CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5
Intro	**Embedded questions, question embedding verbs, exhaustivity**	**Compositional semantics, de re/ de dicto readings**	**Questions over functions: Identity questions, Intensional answers, Functional questions, (quantifiers in questions)**	**Uniqueness presupposition, Multiple questions**
Literature: Karttunen (1977) Hagstrom (2003)	Literature: Groenendijk and Stokhof (1982) Heim (1994) Beck and Rullmann (1999) Sharvit (1997)	Literature Karttunen (1977) Groenendijk and Stokhof (1982) Heim (1994)	Literature**:** Aloni (2000) Engdahl (1986) Chierchia (1993) Szabolcsi (1997)	Literature Karttunen (1977) Hagstrom (1998) Dayal (1996)

- **References** (all of these are meant for further reading if you are interested, not as pre-requisites)

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Interrogatives 1

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1. Questions

Matrix questions

Yes-no questions

(1) Is Bill a zebra?

Single wh-questions

(2) Which student called?

Multiple wh-questions

(3) Which boy insulted which girl?

Embedded questions

Yes-no questions

(4) John knows whether Bill is a zebra

Single wh-questions

(5) John asked which student called

Multiple wh-questions

(6) John wonders which boy insulted which girl

■ **What do questions mean?**

♦ There is a general lack of intuitions about the kind of semantic object that is to be associated with questions. E.g., questions cannot be true or false.

♦ Wh-complements: have a clear advantage: we do have some intuitions about the semantics of declarative sentences in which they occur embedded under verbs such as *know, tell, wonder…*

■ Since we don't know what to do with questions, we want to relate questions to statements that we already know how to handle:

Some ideas:

(a) We could relate a question to the set of possible (true or false) answers to it (Hamblin (1973)).
[Consider: we know the content of a proposition when we know its *truth* conditions, i.e. the conditions under which it is true. Similarly then we can say that we know a content of a question when we know its *answerhood* conditions, i.e. the conditions under which it is answered.]

(b) We could relate the question to the set of its true answers (in a given world). (Karttunen (1977))

(c) We could relate the question to the complete true answer to that question (in a given world) (Groenendijk and Stokhof (1982), Groenendijk and Stokhof (1984))

■ **But what sort of considerations would make us choose one or the other type of approach?**

First, the simple case…

(7) Who came?

(a) **Hamblin 1973**: We get the denotation of the question by replacing *who* with all the individuals in a given domain:
[[Who came]]^w={that Bill came, that Mary came, that John came, that Sue came}
→this is now the set of possible answers (a set of (true and false) propositions)

But what about…?

(8) John told Fred who came
(9) Who is elected depends on who is running

(b) **Karttunen 1977**: if we want to analyze embedded and matrix questions alike, we'd better restrict the propositions in the question denotation to the true ones: Suppose that Bill and John came in the actual world:

[[Who came]]^w ={that Bill came, that John came}

Ok, but what about…?

(10) John knows who came and that Mary was upset

(c) **Groenendijk and Stokhof 1984**: The coordination and other facts (that we will come back later) suggest that we rather want to analyze questions as denoting the same type of objects as *that*-clauses, i.e. propositions, namely the complete true answer to a question in a given world.

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2. Answers

(11) Who came?

--full answer	Bill and Sue	(aka Weakly exhaustive answer)
--exhaustive answer	Bill and Sue and nobody else	(aka. Strongly exhaustive answer)
--partial answer	Bill, e.g ./ Bill or Mary.	

--direct answer	Bill and Sue
--indirect answer	Your husband and his sister

♦ *Mention some* questions vs. *exhaustive* questions:

(12) Where can I buy an Italian newspaper?

--Most informative answer given the pragmatic situation:
At the gas station—vs—In the following 123 locations in Debrecen: [give exh. list]

❖ A question about question-answer relations: Is semantics enough? What is the role of pragmatics?

■ **What is a *good* answer?** (Ginzburg (1996))

- What counts as good answer is often dependent on the perspectives, interests of the person who asks the question. E.g:

(13) A. Where am I located now?
B. In Hungary.

Also in embedded contexts:

(14) A. [context: Jill is about to step off a plane in Helsinki]
Flight attendant: Do you know where you are?
Jill: In Helsinki
B. Flight attendant: OK. Jill knows where she is.

(15) A. [context: Jill about to step out of a taxi in Helsinki]
Driver: Do you know where you are?
Jill: In Helsinki
B. Driver: Oh dear. Jill doesn't know where she is.

- **Ginzburg**: approach the question-answer relationship in a fundamentally different way from the approaches outlined above.

- Denotations of questions should not be taken the set of answers in some absolute sense, but taken to be something basic, and the answerhood relation ("resolvedness") be relativized what he calls the *goals* of the agent who asks the question.

- The answerhood (resolvedness) relation is inherently more pragmatic than in the theories outlined above:

(16) A. The interrogative *Where is Jill?* Denotes a question, call it Q.
B. the answerhood relation is relative to a goal G of an agent, i.e. p truly answer Q relative G. (e.g. G could be modelled as a set of possible worlds)
C. The proposition that Jill is in Helsinki answers Q relative to the flight attendant's goal, but not relative to the drivers goal.

