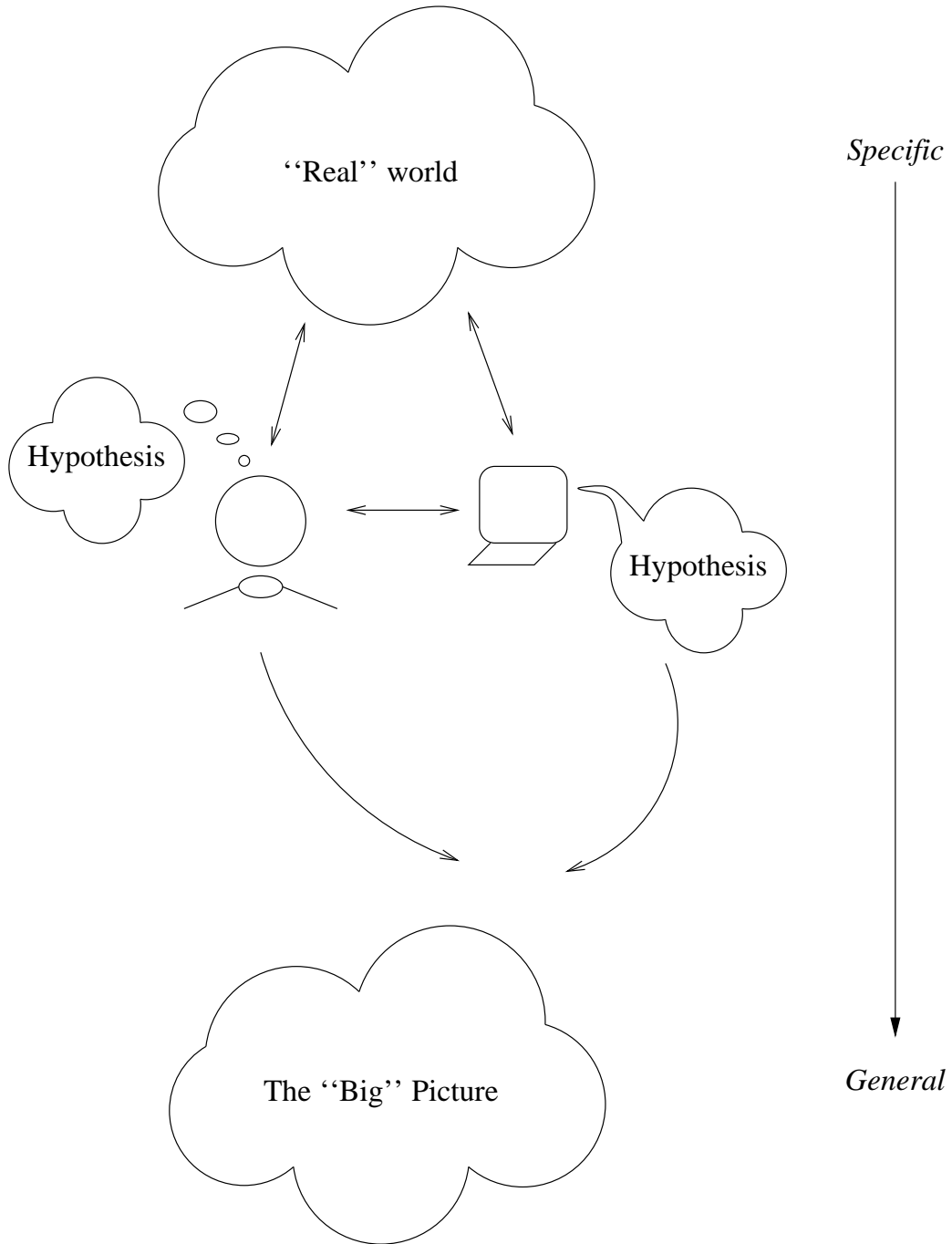# Imagine

- An assistant who suggested to

    Kepler that an ellipse best fitted Brahe's observations of Mars

    Ramanujan that the numbers like 12 were like $2^{a_1} \times 3^{a_2}$ where $a_1 \geq a_2$

    Rachmaninoff that he had a tendency to anticipate notes in some conditions

- How much more would such a Sorcerer and Apprentice team have achieved . . .

