but A readings don't.

Prediction 3: might be simpler to block higher-typed (B) reading, leaving only A reading. Correct in previous lit:

- Superlatives, extraposition, ACD, "the same", block B-reading (Harris, 2008; Frana, 2010)

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Some puzzling data concerning the 4 predictions.

or,

What happens when you look at concealed questions outside of attitude contexts?

Unconditional CQs

(19) {No matter / Regardless of} the price of the iPhone, I'm going to buy one.

$\rightsquigarrow$ Regardless of what the price is, ...

- Question paraphrase...
- Compatible with speaker ignorance. Does not mean the same thing as:

(20) Despite the price of the iPhone, I'm going to buy one.

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Unconditional CQs

What else occurs in this construction? (Rawlins, 2008)

- Interrogative clauses:

(21) No matter what (else) Miles buys, he will run out of money.

(22) No matter why Clara did that, she will get in trouble.

- Note: presence of "else" / "why" evidence against a free relative analysis. (Baker, 1968; Gawron, 2001; Rawlins, 2008)
- Referential DPs / declarative clauses are bad:

(23) * No matter Clara, Miles will get in trouble.

(24) * No matter that Clara did that, she will get in trouble.

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The selectional generalization

The heads of headed unconditionals (e.g. "regardless of ϕ, ψ") select for question-denoting complements.

Next question: what about Heim-ambiguity style CQs?

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Unconditionals and RCs I

(25) Scenario 1 (single product/what-value): Apple is announcing the price of a single product tomorrow – the new iPhone. Miles has inside information and knows in advance what this price is. We are discussing whether to ask Miles about this price.

(26) # Regardless of *the price that Miles* knows, I won't buy one, so what's the point?
⇝ # Regardless of what the price of the new iPhone is, ...

(27) Regardless of *the price that Miles* tells us, I won't buy one, so what's the point?
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Unconditionals and RCs II

(28) Scenario 2 (multiple products/which-concept): Apple is announcing the price of several products tomorrow. Miles has some inside information and knows just one of these prices, but we don't know which. We are discussing whether to ask Miles about his inside information.

(29) Regardless of *the price that Miles* knows, we should still watch to find out all the rest, so why bother?
$\rightsquigarrow$ Regardless of which product Miles knows the price of, ...

(30) Regardless of *the price that Miles* tells us, we should still watch.
$\rightsquigarrow$ Regardless of which product he tells us the price of, ...

What+RN questions

One precondition for Heim's ambiguity: CQ-taking predicate combines with a trace.

- Another situation that sets this up: questions with gap in this position.

(31) What price did Miles know?

(32) What price did Miles tell you?

- Available readings match the behavior in unconditional CQs.
  - I.e. cannot answer (31) with a particular price...

Why this data is puzzling

Prediction 1: We should not expect a close selectional correlation between CQs and "true" questions.

- Problem: this is exactly what we find in unconditionals.

Prediction 2: We don't expect a construction where simple CQs arise, but A readings don't.

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Prediction 3: should be simpler to block B reading, leaving only A reading.

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- Puzzle: "What"+RN questions show matched behavior.

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Solving the problem: which-concept(/B) readings.

The selectional restrictions of headed unconditionals

The selectional generalization (repeated)

The heads of headed unconditionals select for question-denoting complements.

- Existing analyses of unconditionals, regardless of syntax, assume a question-like analysis (Zaefferer, 1991; Lin, 1996; Izvorski, 2000b; Gawron, 2001; Rawlins, 2008).
- Romero's verbal ambiguity: not obviously spurious because selectional restrictions of attitude predicates are complicated.
- Headed unconditionals, in contrast, are simple.