- An alternative way of thinking of Ginzburg's examples: (Lahiri (2002)): an implicit perspectival restriction on the domain of wh. In the above examples: the restrictions of *where* could be set by the goals of the queriers. Cf:

(17) A. Everyone came to the party.
B. Everyone? Even the medical students?
A. I meant every linguist.

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3. Interim summary:

We want a denotation of interrogatives that:

(a) Supports the notion(s) of answerhood (wrt. **matrix questions**)

(b) Enter into the compositional calculation of truth-conditions of the sentences that embed them (wrt. **embedded questions**)

(c) Have a uniform type for **different types of questions** [yes-no questions, (if/whether questions), single wh questions, multiple wh questions]. Why? Because they have (mostly) the same distribution in embedded contexts[1].

(18) John knows (which student came / whether Bill came/ who loves who/ etc.)
(19) *John believes (which student came / whether Bill came/ who loves who/ etc.)

■ **More about H/K denotations**

- The <u>extension of an interrogative clause</u>:
---A set of possible answers
---Technically: a set of propositions, or a characteristic function of a set of propositions (type <st,t>)
---Notation: $[[\alpha]]^w$:= the extension of α in w.

- The <u>intension of an interrogative clause</u>:
---a function from worlds to a set of propositions
---notation: $[[\beta]]_¢$:= the intension of β

***

- <u>Propositions</u> are sets of possible worlds, or alternatively functions from worlds to truth values, i.e. of type <s,t>

- That-clauses in the meta-language refer to propositions. E.g. that John is a student=λw. John is a student in w

[1] Some exceptions: *surprise*:
(1) A. John was surprised who came
B. *John was surprised whether Bill came.

Single wh-questions

(20) [[Which student called?]]^{w}=

Suppose John, Bill, Mary are the students in w

a. {that John called, that Bill called, that Mary called}
b. $\{p : \exists x. [x \in \{John, Bill, Mary\} \& p = that\ x\ called]\}$
c. $\lambda p. \exists x. x \in \{John, Bill, Mary\} \& p = \lambda w'. x\ called\ in\ w'$

Multiple wh-questions

(21) [[Which boy insulted which girl?]]^{w}=

Suppose John, Bill, Mary, Sue are the boys and girls in w

a. {that John insulted Mary, that Bill insulted Mary, that John insulted Sue, that Bill insulted Sue}
b. $\{p : \exists x. \exists y\ [x \in \{John, Bill\} \& y \in \{Mary, Sue\}\ \&\ p = that\ x\ insulted\ y]\}$
c. $\lambda p. \exists x. \exists y\ [x \in \{John, Bill\} \& y \in \{Mary, Sue\}\ \&\ p = \lambda w'. x\ insulted\ y\ in\ w']\}$

NOTES:

- Here, question extensions are sets of true or false propositions

- What is good about the formulations in (b) and (c) is that they are suitable for describing infinite sets. The representations in (b) gives us a set of propositions. The representations in (c) are the characteristic functions of the set of propositions in (b), functions of type <st,t>.

- How does the semantic value of questions figure in the speech act of question asking?

  - When an interrogative clause φ is uttered in a world w, the utterer thereby requests to be told which of the propositions in [[φ]]^{w} is true

- The notion of **answerhood**: A sentence is a (direct) answer if its intension (the proposition that it expresses) is an element of the question extension.

  - ψ is a (direct answer) to φ in w iff $[[\psi]]_{\varepsilon} \in [[\varphi]]^{w}$

- **We** could have also restricted our answer set to true answers (Karttunen 1977)

- **More on Groenendijk and Stokhof: Partitions**

- Interrogatives are also analyzed in terms of their possible answers

- Whereas indicatives express propositions, interrogatives determine partitions of the logical space. While the meaning of an indicative corresponds to its truth conditions, the meaning (intension) of an interrogative corresponds to the set of all its possible complete answers.

- The latter is a set of mutually exclusive propositions whose union exhausts the set of worlds. Thus, we can say that questions partition the logical space. E.g.:

  i. A yes-no question divides the set of worlds into two alternatives

p
¬p

  ii. A single constituent question divides the world into as many alternatives as there are possible denotations of the predicate P

λw. nobody is P in w
λw. a is the only P in w
λw. b is the only P in w
λw. a+b are the only P in w
…
λw. all individuals P in w

- Two worlds belong to the same block in the partition in their differences are irrelevant to the issue raised by the question
- The denotation (extension) of an interrogative in a given world is the proposition that expresses the complete true answer to the question in that world.

- **Answers**
- Each of the above alternatives corresponds to a **complete answer** to the question
- A **partial answer** is a disjunction of at least one, but not all complete answers. In other words, a partial answer eliminates some blocs from the partition.

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Embedded questions, predicates that embed them, exhaustivity

■ **Embedded questions**

Generally, it is assumed that embedded questions such as (1) e.g. should have the same denotation as matrix questions.

