Semantics Bootcamp (II): Questions

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- Goals for today: introduce the basic ideas of each canonical approach; compare the canonical approaches

	A question denotes ...	**A *wh*-item denotes ...**
Categorial Semantics:	an λ-abstract	an λ-operator
Hamblin Semantics:	a set of possible answers	a set of individuals
Karttunen Semantics:	a set of true answers	an $\exists$-quantifier
Partition Semantics:	a partition of worlds	an λ-operator

Table 1: Canonical approaches of composing questions

1. Categorial approaches of question semantics

- A *wh*-question can receive short or full answers.

(1) Who came?
  a. John. (short answer)
  b. John came. (full answer)

- Core assumptions in categorial approaches (Representatives include: Hausser & Zaefferer 1979, Hausser 1983, von Stechow & Zimmermann 1984, Ginzburg & Sag 2000, among others.)
  - short answers are bare nominal, not covertly clausal (cf. Merchant 2004).
  - short answer is primary; the root denotation of a question is a function (or a *lambda (λ-)abstract*) that can take a denotation of a short answer as an argument and return the denotation of the corresponding full answer.

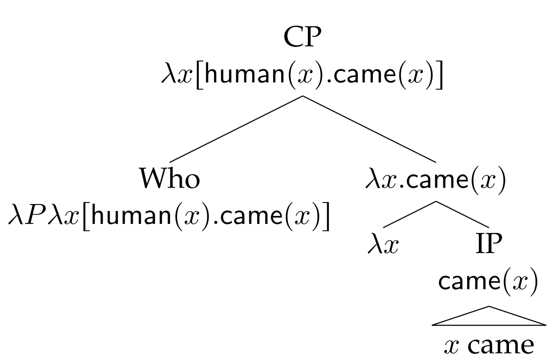
(2) a. $[\![\text{who came}]\!] = \lambda x[\mathsf{human}(x).\mathsf{came}(x)]$
  b. $[\![\text{who came}]\!]([\![\text{John}]\!]) = \lambda x[\mathsf{human}(x).\mathsf{came}(x)](j) = \mathsf{came}(j)$

  - *Wh*-items are *λ-operators*.

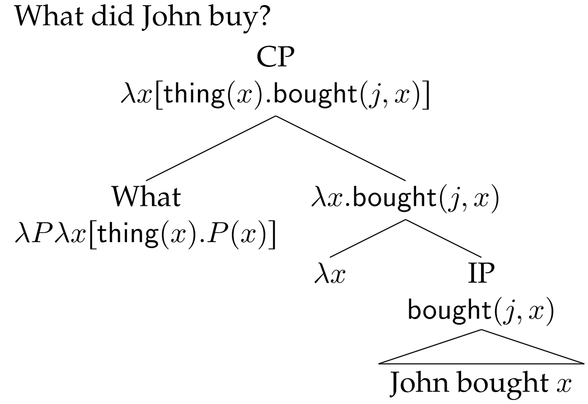
(3) a. $[\![\text{who}]\!] = \lambda P \lambda x[\mathsf{human}(x).P(x)]$
  b. $[\![\text{what}]\!] = \lambda P \lambda x[\mathsf{thing}(x).P(x)]$

Examples:

(4) Who came?



(5) What did John buy?



- **Advantages of categorial approaches**

Ad1: The relation between questions and short answers is very directly modeled:

Question (short answer) = Function (argument)

Ad2: Similarity of *wh*-questions and free relatives is captured nicely.

(6) a. "Whom did Mary vote for?" "Andy and Billy ."
b. We hired whom Mary voted for. = We hired Andy and Billy.

(7) a. "Where can we get coffee?" "Starbucks"/"J.P. Licks"/...
b. We went to where can get coffee. = We went to Starbucks/J.P. Licks/...

Why it is advantageous to model the relation between questions and short answers semantically? (come to the talk on July 3)

- **Problems of categorial approaches**

P1: It assigns different semantic types to different questions, which makes it difficult account for question coordinations:

(8) a. John asked Mary [[$_{\langle e,t\rangle}$ who came] and [$_{\langle e,et\rangle}$ who bought what]].
b. John knows [[$_{\langle e,t\rangle}$ who came] and [$_{\langle e,et\rangle}$who bought what]].

P2: Treating *wh*-items as lambda operators cannot account for the cross-linguistic fact that *wh*-words behave like existential indefinites in non-interrogatives.