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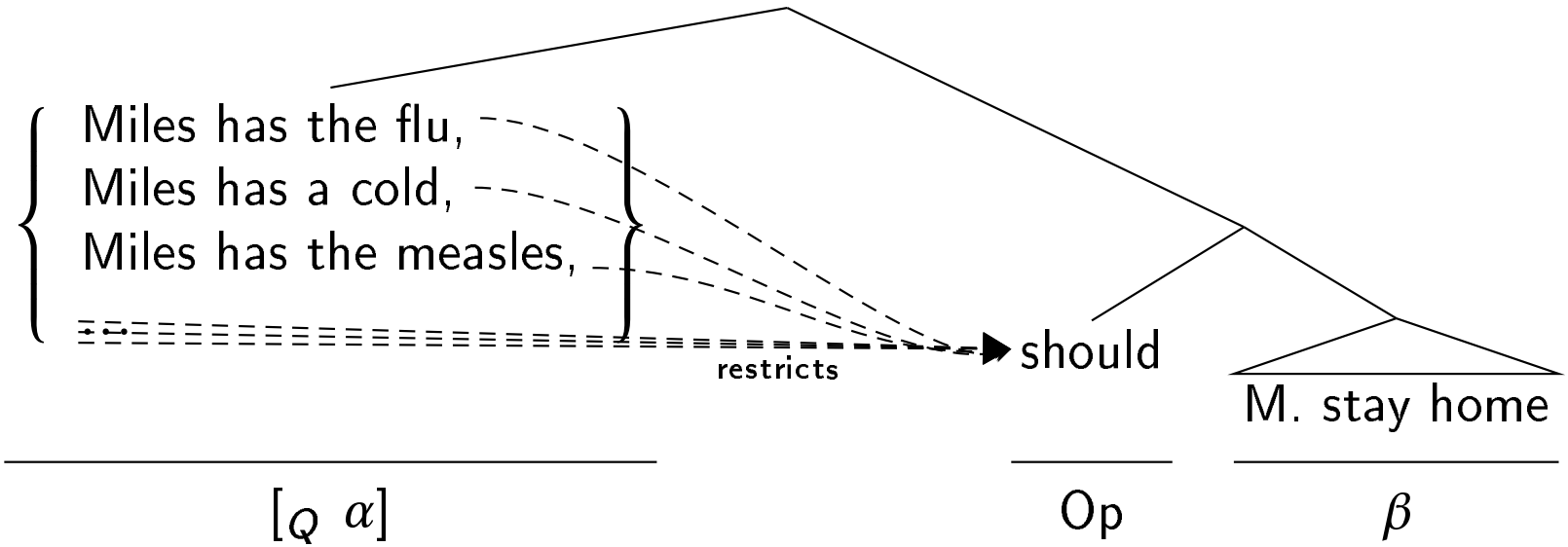
Background: the analysis of unconditionals

Basic idea: (Izvorski, 2000a,b; Rawlins, 2008)

1. Unconditional adjuncts are question-denoting, providing a set of propositional Hamblin alternatives.
2. These alternatives compose "pointwise" with a main-clause operator, each providing a domain restriction for that operator. (Cf. Lewis 1975; Kratzer 1981 etc.)

Background: the analysis of unconditionals

(33) No matter what (illness) Miles has, he should stay home from school.



(34) $[\![\text{No matter } [_Q\ \alpha],\ \text{Op } [\beta]]\!]^w$
$= \forall p \in [\![[_Q\ \alpha]]\!]^w : [\![\text{Op}]\!]^w(p)([\![\beta]\!]^w)$

A Q-shifter for unconditionals

	CQs in unconditionals are question-denoting
+	Q-denotations are sets of propositional alternatives (Hamblin)
	CQs in unconditionals denote sets of propositional alternatives.

Implementation via type-shift:

(35) $[\![\mathrm{Q}_{eq}(\alpha)]\!]^w = \left\{ p_{\langle st \rangle} \mid \exists y \in D_\tau : p = (\lambda w' . y = [\![\alpha]\!]^{w'}) \right\}$

(Where τ is e or some intension of e)

Paraphrase of the equative question shifter

"What thing does α equal?" (Closest prior proposals: Nathan 2006; Aloni 2008; cf. Aloni and Roelofsen 2009)

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Simple CQs via shifting

(36) Regardless of *the price of that iMac*, you should buy it.

(37) $[\![\text{the price of that iMac}]\!]^w =$
$\iota x_e \,.\, x$ is the price-value of that iMac in w

(38) $[\![\text{Q}_{eq}(\text{the price of that iMac})]\!]^w =$

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Side-note: blocking referential DPs

(See also Nathan 2006)

(39) # No matter Miles, the party will be fun.
$[\![\mathrm{Q}_{eq}(\mathrm{Miles})]\!]^w = \{p_{\langle st \rangle} \mid \exists y \in D_e : p = (\lambda w' . y = \mathit{Miles})\}$

Why is this out?

Reduces to a trivial, singleton set!
$\approx \{\lambda w' . \mathit{Miles} \in D_e\}$
$= \{\lambda w' . 1\}$