Machines as "intelligent assistants"

- Science

  - Forming and refining new theories

- Engineering

  - Data analysis

  - Training professionals

- Arts

  - Artist/author-specific patterns

  - Suggesting playing method

- "Assistance" should be understandable

2-Way Learning

"Real" world

Hypothesis

Hypothesis

The "Big" Picture

Specific

General

ILP: Areas of Application

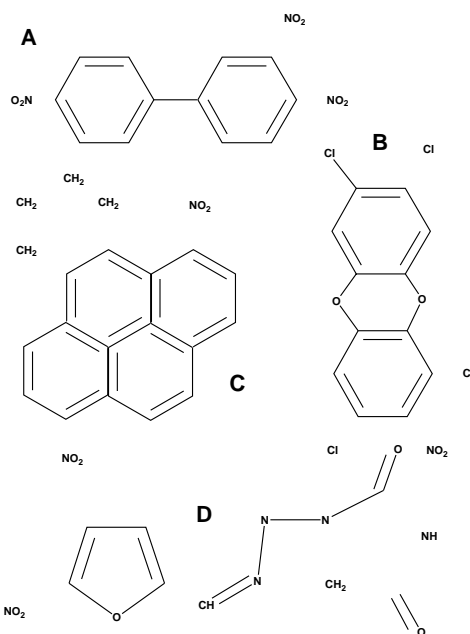**Science.** Protein shape prediction, drug structure activity prediction, . . .

Engineering. Finite element mesh design, satellite fault diagnosis, circuit design, automobile traffic-flow analysis, intelligent software agents for the Internet, reconstruction of simulator models, numerical prediction, . . .

Language. Part-of-speech disambiguation from large real-world corpora, learning grammars, . . .

Music. Analysis of Rachmaninoff's pianoforte performances, . . .

Scientific Application: Mutagenesis

Task. Find rules describing highly mutagenic compounds using molecular structure of chemicals

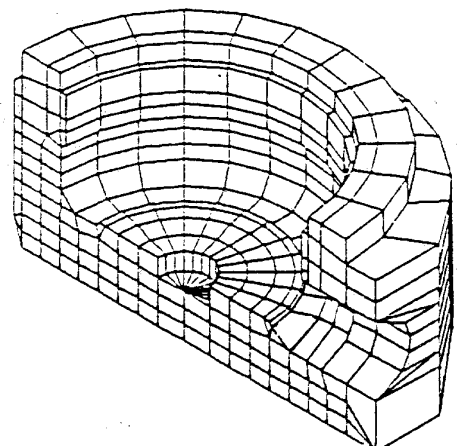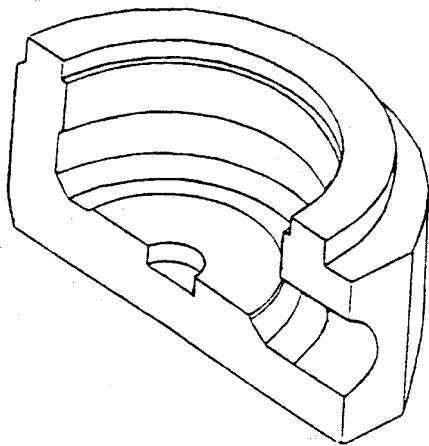- ILP found new structural alert for poorly-understood subset

- Example rule:

```
A chemical is mutagenic if:
        it contains a double bond conjugated to a
        5-membered aromatic ring via a carbon atom
```

Engineering Application: Mesh-Design

Task. Find correct mesh resolution (partitions) for component parts of a physical object using factors such as the type of edges, boundary conditions and loadings, shape of the structure etc.

- ILP derived rules being incorporated into a commercial program for mesh-design

- Example rule:

```
The resolution of an edge A is 2 elements if:
        it is an ``important short'' edge, and
        it is adjacent to an element B, and
        B is completely fixed, and
        B contains no load.
```

Language Application: Tagging

Task. Find rules to eliminate incorrect part-of-speech tags in corpus-based data (1,000,000's of sentences)

```
A House-Senate conference last week accepted...
```

determiner   adjective   noun   adjective noun past-tense verb

sing. prop noun   past-particple verb

- ILP rules comparable to best statistical taggers on word-by-word basis

- ILP rules much better on a sentence-by-sentence basis

- Example rule:

```
A word cannot be a past participle if:
    it is sandwiched between a determiner (right) and
    a noun-phrase (left)
```

Music Application: Interpreting Rachmaninoff

Task. Find interpretive rules that may have
been used by Rachmaninoff using Ampico
recordings of his piano performances (*ca.*
1920, records notes, duration, tempo, dy-
namics of key pressure, pedalling in a digi-
tal form)

- ILP rules conform to musical expectations
  and find some unusual patterns

- Example rules:

```
A note marked ''staccato'' is interpreted by:
      a severe shortening of the note followed by
      lengthening the gap before the next note

A note is played slightly earlier than indicated if:
      it appears at the beginning of a bar
```