(9) a. Yuehan haoxiang jian-le **shenme-ren**
John perhaps meet-PERF what-person
'It seems that John met **someone**.'
b. Ruguo Yuehan jian-guo **shenme-ren**, qing gaosu wo.
If John meet-EXP what-person, please tell me.
'If John met **someone**, please tell me.'

2. Hamblin Semantics of questions

2.1. Hamblin (1973)

- **Core assumptions**
  - A possible answer denotes a proposition. A short answer is an elliptical form of the corresponding full answer. A question denotes the set of propositions that are possible (direct) answers of this question, called a **Hamblin (alternative) set**.

(10) a. $[\![\text{who came?}]\!] = \{\mathsf{a\ came}, \mathsf{b\ came}, \mathsf{a\ and\ b\ came}, ...\}$
b. $[\![\text{which person likes which person?}]\!] = \{\mathsf{a\ likes\ b}, \mathsf{b\ likes\ a}, ...\}$
c. $[\![\text{Did John come?}]\!] = \{\mathsf{John\ came}, \mathsf{John\ didn't\ come}\}$
d. $[\![\text{Does Mary like coffee or tea?}_{\text{ALT-Q}}]\!] = \{\mathsf{Mary\ likes\ coffee}, \mathsf{Mary\ likes\ tea}\}$
e. $[\![\text{Does Mary like coffee or tea?}_{\text{Y/N-Q}}]\!] = \{\mathsf{Mary\ likes\ coffee\ or\ tea}, \mathsf{Mary\ doesn't\ like\ coffee\ or\ tea}\}$
f. $[\![\text{How many cats does John have?}]\!] = \{\mathsf{John\ has\ one\ cat}, \mathsf{John\ has\ two\ cats}, ...\}$

  - A *wh*-item denotes a set of individuals.

(11) a. $[\![\text{who}]\!] = \{x : \mathsf{human}_{@}(x) = 1\}$
b. $[\![\text{what}]\!] = \{x : \mathsf{thing}_{@}(x) = 1\}$
c. $[\![\text{which cat}_{@}]\!] = \{x : \mathsf{cat}_{@}(x) = 1\}$

– Hamblin sets are composed via *Point-wise Functional Application*.

(12) **Point-wise Functional Application**
If α is of type $\langle\sigma,\tau\rangle$ and β is of type σ, then

a. $[\![\alpha]\!] \subseteq D_{\langle\sigma,\tau\rangle}$

b. $[\![\beta]\!] \subseteq D_{\sigma}$

c. $\alpha(\beta)$ is of type τ, and $[\![\alpha(\beta)]\!] = \{a(b) \mid a \in [\![\alpha]\!] \wedge b \in [\![\beta]\!]\}$

- **Composing declaratives and *wh*-questions:**

– A proper name *Mary* denotes a singleton set; thus a declarative denotes a singleton set.

– A *wh*-item denotes a set of individuals, thus a *wh*-question denotes a set of propositions.

(13) a. Mary came.

$\{\lambda w.\mathsf{came}_w(m)\}$
- Mary $\{m\}$
- came $\{\lambda x\lambda w.\mathsf{came}_w(x)\}$

b. Who came?

$\{\lambda w.\mathsf{came}_w(x) : \mathsf{human}_@(x) = 1\}$
- who $\{x : \mathsf{human}_@(x) = 1\}$
- came $\{\lambda x\lambda w.\mathsf{came}_w(x)\}$

On *wh*-movement: In categorial approaches (and Karttunen Semantics), (non-subject) *wh*-items must undertake movement, so as to salvage type-mismatch. For *wh*-insitu languages (e.g., Chinese), categorial approaches and Karttunen semantics predicts covert movement of the *wh*-item. Hamblin Semantics has no such prediction.

- **Composing polar questions and alternative questions:**

– *Is it the case that* denotes the set with the identity function on the question nucleus and its negation.

(14) Is it the case that John left?

$\{\lambda w.\mathsf{left}_w(j), \lambda w.\neg\mathsf{left}_w(j)\}$
- is it the case that $\{\lambda p.p,\ \lambda p\lambda w.\neg p_w\}$
- $\{\lambda w.\mathsf{left}_w(j)\}$ John left

– *or* applies to two sets of propositions, and returns the union of these two sets.