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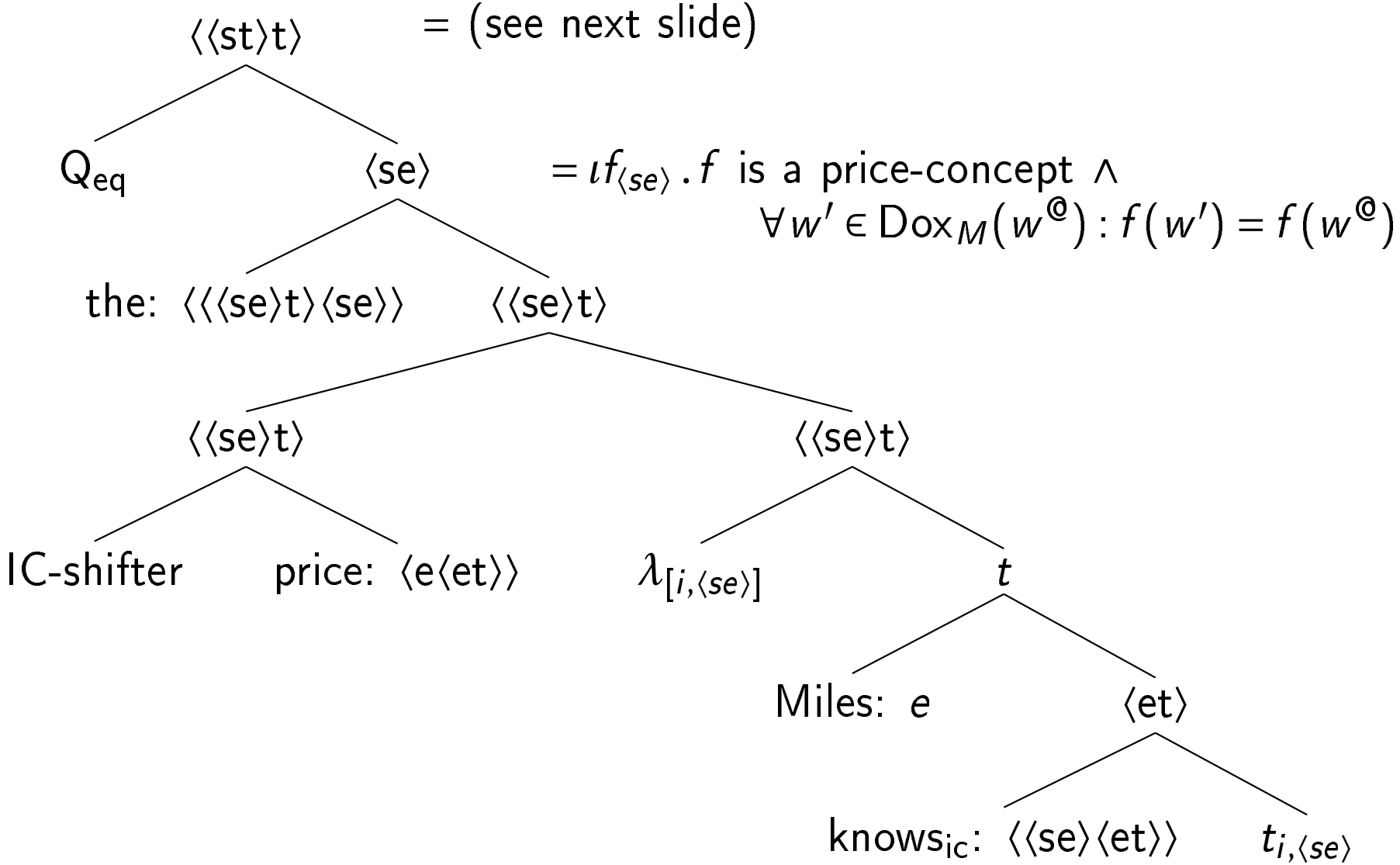
Deriving which-concept readings

Putting together the pieces: how to interpret nested CQs?
Preliminaries:

- Will continue to assume a Nathan-style IC-shifter – intensional existential closure over internal argument.
- Embedded "know": combines with trace of type $\langle se \rangle$ – Romero's know_{ic}

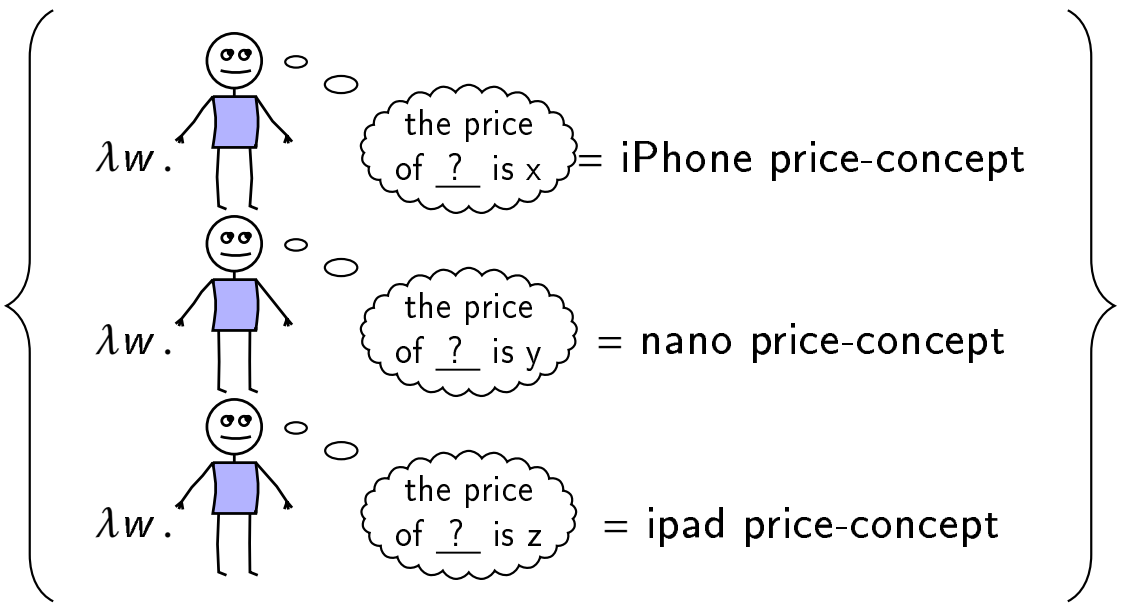
Nested CQs under Q-shifting (which-concept reading)

