Description Logics

Introductory Lecture

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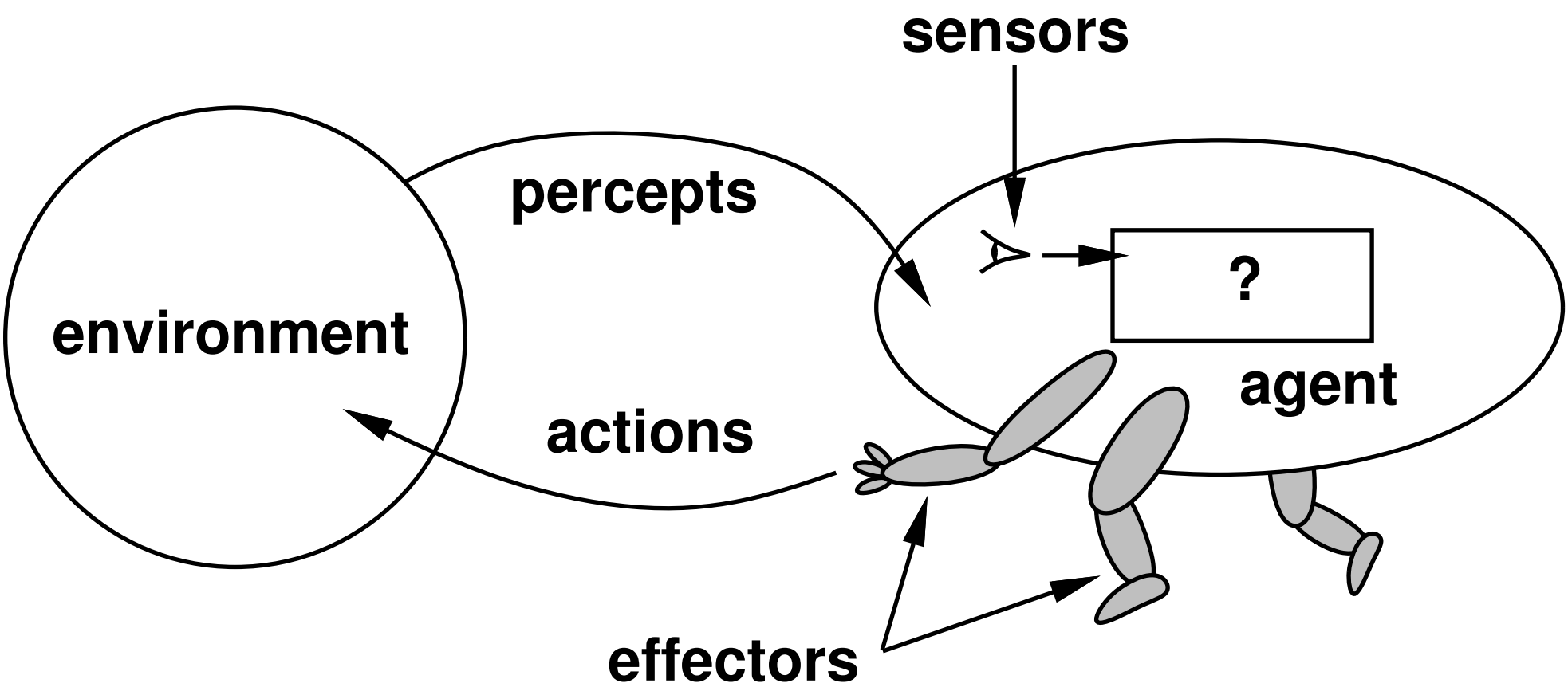
Administrativia

- Class home page:

  `http://www.cs.man.ac.uk/~franconi/dl/course/2002/`

  - All relevant information about the course.
  - Slides, lecture by lecture.
  - Downloadable reference articles.
- Suggested book on logic:
  - "The Essence of Logic", by John Kelly. Prentice Hall, 1997.
- Various scientific articles on the topic will be referenced during the course.

Systems $\Longleftrightarrow$ Agents



An agent

Consider, e.g., the task of designing an automated vehicle:

Percepts: video, accelerometers, gauges, engine sensors, keyboard, GPS, . . .