(15) Did JOHN come or MARY come?$_{\text{ALT-Q}}$

$\{\lambda w.\mathsf{came}_w(j), \lambda w.\mathsf{came}_w(m)\}$
- $\{\lambda w.\mathsf{came}_w(j)\}$ John came
-
  - or $\lambda\alpha_{\langle st,t\rangle}\lambda\beta_{\langle st,t\rangle}.\alpha \cup \beta$
  - $\{\lambda w.\mathsf{came}_w(m)\}$ Mary came

Exercise: Compose the following polar question. [Consider: can we use the lexical entry of *or* in (15)?]

(16) Is it the case that [[John came] or [Mary came]]?

2.2. Compare Hamblin Semantics and traditional categorial approaches

- **Discussion**: (i) Are the denotations of (17a-b) equivalent under Hamblin Semantics? What about under categorial approaches? [Recall that categorial approaches assume that questions denote lambda abstracts.] (ii) Then, consider: Can we derive a Hamblin set based on a lambda abstract? What about retrieving a lambda abstract out of the corresponding Hamblin set?

(17) a. Did JOHN come or MARY come?$_{\text{ALT-Q}}$
  b. [Among John and Mary,] which person came?

- An inclusive comparison between categorial approaches and Hamblin Semantics

	Categorial approaches	Hamblin Semantics
Retrieving the question nucleus	Yes	No
Getting short answers	Yes	No
Getting full answers	Yes	Yes
Uniform semantic type	No	Yes: $\langle st, t\rangle$
Question coordinations	No	No
Type-driven *wh*-movement	Yes	No

- Although Hamblin Semantics defines questions uniformly as of type $\langle st, t\rangle$, it still has problems with question coordinations.
  - Conjunction is traditionally treated as set-intersection. Conjunction of two propositions is the set of worlds where both propositions are true.

    (18) $[\![\text{John left and Mary stayed}[\![= [\![\text{John left}]\!] \cap [\![\text{Mary stayed}]\!]$
    $= \{w : \textsf{John left in } w\} \cap \{w : \textsf{Mary stayed in } w\}$

  - But, the conjunction of two questions cannot be the intersection of the Hamblin sets of the two questions:

    (19) $[\![\text{who left and who stayed}]\!] = [\![\text{who left}]\!] \cap [\![\text{who stayed}]\!] = \varnothing$ NO WAY!

  - Hence, Hamblin Semantics has to define conjunction as pointwise intersection. [1]

    (20) $[\![\text{Q}_1 \text{ and Q}_2]\!] = \{p \cap q : p \in Q_1 \wedge q \in Q_2\}$

3. Karttunen Semantics

3.1. Karttunen (1977)

- The denotation of a question is the set of *true* answers (called "Karttunen set"). Indirect questions that use a non-factive interrogative-embedding predicate (e.g., *tell*, *predict*) take veridical readings. This contrast seems to suggest that the veridicality of *tell* in (21b) comes from the embedded question. [2]

(22) a. John told us that Mary left. $\not\leadsto$ *Mary left.*
  b. John told us who left. $\leadsto$ *For some true answer p as to who came, John told us p.*

[1] Inquisitive Semantics maintains the basic intersection semantics of conjunction by treating questions as sets of proposition sets. (See Ciardelli et al. 2016, "Composing Alternatives")

[2] In contrast, Spector & Egré (2015) show that declarative-embedding *tell* does admit a factive/veridical reading.

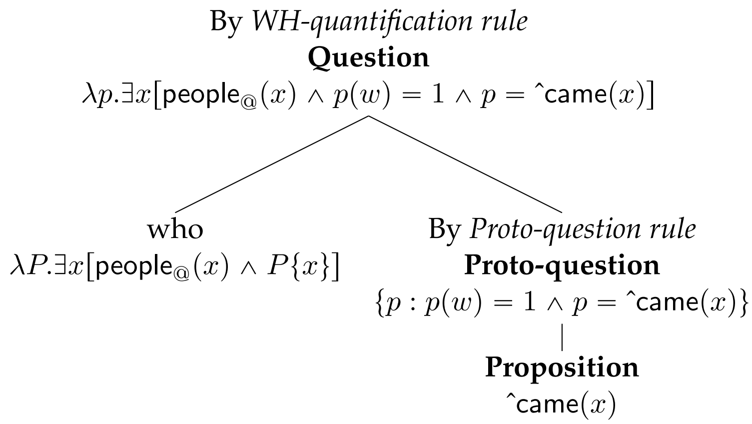
(21) a. Sue told Jack that Fred is the culprit. $\not\leadsto$ *Fred is the culprit.*
  b. Sue didn't tell Jack that Fred is the culprit. $\leadsto$ *Fred is the culprit.*
  c. Did Sue tell Jack that Fred is the culprit? $\leadsto$ *Fred is the culprit.*

– *Wh*-words are existential generalized quantifiers.