(40) $[_{DP}$ the price that Miles knows $t]$



Nested CQs under Q-shifting

(41) $[\![\mathrm{Q}_{eq}(\text{the price that Miles knows})]\!]^{w^@}$
$= \{p_{\langle st\rangle} \mid \exists y \in D_{\langle se\rangle} : p = (\lambda w\,.\, y = (\iota f_{\langle se\rangle}\,.\, f \text{ is a price-concept} \wedge \forall w'' \in \mathrm{Dox}_M(w) : f(w'') = f(w)))\}$



Nested CQs in unconditionals

$[\![\text{No matter Q(the price that Miles knows), we should still watch.}]\!]^{w^@} =$

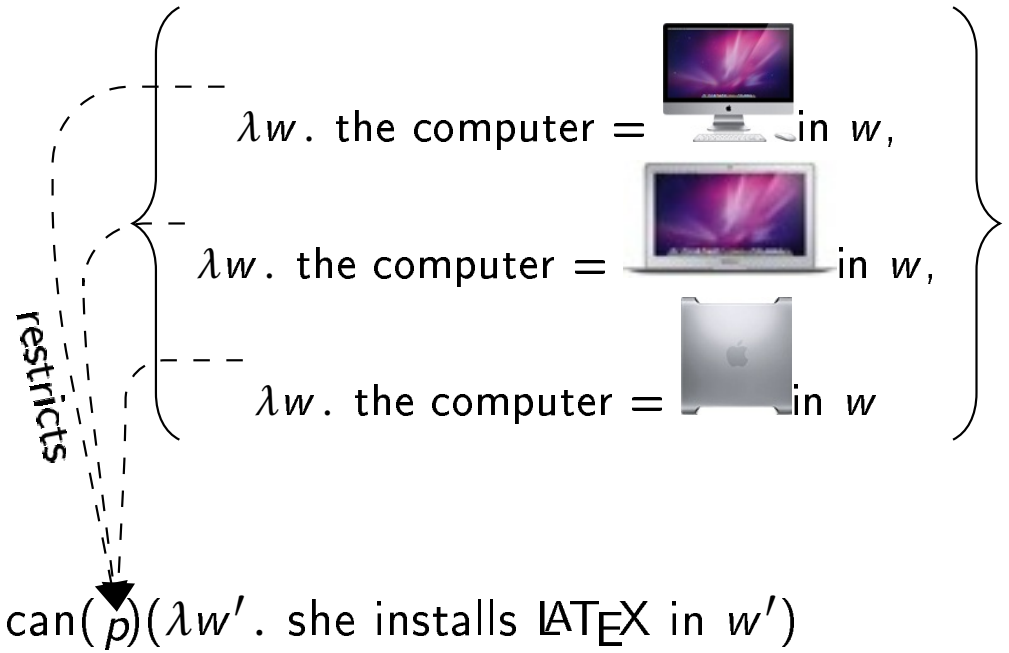
$$\forall p' \in \left\{ p \;\middle|\; \begin{array}{r} \exists y_{\langle se \rangle} : p = (\lambda w' \,.\, y = [\iota f_{\langle se \rangle} \,.\, f \text{ is a price-concept} \wedge \\ \forall w'' \in \mathrm{Dox}_M(w') : f(w'') = f(w')]) \end{array} \right\} :$$
$$\mathrm{should}_{w^@}(p')(\lambda w' \,.\, \text{we still watch in } w')$$

"For any concept, if that concept is the price-concept that Miles' doxastic alternatives correctly determine the value of, then we still watch the press conference in accessible worlds."

Nested CQs in unconditionals

Q_{eq}-shifter case 1:

$\tau = e$, $\alpha =$ "the computer that Clara buys"

