Assumption-based Reasoning

Often we want our agents to make assumptions rather than doing deduction from their knowledge. For example:

- In default reasoning the delivery robot may want to assume Mary is in her office, even if it isn't always true.
- In diagnosis you hypothesize what could be wrong with a system to produce the observed symptoms.
- In design you hypothesize components that provably fulfill some design goals and are feasible.

Design and Recognition

Two different tasks use assumption-based reasoning:

- **Design** The aim is to design an artifact or plan. The designer can select whichever design they like that satisfies the design criteria.
- **Recognition** The aim is to find out what is true based on observations. If there are a number of possibilities, the recognizer can't select the one they like best. The underlying reality is fixed; the aim is to find out what it is.

Compare: Recognizing a disease with designing a treatment. Designing a meeting time with determining when it is.

The Assumption-based Framework

The assumption-based framework is defined in terms of two sets of formulae:

- F is a set of closed formula called the facts.
  These are formulae that are given as true in the world.
  We assume F are Horn clauses.

- H is a set of formulae called the possible hypotheses or assumables. Ground instance of the possible hypotheses can be assumed if consistent.

Making Assumptions

- A scenario of $\langle F, H \rangle$ is a set D of ground instances of elements of H such that $F \cup D$ is satisfiable.

- An explanation of g from $\langle F, H \rangle$ is a scenario that, together with F, implies g.

  D is an explanation of g if $F \cup D \models g$ and $F \cup D \not\models \mathit{false}$.

  A minimal explanation is an explanation such that no strict subset is also an explanation.

- An extension of $\langle F, H \rangle$ is the set of logical consequences of F and a maximal scenario of $\langle F, H \rangle$.

Example

$a \leftarrow b \wedge c.$

$b \leftarrow e.$

$b \leftarrow h.$

$c \leftarrow g.$

$c \leftarrow f.$

$d \leftarrow g.$

$false \leftarrow e \wedge d.$

$f \leftarrow h \wedge m.$

assumable e, h, g, m, n.

- $\{e, m, n\}$ is a scenario.
- $\{e, g, m\}$ is not a scenario.
- $\{h, m\}$ is an explanation for a.
- $\{e, h, m\}$ is an explanation for a.
- $\{e, h, m, n\}$ is a maximal scenario.
- $\{h, g, m, n\}$ is a maximal scenario.

Default Reasoning and Abduction

There are two strategies for using the assumption-based framework:

- **Default reasoning** Where the truth of *g* is unknown and is to be determined.
  An explanation for *g* corresponds to an **argument** for *g*.

- **Abduction** Where *g* is given, and we are interested in explaining it. *g* could be an observation in a recognition task or a design goal in a design task.