– Composition (Using PTQ by Montague) [Don't worry if you don't understand this part ...]

  – A *proto-question rule* shifts the meaning of declarative sentence from a proposition to a *proto-question*, namely, the a set of true propositions that are identical to this proposition.
  – The *wh*-item takes QR and quantifies into the proto-question, yielding a set of true answers.

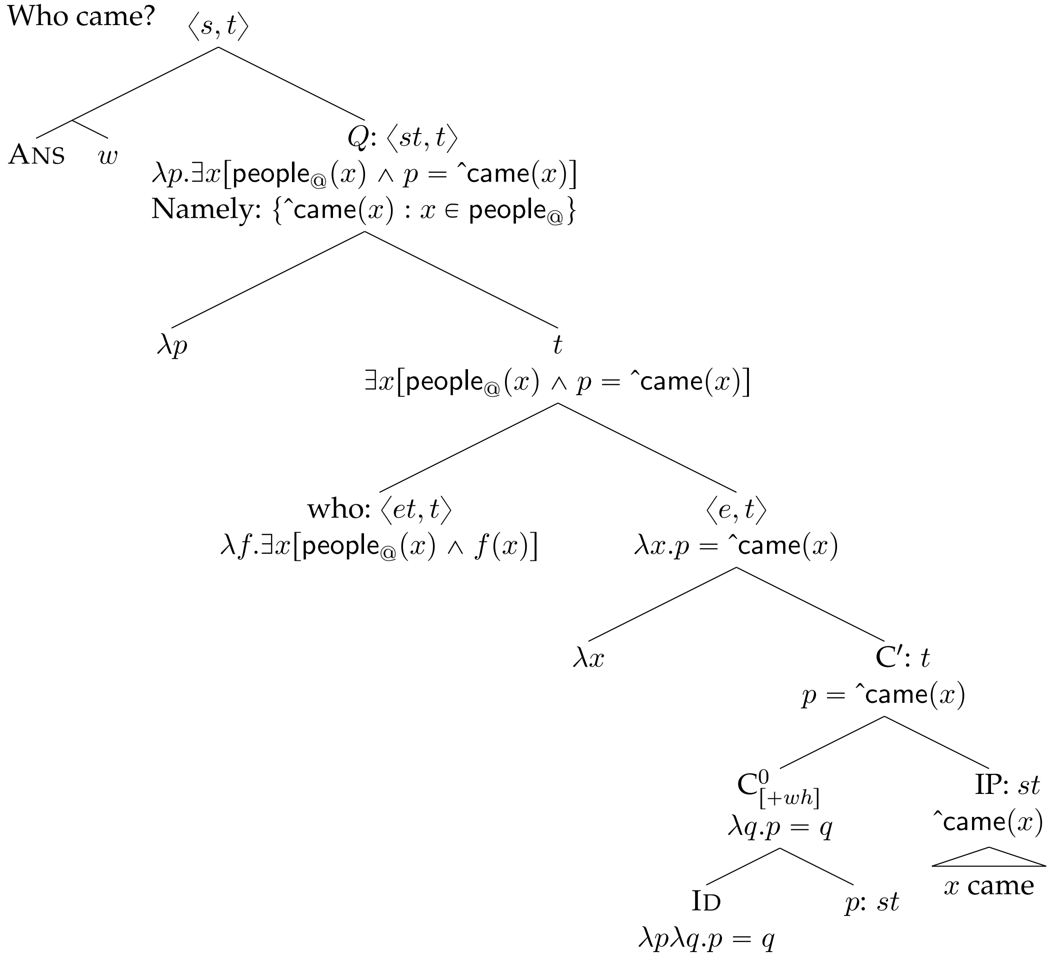
(23)



3.2. Transporting Karttunen Semantics into a GB-style LF

- **Composing *wh*-questions** (Heim 1995; a.o.)

(24) Who came?