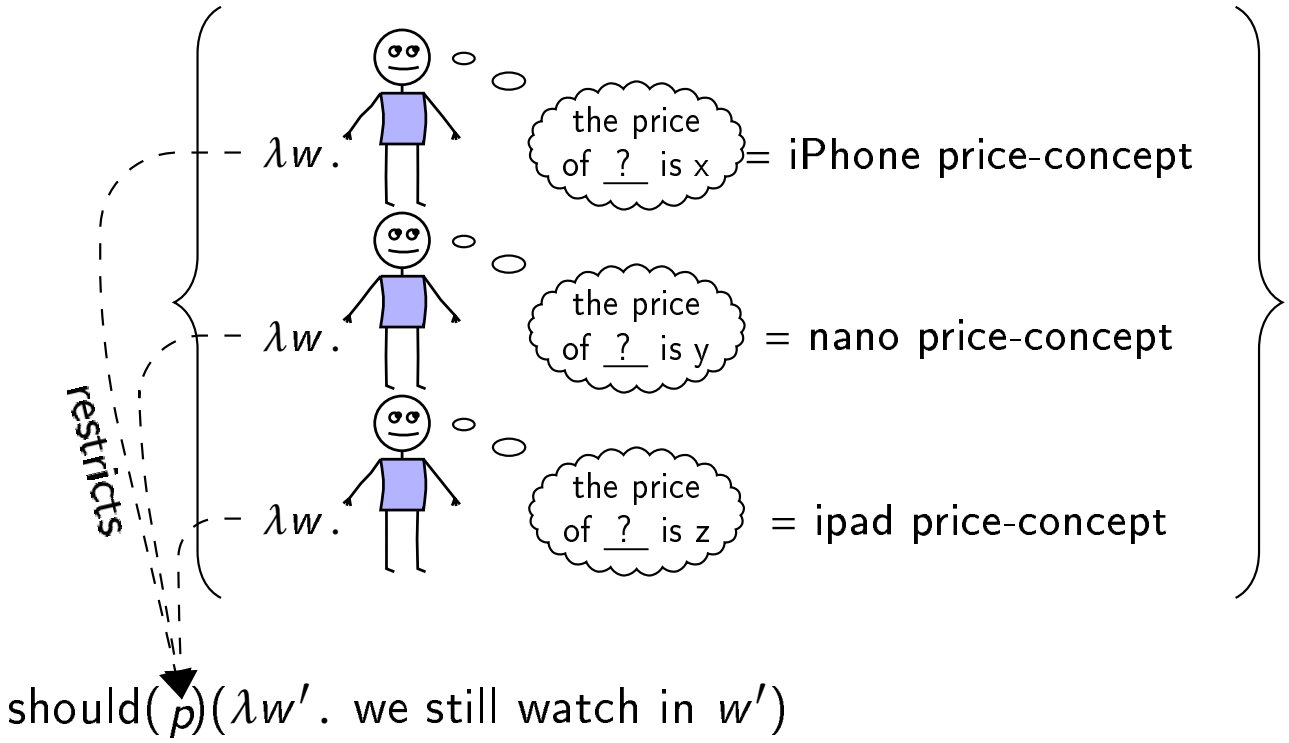


"For each proposition in the alternative set, there are accessible worlds where that proposition is true and she installs latex."

Nested CQs in unconditionals

Q_{eq}-shifter case 2:

$\tau = \langle se \rangle$, $\alpha =$ "the price that Miles knows"



"For each proposition in the alternative set, in all accessible worlds where that proposition is true, we still watch the press conference."

Summary: how the Q-shifter works

The Q_{eq}-shifter produces a set of propositional alternatives, each equating its argument with some individual or concept.

- When its argument is type e, it produces questions equating individuals: Simple CQs
- When its argument is type $\langle se \rangle$, it produces questions equating concepts: which-concept readings
- It *never* checks the value of a concept – no what-value readings.
- Note: similarly to the Romero's analysis of which-concept readings, the Q-shifter binds a world variable in its scope.

Back to Heim's ambiguity in multiple-attitude contexts

Analysis is hybrid – we haven't dropped Heim's "know$_{ic}$" (that takes type $\langle se \rangle$

- Required for traces. (Many independent arguments for IC-taking predicates.)

- Heim's original data – multiple attitude verb contexts.
- Analysis of Heim's what-value readings:

(42) Clara knows$_{ic}$ the price that Miles knows$_{ic}$ t.

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What-value(/A) readings?

The next puzzle

Why are there any what-value readings in unconditionals?

Analysis as it stands predicts none...

The crucial data:

(43) Regardless of the price that Miles told you, we should still watch the press conference.

$\rightsquigarrow$ Regardless of the value that Miles told you, ...

Proposal: follows from different behavior of the relevant class of verbs.

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Transparent readings for verbs of communication

Basic proposal: verbs that license what-value readings in this context allow extensional, *transparent readings* with DPs.

(44) Miles to Clara the price of the iPhone
⇝ Miles uttered a particular number, that is the value of the specified price-concept.

- Leads to the prediction of an ambiguity... "what-value" readings in this case *are* simple CQ readings.
- Most analogous to "acquaintance" reading of "know".
- We will need to investigate the semantics of particular verbs...

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Verbs of communication

Three core uses of "tell":

(45) a. Miles told me that the iPhone costs 400USD. $tell_{that}$

b. Miles told me what the iPhone costs. $tell_{Q}$

c. Miles told me the price of the new iPhone. $tell_{ic}$

Verbs of communication: declarative complements

(Simplified account; see e.g. Davidson 1968; Ogihara 1995; Cappelen and Lepore 1997; Kemp 2001 among many others for further problems.)