(1) John knows who left

Compositionally, the meaning of the whole sentence is arrived at by assuming that question embedding verbs such as *know* or *wonder* express a relation between a subject and the embedded question:

(2) Know (w) (x, Q)

---

1 Karttunen (1977)

- An interrogative clause refers to a set of true propositions, intuitively a set of its true answers:

(3) $[[\text{Which student called?}]]^{w}$=

Suppose John, Bill, Mary are the students in w

d. {that John called, that Bill called}
e. {p : p(w) & ∃x. [x∈{John, Bill, Mary}& p=that x called]}

- Regarding the question embedding verb *know*, the intuition that Karttunen implements is that you stand in the *know* relation to a question if you believe all the true answers to it:

(4) Simplified Karttunen-analysis:
For any world w, question intension (Q), and individual x:
[[Know]](w) (x, Q)=1 iff x believes ∩ Q(w) in w.

■ **Notes**:

- ∩ Q(w) is the intersection of the set Q(w).
- Recall that propositions are sets of possible worlds. Intersecting these sets of possible worlds amounts to the conjunction of these propositions.
- To know which students called, is to believe the conjunction of all the propositions that x called, where x is a group of students that actually called.

■ **A special case**: What happens if no students called?

- In this case, the extension of which students called is the empty set.
- The intersection of this is a tautological proposition, which one cannot fail to believe.
- Therefore in this case *John knows which students* called should be automatically true, even is John is completely ignorant….
- To avoid this conclusion, Karttunen refines the lexical entry for *know* as follows:

(5) Karttunen-analysis:
For any world w, question intension (Q), and individual x:
[[Know]](w) (x, Q)=1 iff
a. x believes ∩ Q(w) in w.
b. if Q(w)=Ø, then x believes λw' [Q(w')=Ø] in w

- When the interrogative complement is empty, an additional requirement must be met: namely that one must believe that it is empty.
- What proposition is λw' [Q(w')=Ø]? : In our example, it is the proposition that assigns 1 to any w' in which no students called, and to any w' in which some students called, it assigns 0. I.e. it is simply the proposition that no students called.

■ **Multiple entries for question embedding verbs such as *know***

Since *whether* and *that* complements have different types, we need to assume that there are two complement taking verbs *know*: one that takes *that*-complements, the other that takes question complements.

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2. Exhaustiveness

■ **False beliefs**: Karttunen himself noted a problem with his analysis:

- Suppose a student, Mary, did not call, but John fails to know this. Suppose, that he even falsely believes that Mary called.
- Intuitively, we feel that in this case *John knows which students* called should be false. However, Karttunen's analysis predicts it to be true: As long as John believes of all students that called that they did call, he qualifies as knowing which students called, irrespective of what other false beliefs he might have.
- In other words, Karttunen's meaning for interrogatives predicts the validity of the first, but not the second inference pattern below:

(6) John knows who called
Mary called
―――――――――
John knows that Mary called

(7) John knows who called
Mary did not call
―――――――――
John knows that Mary did not call

■ **Groenendijk and Stokhof (1984): Degrees of exhaustiveness**

We can distinguish different degrees of exhaustiveness of complements:

- A **weakly exhaustive answer** provides a complete list (this is the meaning that K predicts)
- A **strongly exhaustive answer** contains in addition the closure "and that is all, folks"[2]

G&S: to capture the correct meaning of (6), we need to give a question denotation that supports the strongly exhaustive meaning.

■ **Groenendijk and Stokhof's way of predicting the strongly exhaustive reading:**

- ***Excursus**:*

(8) [[John believes that it is raining]]^w=
'In every world w' compatible with John's belief in w, it is raining in w'

i.e. The set of possible worlds W can be partitioned as follows:

{w': it is raining in w'}
{w': it is not raining in w'}

For John to believe that it is raining means that John believes that the actual world belongs to the set of worlds {w': it is raining in w'}

- Recall now, that in G&S, the meaning of a question is the partition of possible worlds, defined by the question:

Suppose there are only 3 individuals: Bill, John and Mary:

p1= {w': that Bill did not call and John did not call and Mary did not call}
p2= {w': **that Bill called** and John did not call and Mary did not call}
p3= {w': that Bill did not call and **John called** and Mary did not call}
p4= {w': that Bill did not call and John did not call and **Mary called}**
p5= {w': that **Bill called and John called** and Mary did not call}
p6= {w': that **Bill called and** John did not call and **Mary called}**
p7= {w': That Bill did not call **and John called and Mary called}**
p8= {w': **That Bill called and John called and Mary called}**

Their entry for *know*:

(9) For any world w, question intension Q and individual x,
[[Know]](w) (x, Q)=1 iff x believes Q (w) in w.

[2] G&S, 1997.