1. The proto-question rule is ascribed to an identify (ID)-function at the C^0.

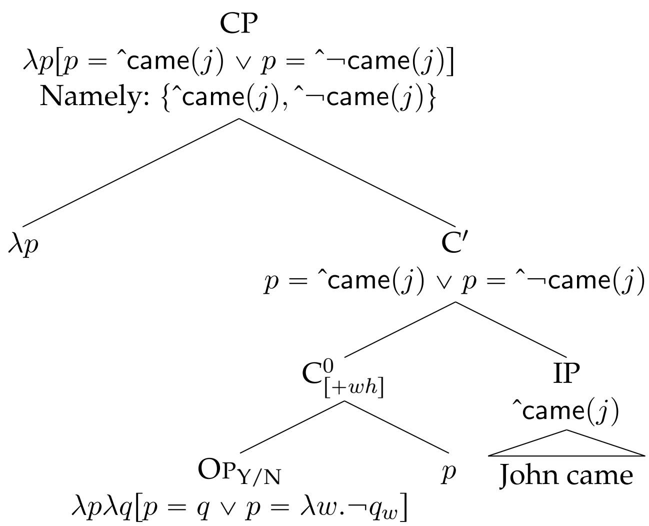
2. The *wh*-word is an existential generalized quantifier; it undertakes QR to [Spec, CP] and quantifies into a predicate of identity relation.
3. Abstracting the first argument p of ID returns a Hamblin set, which is the question denotation.
4. An answerhood (ANS)-operator applies to the Hamblin set Q and the evaluation world w, returning the/a complete true answer in w. (Unlike Karttunen (1977), truth is introduced by the ANS-operator.) Many different ANS-operators have been proposed in the literature.

(25) $\textsc{Ans}_{Heim}(Q)(w) = \bigcap\{p : w \in p \in Q\}$ (Heim 1994)
(The conjunction of all the true answers)

(26) $\textsc{Ans}_{Dayal}(Q)(w) = \exists p[w \in p \in Q \wedge \forall q[w \in q \in Q \rightarrow p \subseteq q]].$
$\iota p[w \in p \in Q \wedge \forall q[w \in q \in Q \rightarrow p \subseteq q]]$ (Dayal 1996)
(The unique strongest true answer)

- **Composing polar-questions**

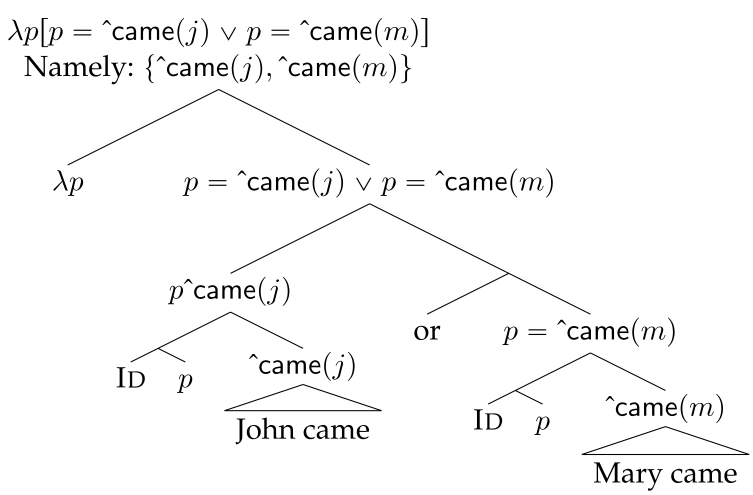
(27) Did John come?



- **Composing alternative-questions**

Recall that in Hamblin semantics, composing an alternative question has to use the type-shifted meaning of *or* (see (15)). We can avoid doing so using the ID-function. (Modified from Heim 2012)

(28) Did JOHN come or MARY come?



3.3. Compare Hamblin Semantics and Karttunen Semantics:

	Hamblin	Karttunen (1977)	Transformed Karttuen
A declarative denotes	A singleton set of propositions	a proposition	a proposition
A question denotes	a Hamblin set	a Karttunen set	a Hamblin set
A *wh*-word denotes	a set of individuals	an $\exists$-quantifier	an $\exists$-quantifier
Composition rules	point-wise FA etc.	Montague PTQ	basic composition rules

4. Partition Semantics

4.1. Core assumptions

- The interpretation of a question is **index/world-dependent**:

(29) Andy knows whether it is raining.
  a. If it is raining, Andy knows that it is raining.
  b. If it isn't raining, Andy knows that it isn't raining.