(46) $[\![\text{tell}_{\text{that}}]\!]^w =$
$\lambda x_e.\lambda p_{st}.\lambda y_e.\lambda e.\exists \alpha$: e is an event of y uttering α to x at w
$\wedge \forall w' \in [\![\alpha]\!]^{w', c_e} \rightarrow p(w')$

Paraphrase: "someone tells someone else that p" just in case there is a speech event in which its agent utters something that has a denotation corresponding to p.

- "Correspond": entailment. (Potentially too strong; see literature.)

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An example

(47) Context: Miles and Clara are having a conversation about the new iPhone, during which Miles tells her what the iPhone costs. Later on Clara reports what she has learnt from Miles by saying (49).

(48) Miles: The new iPhone just came out,
it costs only 400USD. I am going to buy it tomorrow [...]

(49) Miles told me that the iPhone costs 400USD.

Prediction: (49) is true in this context.

Paraphrase

There is some linguistic utterance α, such that if α (when interpreted relative to the context of the utterance event) is true in a world w, the content of the report is true in w.

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An IC-taking entry

After Romero's "know$_{ic}$":

(50) $[\![\text{tell}_{ic}]\!]^w = \lambda x_e . \lambda f_{\langle se \rangle} . \lambda y_e . \lambda e . \exists \alpha :$
e is an event of y uttering α to x at w
$\wedge \forall w' \in [\![\alpha]\!]^{w', c_e} \rightarrow [f(w') = f(w)]$

True if the content of the utterance α determines the value of the concept f.

The transparency effect

The above entry makes wrong predictions for some data.

(51) Context: Miles asks Clara what her ATM password is. Clara responds, "My PIN is 01060". In fact, her actual password is 01170, while 01060 is Northampton's zip code.

(52) Clara told Miles Northampton's zip code instead of her PIN.

Prediction: (52) should be false in this scenario. Judgement: it is true.

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Descriptions can be used *transparently* with verbs like "tell"

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The above entry makes wrong predictions for some data.

(51) Context: Miles asks Clara what her ATM password is. Clara responds, "My PIN is 01060". In fact, her actual password is 01170, while 01060 is Northampton's zip code.

(52) Clara told Miles Northampton's zip code instead of her PIN.

Prediction: (52) should be false in this scenario. Judgement: it is true.

The transparency effect

Descriptions can be used *transparently* with verbs like "tell"

Accounting for the transparency effect

Further complexities:

(53) # John told me 400USD.

(54) When I asked Miles for the price of the iPhone, he told me 400USD.

Need some salient concept/QUD in the context of the reported speech. There is no "concept-free" transparent entry!

- Concept not provided by description.

Accounting for the transparency effect

"Direction mention" entry:

(55) $[\![\text{tell}_{\text{dm}}]\!]^w = \lambda x_e . \lambda s_e . \lambda y_e . \lambda e . \exists \alpha :$
e is an event of y uttering α to x at w
$\wedge \forall w' : [\![\alpha]\!]^{w', c_e} \rightarrow (s = \mathbf{f}(w'))$
Where $\mathbf{f} \in D_{\langle se \rangle}$ is salient in the utterance context of α.

True if the content of the utterance determines that the type e argument is the value of the salient concept $\mathbf{f}$.

Accounting for the transparency effect

An example:

(56) $[\![\text{Clara told}_{\text{dm}}\ \text{Miles NOHO-zip code}]\!]^{w^@} = 1$ iff
$\exists e . \exists \alpha :$ e is an event of Clara uttering α to Miles at $w^@ \wedge$
$\forall w' \in [\![\alpha]\!]^{w^@, c_e} \rightarrow$
$(\iota x . \text{NOHO-zip-code}(x)(w^@) = \iota x . \text{Clara-PIN}(x)(w'))$

(Where $\mathbf{f}$ has been resolved in the context of α as
$\lambda w^* . \iota x .$ Clara-PIN$(x)(w^*)$)

Prediction: interaction with the Q-shifter

Simple CQs: Q-shifter combines with a DP of type e.

- Prediction: tell_{dm} should be able to combine with a trace of type e, leading to a description of type e.

A simplifying assumption

Assume that Ns like "price"/"zip-code" are ambiguous and also have a separate intransitive entry.

- $[\![\text{price}_i]\!]^{w,c} = \lambda x_e \,.\, x$ is a price-value in w
- True of an individual if it meets the formatting requirements for prices.

An alternative – Frana's 2010 IOD shifter:

- Existentially close over internal argument without generating concept, analogous to verbal implicit arguments.