- For John to know who called means that he knows to which of these cells (sets of worlds) the actual world belongs to.
- Technically, this is captured as:

(10) [[Who called]]^w= λw'. [λx. called x in w=λx. called x in w']

i.e. the proposition that is true in a world w' if the set of people that came in w' is the same as the set of people that came in w (the actual world)

informally:

(11) John knows (who called)
= In every world w' that is compatible with John's beliefs, the set of people that called in w' is the same as the set of people that called in w (the actual world)

- Consider: if Mary did not call, and John fails to know this, then there are worlds w' compatible with John's beliefs such that in w' Mary called. Hence, such a w' falsify (10), and this means that John in w does not believe the proposition in (10).

■ **No need for multiple entries for question embedding verbs such as *know***

If *whether* and *that* complements have the same type, we do not need to assume that there are two complement taking verbs *know*, e.g., one that takes *that*-complements, the other that takes question complements.

3. Flexibility is needed?

- Groenendijk and Stokhof can capture the strongly exhaustive readings very well: strong exhaustivity is just a property of question denotations.
- However, they cannot capture very well the weakly exhaustive readings. Therefore, if we found cases for which the strongly exhaustive reading is too strong, and we need weakly exhaustive readings, G&S would be in trouble.
- On the other hand, perhaps there is way of also strengthening Karttunen's analysis in a way that can capture the strongly exhaustive readings as well.

■ **Heim (1994)** argued exactly that:

- She observed that some predicates (*know*) require their complements to be understood in a strongly exhaustive way, others (*surprise*) do not.
- Therefore, she argued that the weak/strong exhaustivity should be thought of as a lexical property of question embedding predicates, rather than being a property of question meanings.

First step:

- We might generalize Karttunen's proposal for the special case:

(12) Modified Karttunen-analysis for *know*
For any world w, question intension (Q), and individual x:
[[Know]](w) (x, Q)=1 iff
x believes λw' [Q(w')=Q(w)] in w

- The second clause will give us exactly the same meaning as the meaning that G&S predict.
- But it is part of the lexical meaning of *know*. Other question taking predicates might behave differently:

E.g speech act verbs might favor Kartunnen's approach.

Tell: Intuition: to tell us which students called is to cause to know the strongly exhaustive answer by asserting the weakly exhaustive answer

(13) *tell*
For any world w, question intension (Q), and individual x:
[[tell]](w) (x, Q)=1 iff
x told ∩ Q(w) in w.

Surprise:

(14) It surprised Bill who came to the party, but it did not surprise him who did not come

(15) *surprise*
For any world w, question intension (Q), and individual x:
[[surprise]](w) (x, Q)=1 iff
Not-expect P (x)(w) (∩ Q(w) in w.

Second step

- We can derive the strongly exhaustive answer from the weakly exhaustive answer:

(16) Answer 1: to the question Q in w is the proposition (weakly exhaustive answer)
$\cap Q_K(w)$ (abbreviation: Ans1(Q, w))

(17) Answer 2: to the question Q in w is the proposition (strongly exhaustive answer)
(λw'[Ans1(Q, w))= Ans1(Q, w'))] (abbreviation: Ans1(Q, w))

- However, G&S's proposal does not allow such flexibility.

■ Further developments:

- Beck and Rullmann (1999)
- Sharvit (2002)

■ **A question for the future:** But what is the relationship between the meaning of the question embedding verbs, and the fact whether they are strongly or weakly exhaustive?

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1 Compositional interpretation of constituent questions

■ Karttunen made type-driven (with higher type quantifiers)

♦ Higher type quantifier, but no special interpretational rule

We look at a variant of Karttunen (1977) approach, worked out in lecture notes by Irene Heim (Heim (2001)) where the *wh*-word, instead of denoting a simple existential quantifier over individuals, is a higher type 'question quantifier':

(1) $[[\text{Who}]]^w = \lambda \mathcal{Q}_{<e,<st,t>>}.\lambda p.\exists x\ [\text{person}(x)(w) \wedge \mathcal{Q}(x)(p)]$

--type <<e<st,t>>,<st,t>>, a "generalized generalized quantifier":<<e,σ>,σ>

--this quantifier can directly combine with it's sister constituent, (without resorting to a special combinatory rule)

♦ Q morpheme:

Following the spirit of Karttunen (1977), we postulate that a question morpheme turns an expression of type <s,t> (a proposition) into a set of propositions of type <st,t>.

(2) $[[?]] = \lambda p_{<s,t>}.\{p\}$

--This question morpheme might be located in the syntactician's C-head.

-- Wh-movement creates an abstract in the usual fashion, of type <e<st,t>>.

--The wh-word, a question quantifier, as assumed in (1), is of type <<e<st,t>>,<st,t>>

--It can combine with this abstract via simple function application.

■ A sample derivation:

(3) Who left?

(4) λp.∃x [person(x)(w)∧ p=λw'. x leaves in w'] *<st,t>(**question**)*

Who λx.λp.p=λw'. x leaves in w'

1 λp.p=λw'. t_1 leaves in w' *<st,t>(**proto-question**)*

? λw'. t_1 leaves in w'

t_1 leave

■ Iteration

Why do we need the Q morpheme? To deal with iteration.

