1 Some good questions:

- Why are grammar-based Natural Language Processing systems useful?
- What are some of the syntactic phenomena involved with questions?
- How are they modeled in a formal theory or implementation?

2 An example of the CONTENT of a question:

(1) Who left? \rightarrow

\[
\begin{align*}
\text{question} & \rightarrow \\
\text{PARAMS} & \left\{ \begin{array}{l}
\text{param} \\
\text{INDEX} \\
\text{RESTR} \\
\end{array} \right\} \\
\text{proposition} & \left\{ \begin{array}{l}
\text{person-rel}(\mathbf{1}) \\
\end{array} \right\} \\
\text{PROP} & \left\{ \begin{array}{l}
\text{SIT} \\
\text{SOA} \\
\end{array} \right\} \\
\text{QUANTS} & \{ \} \\
\text{NUCL} & \left\{ \begin{array}{l}
\text{leave-rel} \\
\text{LEAVER} \end{array} \right\}
\end{align*}
\]

3 Another example of a question’s CONTENT:

(2) Who greeted who? \rightarrow
4 One more example:

(3) Did someone leave? $\mapsto$

5 Types of question constructions:

- Polar interrogative Constructions - ‘yes/no’ questions
  “Was Agent Mulder really abducted by aliens?”

- Subject Wh-Interrogatives
  “Who watched last week’s X-Files episode?”

- Non-subject Wh-Interrogatives
“How many alien-human hybrids did Dana Scully unknowingly mother?”

- **In situ Questions** - ‘reprise’ or ‘echo’ questions
  “Agent Mulder believes WHAT?”

6 **Syntactic phenomena relevant to questions:**

- **Extraction**
  “Which government conspiracy did Mulder uncover ___?”

- **Inversion**
  “Did Cancer Man die?” vs. “Cancer Man did die.”

- **Sensitivity to the presence of Wh-Words**
  “Whose funds did Mulder waste?”
  * “The FBI’s funds did Mulder waste?”

7 **Examples of filler-gap dependencies:**

The term “long-distance dependency” describes syntactic phenomena in which a constituent is dislocated from the place that it is normally realized, and instead occurs at a potentially unbounded distance from that location.

\[(4)\]
\[
\begin{align*}
\text{a. } & [\text{These bagels}], \text{ I like } \underline{\text{____}}. \quad \text{(topicalization)} \\
\text{b. } & [\text{These bagels}], \text{ they say they like } \underline{\text{____}}. \quad \text{(topicalization)} \\
\text{c. } & [\text{Whose bagels}], \text{ do you like } \underline{\text{____}}? \quad \text{(wh-interrogative)} \\
\text{d. } & [\text{From whom}], \text{ did you buy these bagels } \underline{\text{____}}? \quad \text{(wh-interrogative)} \\
\text{e. } & [\text{What great bagels}], \text{ they bought } \underline{\text{____}}! \quad \text{(wh-exclamative)}
\end{align*}
\]

8 **The head-filler phrase type:**

All the above constructions inherit from the same parent, the head-filler phrase:

\[(5)\]
\[
\text{hd-fill-ph:}
\[
\begin{array}{c}
\text{SLASH } \underline{\Sigma} \\
\rightarrow \begin{bmatrix} \text{LOC } \underline{\text{H}} \end{bmatrix}, \begin{bmatrix} \text{phrase} \\
\text{SUBJ } (\underline{\text{}}) \\
\text{HEAD } \text{verb} \\
\text{SLASH } \{ \underline{\text{}} \} \uplus \underline{\Sigma} \end{bmatrix}
\end{array}
\]
Note that in the version of HPSG presented in the Ginzburg and Sag, as well as my implementation, maximal subtypes of phrase are treated as grammar rules. So you can essentially read the above as a context free grammar production.

9 The feature SLASH:

The feature SLASH is used to store all arguments which are not canonically realized by the head-complement constructions.

\[(6) \text{ SLASH Amalgamation Constraint} \]

\[
\text{word} \Rightarrow \left[ \text{SS} \left[ \text{LOC|CAT} \left[ \text{ARG-ST} \left[ \text{SLASH} \left[ \Sigma_1 \cup \ldots \cup \Sigma_n \right] \right] \right] \right] \right]
\]

The SLASH Amalgamation Constraint guarantees that a word stores all of its arguments which are not canonically realized, i.e. which participate in filler-gap construction.

10 Non-canonical synsems

Arguments are put into SLASH by being marked as a type of non-canonical synsem, gap-ss, which has the following constraint:

\[(7) \text{ gap-ss} \Rightarrow \left[ \text{LOC} \left\{ 1 \right\} \right] \]

\[
\text{SLASH} \left\{ 1 \right\}
\]

This is what causes an filler-gap constituent to be added to the SLASH list of the word that it is an argument of.
11 An illustration:

(8) S
   /\     /
  NP  [SS|LOC  []]  VP [SLASH { embodies }]
     \   /     \
    These bagels I like

12 Wh-interrogative clause constructions

The type for wh-interrogatives inherits from hd-fill-ph and adds the additional constraint that the filler daughter have the value param for its WH feature:

(9) wh-int-cl:

\[
\begin{array}{c}
\text{SLASH } \{ \} \\
\text{LOC } \{ \} \\
\text{WH param}
\end{array} \rightarrow 
\begin{array}{c}
\text{phrase} \\
\text{SUBJ } \{ \} \\
\text{HEAD } \{ \} \\
\text{SLASH } \{ \} \\
\end{array}, 
\begin{array}{c}
\text{H} \\
\text{LOC } \{ \} \\
\text{gap-ss} \\
\text{SLASH } \{ \} \\
\end{array}
\]

This guarantees that the filler daughter of a wh-int-cl be a wh-word, because all others words are marked [ WH wh-none ].

13 The WH Agreement Principle

Since the wh-word can be properly contained within the filler constituent of a wh-interrogative construction, the following principle is used to percolate the WH value up to the phrase level:
(10) WH Agreement Principle:

\[
word \Rightarrow \text{ss} \left[ \text{loc}\mid\text{cat}\mid\text{spr} \langle \text{WH } \square \rangle \right]
\]

This correctly predicts the following data:

(11) a. Whose books did Kim read?
    b. Whose pictures of Sandy did Kim like?
    c. *Sandy’s pictures of whom did Kim like?