(30) Andy knows who came.
  a. If only John came, Andy knows that only John came.
  b. If only Mary came, Andy knows that only Mary came.
  c. ....

- The root denotation of a question is a **partition on possible worlds**. A partition consists of a set of non-overlapped cells. Two worlds belong to the same cell of a partition if and only if the denotation of the question nucleus has the same extension in these two worlds.

4.2. Polar-questions

- The partition:

(31) $[\![\text{whether it is raining}]\!] = \lambda w \lambda w'[\mathsf{raining}(w) = \mathsf{raining}(w')]$

w: $\mathsf{raining}(w) = 1$	=	w: it is raining in w
w: $\mathsf{raining}(w) = 0$		w: it is not raining in w

Table 2: Partition for *whether it is raining*

Two worlds belong to the same cell iff *it is raining* has the same truth value in these two worlds.

- Interpreting an indirect question:

(32) John knows whether it is raining.
  a. $[\![\text{whether it is raining}]\!] = \lambda w \lambda w'[\mathsf{raining}(w) = \mathsf{raining}(w')]$
  b. $[\![\text{John knows}_{w_0} \text{ whether it is raining}]\!]$
  $= \mathsf{know}(j, \lambda w \lambda w'[\mathsf{raining}(w) = \mathsf{raining}(w')](w_0))$
  $= \mathsf{know}(j, \lambda w'[\mathsf{raining}(w_0) = \mathsf{raining}(w')])$
  c. INDEX-DEPENDENCY:
  If it rains in $w0$, then: $[\![(32b)]\!] = \mathsf{know}(j, \lambda w'[\mathsf{raining}(w') = 1])$
  If it doesn't rain in $w0$, then: $[\![(32b)]\!] = \mathsf{know}(j, \lambda w'[\mathsf{raining}(w') = 0])$

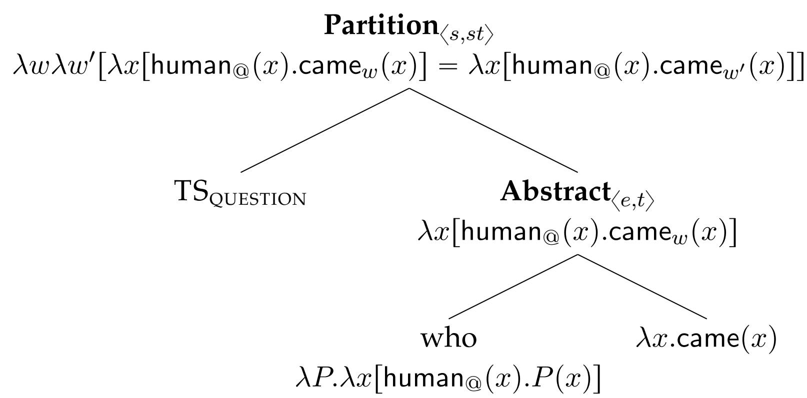
4.3. *Wh*-questions

4.3.1. Forming a partition

- In a *wh*-question, the formation of a question denotation involves two steps:
    1. Like categorial approaches, *wh*-items abstract out the corresponding variables from the nucleus, forming a λ-abstract.
    2. The λ-abstract gets type-shifted, yielding a partition on possible worlds. Two worlds are in the same cell iff the λ-abstract is true for the same set of individuals in these two worlds.

<u>Example:</u>

(33) The formation of the partition of 'who came':



Consider only two individuals John and Mary, the partition can be represented as:

w: $\lambda x[\mathsf{human}_@(x).\mathsf{came}_w(x)] = \{j, m, j \oplus m\}$	w: $\lambda x[\mathsf{human}_@(x).\mathsf{came}_w(x)] = \{m\}$
w: $\lambda x[\mathsf{human}_@(x).\mathsf{came}_w(x)] = \{j\}$	w: $\lambda x[\mathsf{human}_@(x).\mathsf{came}_w(x)] = \varnothing$

=

w: only j and m came in w	w: only m came in w
w: only j came in w	w: nobody came in w

Table 3: Partition for *who came*

Each cell is equivalent to a potential *strongly exhaustive* answer as to *who came*.