The C-bar expression (the proto-question, in Karttunen (1977)'s terms) has an extension of type <st,t>, which is of the same type as that of the extension of the question itself.
→it is possible to iterate *wh*-words in the system: the second wh-word creates a new abstract, which can again combine with the *wh*-word by function application.

■ An example derivation of a multiple question

(5) Who knows who?

(6) $\lambda \mathcal{Q}_{<e,<st,t>>}.\lambda p.\exists x\ [\text{person}(x)(w)\wedge\mathcal{Q}(y)(p)]$ (λx.λp.∃y[person(y)(w)∧ p=λw'. x knows y in w')
=λp.∃x [person(x)(w)∧ (λx.λp.∃y [person(y)(w)∧ p=λw'. x knows y in w'(x)(p)]
=λp.∃x [person(x)(w)∧ ∃y [person(y)(w)∧ p=λw'. x knows y in w')]] ***<st,t>***

who λx.λp.∃y [person(y)(w)∧ p=λw'. x knows y in w'

1 **λp.∃y [person(y)(w)∧ p=λw'. t_1 knows y in w']** ***<st,t>***

who λy.λp.p=λw'. t_1 knows y in w'

2 **λp.p=λw'. t_1 knows t_2 in w'** ***<st,t>***

? λw'. t_1 knows t_2 in w'

t_1 knows t_2

■ Is the order restricted?

The order of the movement of the *wh*-words is not constrained in this system, just as other instances of quantifier movement are not restricted by the combinatory semantic system itself.[3]

■ Why do *wh*-phrases have to move?

Here: Because they are not interpretable anywhere else

→**BUT**, this does not mean there would be no other compositional ways of interpreting the wh in situ… E.g. Karttunen's original proposal 1977 (cf. appendix), unselective binding ('*idea*: interpret *wh*-word as a mere variable, bind it with some operator), alternative semantics (*idea*: a more powerful compositional mechanism, that switches to interrogative type denotations as soon as it encounters a *wh*-word) etc...—we will not discuss these in the class.

→There is no general semantic reason for movement.

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[3] Such freedom is in fact needed for languages that do not observe the subject-object asymmetries known as superiority effects (e.g. Hungarian), but of course it raises a series of well-known questions as to why **What bought who* should be unacceptable in English. Cf. e.g. Richards (2001) for discussion.

2. Excursus

■ **The de re/de dicto ambiguity**

(7) John wants to marry a plumber

♦ Two contexts :

(a) John met Sue in the pub last night, and he instantly fell in love. John has no idea as to what Sue's occupation is, but he wants to marry her right away. Sue happens to be a plumber. (*de re reading*)

(b) John's toilet is constantly broken and he needs to call someone to fix it all the time. He has spent a lot of money by now and is rather desperate. He has decided that a cheaper solution could be to simply marry a plumber, any plumber. (*de dicto reading*)

♦ A real ambiguity: Suppose further, that in context (a), because of a childhood trauma, John is plumberophobic, and if he knew Sue was a plumber, he would in fact change his mind. Then we might truthfully say: *John wants to marry a plumber, but he does not want to a marry a plumber*. –which shows we are dealing with a genuine ambiguity.

♦ **De re/ de dicto ambiguity: an ambiguity of scope**

(8) [a plumber]$_1$ John **wants** to marry t_1 *de re*
(9) John **wants** [[a plumber]$_1$ to marry t_1] *de dicto*

i.e. The existential quantifier can scope above or below the intensional context created by the attitude verb *want*:

(10) $\exists$x. x is a plumber in w [**∀w'** that is compatible with what John wants in w, John marries x in w'] *(de re)*
(11) **∀w'** that is compatible with what John wants in w, [$\exists$x. x is a plumber in w' & John marries x in w'] *(de dicto)*

---

3. De re/ De dicto readings of questions

■ Wh-movement in Karttunen's system (and the variant discussed above) has two effects:

♦ It scopes the existential quantifier above the Q morpheme
♦ It scope the restrictor predicate out of the intensional context created by the Q morpheme

(12) Which plumbers left?
(13) Interpretation after *wh*-movement:
{p: $\exists$x[x is a plumber in w & **p=λw'. x left in w'**]}
={that Sue left, that Mary left}

♦ This resembles the *de re* reading.

■ **Groenendijk and Stokhof (1982)**: Is the following argument valid?

(14) John knows who left
John knows which plumber left

♦ VALID: Since the set of plumbers is a subset of the set of individuals, and since if one know of a set which of its elements have a certain property (*here*: that they left), one also knows this of every subset of that set. So it cannot fail to hold that if John knows who left, he also knows which plumbers left.

♦ INVALID: Suppose only one individual left. Suppose further that this individual is a plumber. If John knows of this individual that this individual is the one that walks, but fails to believe that she is a plumber, then the premises of (14) is true, but the conclusion is false.