(57) $[\![\text{IOD}(\text{price})]\!]^{w,c,f} = \lambda x_e \,.\, \exists y_e : x$ is the price of y at w

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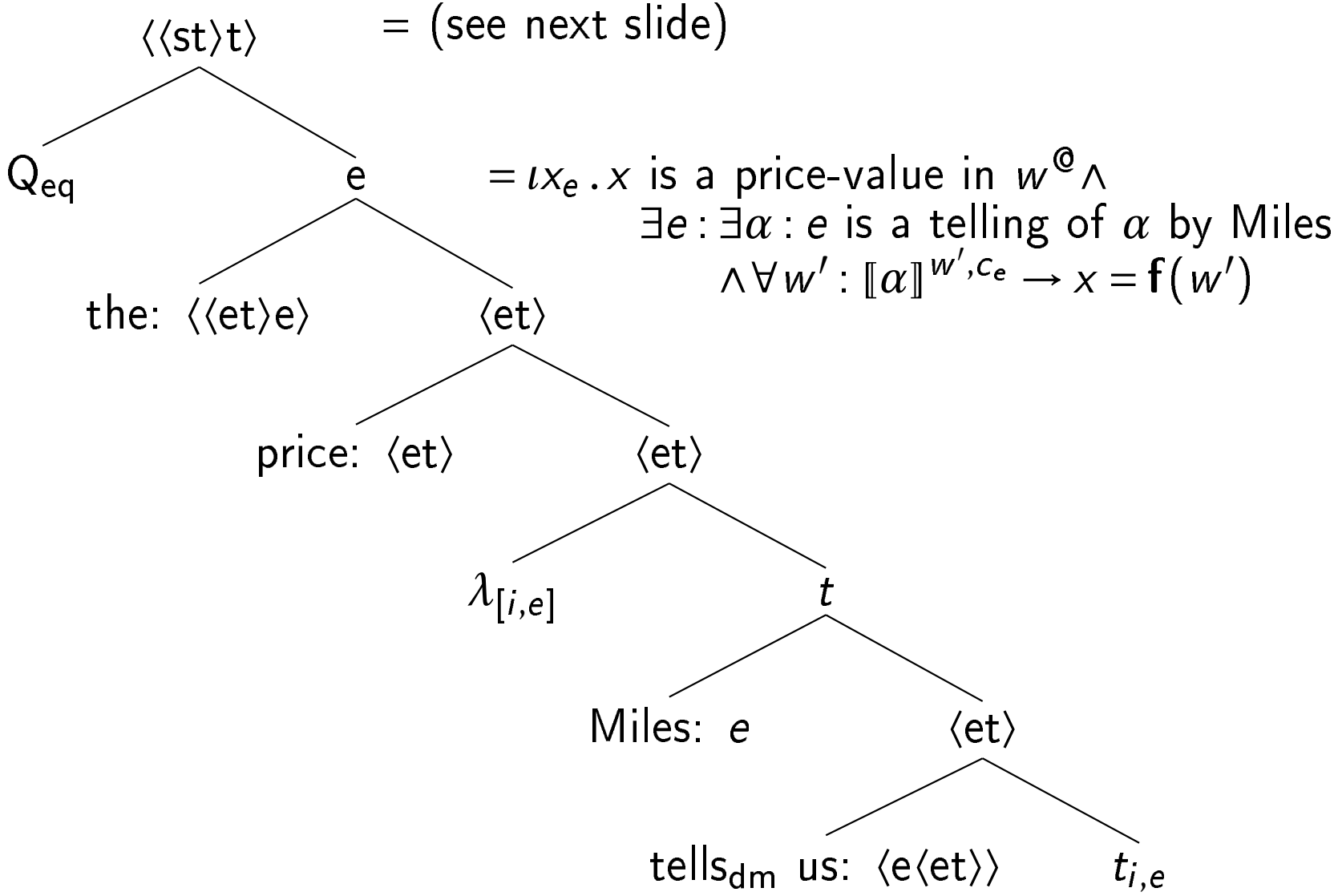
Nested CQs under Q-shifting (what-value reading)

(58) $[_{DP}$ the price that Miles told me $t]$



The Q-shifter and transparent traces

(59) $[\![\mathrm{Q}_{eq}(\text{the price } [\lambda_i \text{ that Miles tells}_{DM} \text{ us } t_i])]\!]^w =$

$$\left\{ p_{\langle st \rangle} \;\middle|\; \exists y \in D_e : p = \left(\lambda w' . y = \left(\iota x_e . \begin{pmatrix} x \text{ is a price-value in } w \\ \wedge \text{M. tells}_{DM} \text{ us } x \text{ as } \mathbf{f} \text{ in } w \end{pmatrix} \right) \right) \right\}$$

(where $\mathbf{f}$ is a concept salient in Miles' utterance's context)

- Exactly analogous to the result of forming a CQ off of an ordinary relative clause!

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- Exactly analogous to the result of forming a CQ off of an ordinary relative clause!

Deriving what-value readings

This shifted denotation for the DP gives a set of propositions each corresponding to a price-value. Can feed unconditional...

The what-value reading gap

What-value readings can be derived from Q-shifter only if the embedded CQ-predicate allows transparent DP arguments.

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Prediction: acquaintance readings

Does "know" ever allow transparent arguments?

- Yes – acquaintance readings.

  (60) Miles knows Northampton well.

- Prediction: should be good in unconditionals (i.e. pattern like tell_{dm}).

(61) Regardless of the city that Miles knows (well), I'm going to Venice for vacation.

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What+RN questions.