(34) Who came? (w: only John and Mary came.)
  a. John and Mary came. [Weakly exhaustive answer]
  b. Only John and Mary came. [Strongly exhaustive answer]

Exercise: Write out the λ-abstract and the partition of the following multi-*wh* question. Consider only two individuals a and b, illustrate this partition with a table.

(35) Who voted for whom?

4.3.2. Interpreting an indirect *wh*-question:

- The index w carried by the question-embedding predicate picks out the cell which it belongs to. This cell is equivalent to the *strongly exhaustive* answer of this question in w. Hence, knowing a question amounts to knowing the strongly exhaustive answer of this question.

(36) John knows who came.

a. $[\![\text{who came}]\!] = \lambda w \lambda w'[\lambda x[\mathsf{came}_w(x)] = \lambda x[\mathsf{came}_{w'}(x)]]$ (domain restriction omitted)

b. $[\![\text{John knows}_{w_0} \text{ who came}]\!]$
$= \mathsf{know}(j, \lambda w \lambda w'[\lambda x[\mathsf{came}_w(x)] = \lambda x[\mathsf{came}_{w'}(x)]](w_0))$
$= \mathsf{know}(j, \lambda w'[\lambda x[\mathsf{came}_{w_0}(x)] = \lambda x[\mathsf{came}_{w'}(x)]])$

c. INDEX-DEPENDENCY:
If only Mary came in w_0, then: $[\![(36a)]\!] = \mathsf{know}(j, \lambda w'[\lambda x[\mathsf{came}_{w'}(x)] = \{m\}])$
If only John came in w_0, then: $[\![(36a)]\!] = \mathsf{know}(j, \lambda w'[\lambda x[\mathsf{came}_{w'}(x)] = \{j\}])$
...

Discussion: Assume that it is raining and that only Mary came, are the sentences in each pair predicted to be semantically equivalent under Partition Semantics? Why or why not?

(37) a. John knows that it is raining.
b. John knows whether it is raining.

(38) a. John knows that Mary came.
b. John knows who came.

- Partition Semantics rules in only the strongly exhaustive reading (39a): (come to the talk on July 4!)

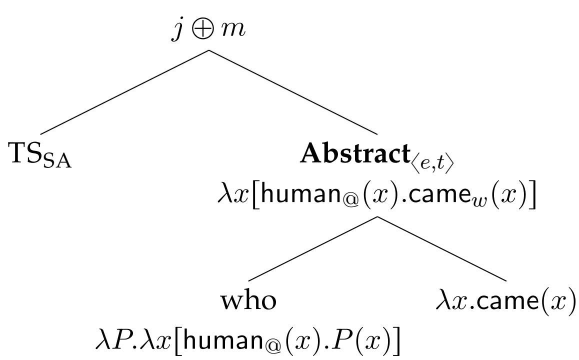
(39) John knows who came.
If x came, J bels that x came. **Weak**
If x came, J bels that x came; if x didn't come, **not** [J bels that x came] **Intermediate**
If x came, J bels that x came; if x didn't come, J bels that x did**n't** come. **Strong**

4.3.3. Forming a short answer

- Constituent/short answers are formed directly from lambda abstracts.

(40) – "Who came?" – "John and Mary."

Constituent Answer



4.4. Comparing Hamblin sets and partitions

- **Discussion:** (i) For each pair of questions, consider: do they have the same Hamblin set, and do they have the same partition? (ii) We have seen that partitions and Hamlin sets can be formed out of λ-abstracts. Then, given the Hamblin set of a question, can we derive the corresponding partition? Given a partition of a question, can be derive the corresponding Hamblin set?

(41) a. Who came?
 b. Who didn't come?

(42) a. Which boy came?
 b. Which boys came?

- Compare the following three denotations:

	λ-abstracts	Hamblin sets	Partitions
Retrieving the question nucleus	Yes	No	
Getting constituent answers	Yes	No	
Getting propositional answers	Yes	Yes	
Uniform semantic type	No	Yes: $\langle st, t\rangle$	

5. Comparing the denotations

- So far, there have been three types of denotations proposed to be the root denotations of questions:

(43) Who came?
 a. $\mathbf{P} = \lambda x[\mathsf{people}_{@}(x) = 1.\hat{}\ \mathsf{came}(x)]$ λ-abstract
 b. $Q = \{\hat{}\ \mathsf{came}(x) : \mathsf{people}_{@}(x) = 1\}$ Hamblin set
 c. $\textsc{Par} = \lambda w \lambda w'[\lambda x[\mathsf{people}_{@}(x) \wedge \mathsf{came}_{w}(x)] = \lambda x[\mathsf{people}_{@}(x) \wedge \mathsf{came}_{w'}(x)]]$ Partition

We can rank them as follows w.r.t. the strength of the expressive power: ('A has greater expressive power than B' means that any information that is derivable from B is also derivable from A, but not the other direction.)