♦ So, whether or not the argument is valid, depends on how the conclusion is read: this shows there are two readings of the conclusion: this first (de re) reading can be paraphrased: *of each plumber, John knows whether she left.*

♦ But can a Karttunen-style analysis capture the second reading? What we would need is:

(15) {p: $\exists$x [p=λw'. x is a plumber in w' & x left in w']}
={ that Sue is plumber and she left, that Mary is a plumber and she left}

…yet it seems Karttunen cannot generate this reading (the *de dicto* reading, in G&S's terminology)

■ How does G&S capture the de dicto reading?

(16) $[[\text{Which plumber left}]]^w = \lambda w'. [\lambda x.\ x \text{ is a plumber in w and x left in } w = \lambda x.$ is a plumber in w' and x left in w']

If in w Mary is a plumber who left, and John does not know that she is a plumber, then there are worlds in w' compatible with what John believes in w where Mary is not a plumber. Any such w' falsify $[[\text{Which plumber left}]]^w = \lambda w'. [\lambda x.$ x is a plumber in w and x left in w=λx. is a plumber in w' and x left in w'] , so John does not believe the proposition in (16).
Thus, it is predicted that John failure to know that Mary is a plumber (when in fact she is a plumber who left) suffices to make the inference in (14) false.

■ Appendix 1: (original Karttunen 1977, with minimal changes, based on Heim 2001)

♦ ***Wh* is like other quantifiers**

Originally Karttunen (1977) has proposed that *wh*-words such as *who* denote existential quantifiers:

(17) $[\![\text{Who}]\!]^w = \lambda P_{<e,t>}.\exists x\ [\text{person}(x)(w) \wedge P(x)(w)=1]$

(18) $[\![\text{someone}]\!]^w = \lambda P_{<e,t>}.\exists x\ [\text{person}(x)(w) \wedge P(x)(w)=1]$

♦ **How do we get a set of propositions?**

There is a covert complementizer, the Q morpheme. (Could be e.g. in the syntactician's C head)

(19) $[\![?]\!]^w = \lambda p_{<s,t>}.\ \{p\}$
(takes a proposition, and returns the singleton set containing it}

--? Wants a proposition, so it can combine with an IP (extension: t, intension: <s,t>)
--the C' node has the type of questions: (extension <st,t>, intension <s<st,t>>)
--the phrase headed by the ?: called the "proto-question" in Karttunen's terminology

♦ **Special composition rule**: How can the wh-word combine with the proto-question?

--Via simple function application, it cannot. We need a special compositional rule:
Wh-quantification rule of Karttunen (1977), in our notation

(20) If α has daughters β and γ, where
$[\![\beta]\!]^{w,g}$ is type <<e,t>t> and $[\![\gamma]\!]^{w,g}$ is type <e<st,t>>, then for every word w and assignment g:
$[\![\alpha]\!]^{w,g} = \lambda p.\ [\![\beta]\!]^{w,g}\ (\lambda x_e .p \in [\![\gamma]\!]^{w,g}(x))=1$

♦ **Semantic types**

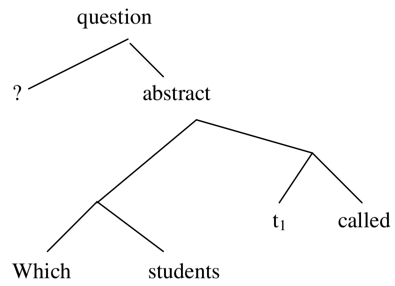
--proto-question: <st,t>
--Type of abstract created by movement: <e,<st,t>>
--wh-phrase:<et,t>
--result: <st,t>

♦ **Iteration:** the result type is such that the process can iterate.

♦ **Why do wh-phrases have to move**? Because we said so.
Wh-could have stayed in situ, and get interpreted as 'someone left'.

■ Appendix 2: Compositional interpretation in G&S's system

(21)



Where

♦ [[?]] = λP.λw.λw'[P(w)=P(w')]
♦ The *whichNP* is a predicate which combines with its sister via intersective modification

References
Groenendijk, J., and M. Stokhof. 1982. Semantic analysis of wh-complements. *Linguistics and Philosophy* 5:175-233.
Heim, I. 2001. Class notes, MIT.
Karttunen, L. 1977. Syntax and semantics of questions. *Linguistics and Philosophy* 1:3-44.

So far the wh-words like *who* or *which student* ranged over individuals.
…But sometimes things seem a bit more complicated…[4]

1. Questions over functions 1: Individual concepts

■ **Identity questions involving proper names (cf. Aloni 2001)**

(1) Who is Bill?

'For which x. x=Bill?'
i.e. {that Bill is Bill, that John is Bill, that Mary is Bill…}

♦ **The problem**: the question is intuitively valid, but all the question meanings that we looked at so far render it vacuous.

♦ **Solution**:

- Questions are reativised to sets of *identification methods*, rather than sets of individuals
- An identification method is a function from worlds to individuals. (aka. individual concept) i.e. concepts represent ways of identifying individuals.

  E.g. λw. the president of Mali w
  λw. Konare in w

  These concepts assign to each world the individual which is the president of Mali or Konare in that world respectively.

- Questions are relativised to sets of individual concepts (conceptual covers, CC) which satisfy the following conditions: (a) each individual is identified by at least one concept in each world (b) in no world is an individual counted twice.