A Hamblin analysis for what+NP questions

Compositional Hamblin semantics:

- "Wh"-DPs denote sets of individuals. (Hamblin, 1973; Kratzer and Shimoyama, 2002)

(62) $[\![\text{who}]\!]^w = \{x \mid x \text{ is human in } w\}$

- What to do with "What"+NP DPs? Natural answer:

(63) $[\![\text{what book}]\!]^w = \{x \mid x \text{ is a book in } w\}$

(64) $[\![\text{what NP}]\!]^w = \{x \mid x \text{ is non-human in } w \wedge [\![\text{NP}]\!]^w(x) = 1\}$

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Works if NP is property-denoting – what if it is lexically relational?

Prediction: interaction with relational type-shifters

Type-shifters available for relational nouns:

- Nathan's IC-shifter – intensionally close over internal argument.
- IOD – extensionally close over internal argument. (Frana 2010)

Punchline: IOD will not work unless verb has a transparent use.

Traces that are individual concepts

Prediction: Nathan's IC-shifter should apply, though at the cost of intensionalization. Recall:

(66) $[\![\text{IC(price)}]\!]^w = \lambda f_{\langle se \rangle} . \exists x_e : \forall w' : f(w')$ is the price of x at w'

- Property of concepts that at each world, coherently describe the price of some stable x.

(67) $[\![\text{what IC(price)}]\!]^{w,c} =$

$$\left\{ f_{\langle se \rangle} \;\middle|\; \begin{array}{l} f \text{ is non-human in } w \\ \wedge \exists x_e : \forall w' : f(w') \text{ is the price of } x \text{ at } w' \end{array} \right\}$$

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Which-concept readings in questions

(68) $[\![\text{What price did John know?}]\!]^{w,c} =$

$$\left\{ p_{\langle st \rangle} \;\middle|\; \begin{array}{c} \exists f \in \left\{ f'_{\langle se \rangle} \mid \exists x_e : \forall w' : f'(w') \text{ is the price of } x \text{ at } w' \right\} : \\ p = \lambda w^* . \forall w' \in \mathrm{Dox}(J)(w^*) : f(w') = f(w^*) \end{array} \right\}$$

Extensional entry leads to extensional answers

Prediction: if trace-selecting V allows transparent readings, "what"+NP will be able to range over values.

- (Need either intransitive noun entry or Frana's IOD-shifter.)

(69) $[\![\text{price}_I]\!]^{w,c} = \lambda x\,.\,x$ is a price-value in w

(70) $[\![\text{what price}_I]\!]^{w,c} =$
$\{x_e \mid x$ is non-human at $w \wedge x$ is a price-value in $w\}$

- Binds trace that combines with "what_{dm}" leading to question about individuals!

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What+RN questions summary

The behavior of "what"+NP questions falls out of existing machinery.

- If head noun is relational and unsaturated, independently needed type-shifts apply.
- "What"+RN can denote a set of individuals or a set of individual concepts, depending on type-shifts.
- If verb that selects trace is ambiguous, will be able to combine with either type.
- If V has no transparent use, will not work with type *e* "what"-DP.

Ingredients of the analysis

Type-shifters:

- Relational nouns: IC – existentially closes over internal argument. (/IOD)
- Non-rigid DPs: Q-shifter – creates equative questions.

Lexical semantics of attitude predicates

- $\text{know}_{\text{that}}$, know_{Q}, know_{ic}.
- $\text{tell}_{\text{that}}$, tell_{Q}, tell_{dm}. (Open question: does our analysis require separate ic-entry?)

An important question...

Do we need all these lexical entries? Can they be collapsed? What are the generalizations?

- We will not provide an answer...
- Nonetheless, we believe that a full understanding of DPs in intensional contexts cannot develop without detailed examination of a variety of predicates.

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The next step: a wider range of verbs

Communication verbs – pattern like "tell" (if they take descriptions at all).

- "mention", "say", "suggest", "offer", "reveal", "announce", etc.

Epistemic verbs: some gradiance acceptability for what-value reading depending on stativity?

(71) * What price did Miles know?

(72) * What price will we soon come to know?

(73) ?? What price did Miles find out?

(74) ?? What price did Miles learn?

(75) ? What price did Miles discover?

(76) ? What price did Miles hear?

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Conclusions

The analysis of complex DPs in intensional contexts is complex!

- Two paths two Heim's A-readings /what-value readings:
  1. An individual-concept taking predicate.
  2. An intensional predicate that allows transparent uses of a DP argument.
- Heim's B-readings / which-concept readings:
  1. True question readings via type coercion.
- Unconditional CQs: the key to understanding concealed questions that are actually questions.
- Key result: apparent CQ-readings are heavily dependent on the semantics of particular verbs.

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Much more investigation required!

A final prediction and question

An attitude predicate that takes only questions and allows CQs will not have what-value readings.

- Candidate predicate: “ask” (Percus, 2010; Nathan, 2006)

(77) Miles asked the price that Clara asked.

True! But why is this nearly the only such predicate in English?

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