(44) **Rank of expressive power**

Lambda abstracts	>	Hamblin sets	>	Partitions
(Categorial)		(Hamblin-Karttunen)		(Partition)

Starting from a λ-abstract, we can reach all the information that is reachable from a Hamblin set or a partition, but not in the other direction.

5.1. Lambda abstracts > Hamblin sets

- From λ-abstracts to Hamblin sets: EASY

(45) $Q = \{\mathbf{P}(\alpha) : \alpha \in \mathrm{Dom}(\mathbf{P})\}$
 (The set of propositions obtained by applying **P** to its possible arguments.)

- From Hamblin sets to λ-abstracts: DIFFICULT

 The following two different λ-abstracts yield the same Hamblin set (i.e., $\{f(a), f(b)\}$). Hence, given a Hamblin set, we cannot retrieve the λ-abstracts, nor the short answers.

(46) a. $\mathbf{P}_1 = \lambda p[p \in \{f(a), f(b)\}.p]$
b. $\mathbf{P}_2 = \lambda x[x \in \{a, b\}.f(x)]$

Recall: (47a-b) are semantically equivalent under Hamblin Semantics but not under categorial approaches.

(47) a. Did JOHN come or MARY come?$_{\text{ALT-Q}}$
b. [Among John and Mary,] which person came?

5.2. Lambda abstracts & Hamblin sets > Partitions

- From λ-abstracts to partitions: EASY (Gr&S 1984)

(48) $\lambda w.\lambda w'[\lambda x.\mathbf{P}_w(x) = \lambda x.\mathbf{P}_{w'}(x)]$

- From Hamblin sets to partitions: EASY

- From partitions to Hamblin sets and λ-abstracts: DIFFICULT
The following questions yield different λ-abstracts and Hamblin sets but the very same partition.

(49) a. Who came?
b. Which person came?

  – Different λ-abstracts and Hamblin sets, because: *which person* only quantifies over atomic elements, while *who* quantifies over also sums (and generalized conjunctions and disjunctions, see Xiang 2016: $ 1.6)

(50) a. Who came?
$\mathbf{P} = \lambda x[\mathsf{people}_{@}(x) = 1.{}^\wedge\,\mathsf{came}(x)]$
$$Q = \left\{ \begin{array}{l} {}^\wedge\,\mathsf{came}(j) \\ {}^\wedge\,\mathsf{came}(m) \\ {}^\wedge\,\mathsf{came}(j \oplus m) \end{array} \right\}$$
b. Which person came?
$\mathbf{P} = \lambda x[\mathsf{person}_{@}(x) = 1.{}^\wedge\,\mathsf{came}(x)]$
$$Q = \left\{ \begin{array}{l} {}^\wedge\,\mathsf{came}(j) \\ {}^\wedge\,\mathsf{came}(m) \\ \\ \end{array} \right\}$$

  – The same partition:

Partition yielded by (49a)				Partition yielded by (49b)
w: $\{x : w \in c(x)\} = \{j, m, j \oplus m\}$		w: only $j \oplus m$ came in w		w: $\{x : w \in c(x)\} = \{j, m\}$
w: $\{x : w \in c(x)\} = \{j\}$	=	w: only j came in w	=	w: $\{x : w \in c(x)\} = \{j\}$
w: $\{x : w \in c(x)\} = \{m\}$		w: only m came in w		w: $\{x : w \in c(x)\} = \{m\}$
w: $\{x : w \in c(x)\} = \varnothing$		w: nobody came in w		w: $\{x : w \in c(x)\} = \varnothing$

- **Discussion:** For each pair of questions, consider: do they have the same λ-abstracts? ...Hamblin set? ...partition?

(51) a. Who came?
b. Who didn't come?

(52) a. Who came?
b. Which people x is such that only x came?

- **A tricky case**: Do the following questions have the same partition?

(53) a. Which people x is such that only x came?
b. Which person x is such that only x came?