[<u>context</u>: we are looking at two people standing in the distance. You ask]

(2) Who is Bill?
a. CC={ λw. the guy on the left hand side in w, λw. the guy on the right hand side in w}
b. 'For which f ∈CC. f(w)=Bill?'
{that the guy on the right hand side in w is Bill in w , that the guy on the left hand side in w is Bill in w}

[4] This class, and the next one provide but a simplified and bird's eye view perspective into a number of rather complex topics with rich history, with the intention of raising interest, rather than providing justice to any of the topics or analyses touched.

■ **Other questions that require intensional answers (cf. Heim 2001)**

(3) A. Who do you want to be friends with?
B. The girl with the best grades

<u>Intended meaning of the answer</u>: in every world conforming to my desires, I am friends with the girl who has the best grades

♦ **Problem**: This seems to be outside of the scope of Karttunen's analysis:

(4) {p: ∃x[x is your classmate in w & p= that you want to be friends with x]}

♦ **Solution**: (3) asks for a function from worlds to individuals (individual concepts)

(5) 'For which f: f(w') is a classmate of yours in w'∈WANT, you want to be friends with f(w') in w?'

informally
{ that you want to be friends with the girl with the longest pony tail, that you want to be friends with the girl with the blondest hair, that you want to be friends with the girl with the best grades, etc…}

More precisely
{p: $\exists f_{<s,e>}$[p= λw': *f(w") is your classmate in w".* ∀w" which conforms to what you want in w', you are friends with f(w") in w"]}

---

2. Questions over functions 2: Functions from individuals to individuals
(Skolem functions)

■ Constituent questions that we have seen so far were of the kind where it was appropriate to give an answer which picks out an individual:

(6) A: Who does every Englishman admire?
B: The Queen

(7) λp.∃x[person(x) & p=λw'.∀y [englishman(y)→ admires (y,x) in w']
'For which x, every Englishman likes x?'

♦ The H/K semantics only gives us the question meaning represented above.

♦ The reason why we only get this reading for (6) is that the existential quantifier in the interpretation of *who* will take wider scope than the universal quantifier in the sentence. [Therefore this reading is also sometimes called the narrow scope reading of the question, meaning that the universal quantifier takes narrow scope.]

♦ However, there are two other possible types of readings of the question in (6) as indicated by the following possible answers:

■ **"Functional questions"** (Engdahl 1981, 1986)

(8) A: Who does every Englishman like?
B': His mother

♦ This reading was discovered by Engdahl, who has showed that this reading cannot be represented if the question simply ranges over individuals as in (7). The reason is that the pronoun in (8) needs to get a bound reading, which is not possible to achieve with a representation such as the one above.

♦ Rather, in this case the question quantifies over functions from individuals to individuals (Skolem functions)[5]:

(9) a. For what f, every Englishman x loves f(x)
b. $\lambda p \exists f\, [p=\lambda w'.\forall x[englishman(x) \rightarrow loves\ (x, f(x))\ in\ w']$
where f is variable of type <e,e>

c. $f_1=$ Bill→Bill's mother
John→ John's mother
Fred→ Fred's mother

■ **Pair-list reading: Chierchia (1991, 1993)**

(10) A: Who does every Englishman like?
B'': Bill likes Mary, Jane likes Sue, etc

♦ The second type of reading is the so called pair-list reading, and is also referred to as the wide scope universal reading, as it is informally paraphrasable by *'For every Englishman x, who does x admire'.*

♦ However, as Engdahl (1986) and Chierchia (1993) have argued, the 'wide scope' universal reading should be represented instead as a type of a functional question.

♦ According to a simple version of this analysis (indeed , too simple[6]) the representation of the wide scope universal reading is exactly as above in (9), but the function f pairs individuals as shown below:

(11) $f_1=$ Bill→Sue
John→Mary
Fred→Jane

(12) $\forall x[loves\ (x, f_1(x))] = love\ (Bill, Sue)\ \&\ love(John, Mary) \&\ love(Fred, Jane)$

[5] In earlier work, Engdahl and Reinhart have argued that these questions range over choice functions. We will not review these proposals here.
[6] [Chierchia, 1993 #196] argues for a more complicated version of this analysis, that we will not review here

3. More about pair list readings

■ **A different story about pair-list questions: G&S**

♦ Groenendijk and Stokhof (1984): According to their view questions that contain quantifiers really dente a *family of questions*. E.g. the question below could be informally paraphrased as *Who do these two people like?, Who do those two people like? Etc. :*

(13) a. Who do two people like?
b. For two people, tell me who they like?

♦ Recall that for Groenendijk and Stokhof (1984) the question intension is the following:

(14) Who does John love?
$=\lambda w'.\lambda w''[\lambda x.\ John\ loves\ x\ in\ w'=\lambda x.\ John\ loves\ x\ in\ w'']$

The relation above holds between *w*' and *w*'' just in case the set of people loved by John is the same in *w*' and *w*''. Now, according to them, the question in (13) denotes a family of questions, i.e. sets of questions. For a question like *Who do two people like*, we want to form a set of questions, one for each minimal restriction (witness set[7]) of *two people.*

(15) *Schematically:*
$\lambda Q\ \exists W$ [W a minimal restriction of [[two people]]
& Q (which $x \in W$ loves whom)

[*More precisely:*
$\lambda Q\ \exists W$ [W a minimal restriction of [[two people]]
& $Q(w')=\lambda w''[\lambda x.\lambda y[\ x\in W\ \&\ x\ likes\ y\ in\ w'=\lambda\ x.\lambda y[\ x\in W\ \&\ x\ likes\ y\ in\ w'']$
Where 'W' stands for 'is a minimal restriction (witness) of'

♦ This family of questions (or set of questions) contains as many questions as there are groups of people. To answer such a family of questions is to answer any of its members.

■ **Further reading if you are interested**

Aloni, M. 2000. Quantification under Conceptual Covers. University of Amsterdam dissertation.
Chierchia, G. 1993. Questions with quantifiers. *Natural Language Semantics* 1:181-234.
Engdahl, E. 1986. *Constituent questions*: D. Reidel Pub. Co Hingham, MA.
Szabolcsi, A. 1997. Quantifiers in pair-list readings. In *Ways of scope taking*, ed. Anna Szabolcsi, 311-347: Springer.

[7] Barwise and Cooper (1981) have shown that each natural language quantifier $\wp$ "lives on" set A. (A generalized quantifier $\wp$ "lives on" set A iff for any set B, $B\in\wp \Leftrightarrow B \cap A\in\wp$) Let $\wp_A$ be a quantifier that lives on A. Further, each quantifier has one or more "minimal witness sets". A minimal witness set for $\wp_A$ is a $B \subseteq A$ such that $B\in\wp$ and for no $P'\subseteq B$, $B'\in\wp$. E.g. a minimal witness set for the (value of) two men is a set of exactly two men. No man has the empty set as their unique minimal witness set. In fact, DE quantifiers all have the empty set as their unique minimal witness set.

Uniqueness presupposition, multiple *wh* questions

■ Uniqueness presupposition of which questions

♦ Non-multiple singular questions have a uniqueness presupposition.

(1) Which man came?
Presupposes. $\exists!x$. x is a man and x came

(2) Which men came?
Presupposes. nothing

♦ How can this difference between the singular and the plural questions explained?

(3) Which man came?
a. $\lambda p \exists x\ [man(x)(w) \wedge p = \lambda w'.\ came\ (x)\ in\ w']$
b. {John came, Bill came, Peter came…}

♦ In the above example *which man* is a singular noun phrase, and therefore it restricts the domain of quantification to atomic men. Therefore the question in (1) denotes a set of atomic propositions.

♦ In principle many of these alternative propositions could be true. So why does the question presuppose that only one man came?

♦ **Dayal (1996):** Every question presupposes that it has a unique most informative true answer.

♦ If there are more true singular propositions, their maximum is not defined and therefore the question will not be defined either. The will only avoid being a presupposition failure if the set of possible answers only contains one true answer: this will be at the same time the maximal true answer.

■ Multiple singular which questions

Dayal's presupposition predicts the correct facts for plural and singular single constituent questions, yes-no questions. Alternative questions etc.

But it runs into a problem with multiple singular which-questions:

As we saw in class 3, in Karttunen's system additional wh-phrases required no special mechanisms. The division of labour btw the Q morpheme and the wh-word allowed an unlimited number of wh- to be quantified into the same question.

(4) $[[\text{Which boy insulted which girl?}]]^{w}=$

Suppose John, Bill, Mary, Sue are the boys and girls in w
f. $\{p : \exists x.\ \exists y\ [x \in \{John, Bill\}\ \&\ y \in \{Mary, Sue\}\ \&\ p = \text{that x insulted y}]\}$

g. {that John insulted Mary, that Bill insulted Mary, that John insulted Sue, that Bill insulted Sue}

♦ None of these 4 propositions entails the others. Therefore it would seem that Dayal's (1996) condition predicts it to presuppose that there is a unique pair of a boy and a girl such that the boy insulted the girl.

■ Response 1: fronted wh-phrase is a disguised universal (Dayal 1996)
(cf. also E. Kiss 1993, Hagstrom 1998)

~Chierchia's treatment of pair-list readings with quantifiers reviewed in class 4

(5) Which boy insulted which girl?=
Which girl did each boy insult?
$\{p: \exists f\ [p = \text{that each boy x insulted the girl } f(x)\}$

■ Response 2: multiple questions as second order questions (family of questions)

~G&S's treatment of pair-list readings with quantifiers reviewed in class 4

(6) Which boy insulted which girl?=
For each boy, tell me which girl he insulted?

References

Dayal, V. 1996. *Locality in WH quantification*: Kluwer Academic Publishers Boston.
Hagstrom, P. A. 1998. Decomposing Questions, Massachusetts Institute of Technology: PhD. Dissertation.