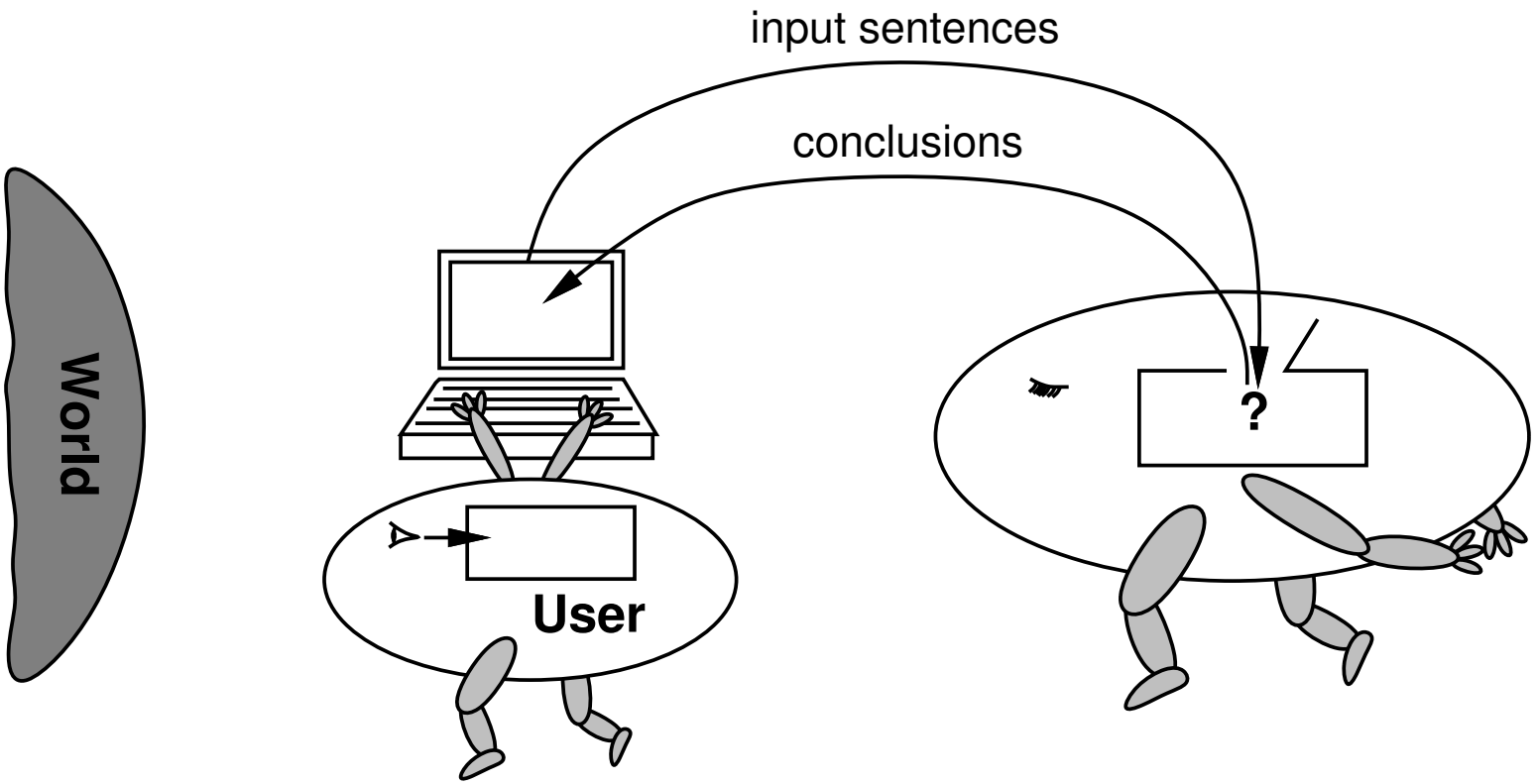
Actions: steer, accelerate, brake, horn, speak/display, . . .

Goals: safety, reach destination, maximize profits, obey laws, passenger comfort, . . .

Environment: US urban streets, freeways, traffic, pedestrians, weather, customers, . . .

Rational Agents

An Agent as Reasoning module of a Rational Agent.



Intelligent Agents

- An *Intelligent Agent* is an entity that perceives and acts according to an *internal declarative body of knowledge*.
- Abstractly, an agent is a function from percept histories and internal declarative knowledge to actions:

$$f : \mathcal{P}^* \times \mathcal{K} \rightarrow \mathcal{A}$$

For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance

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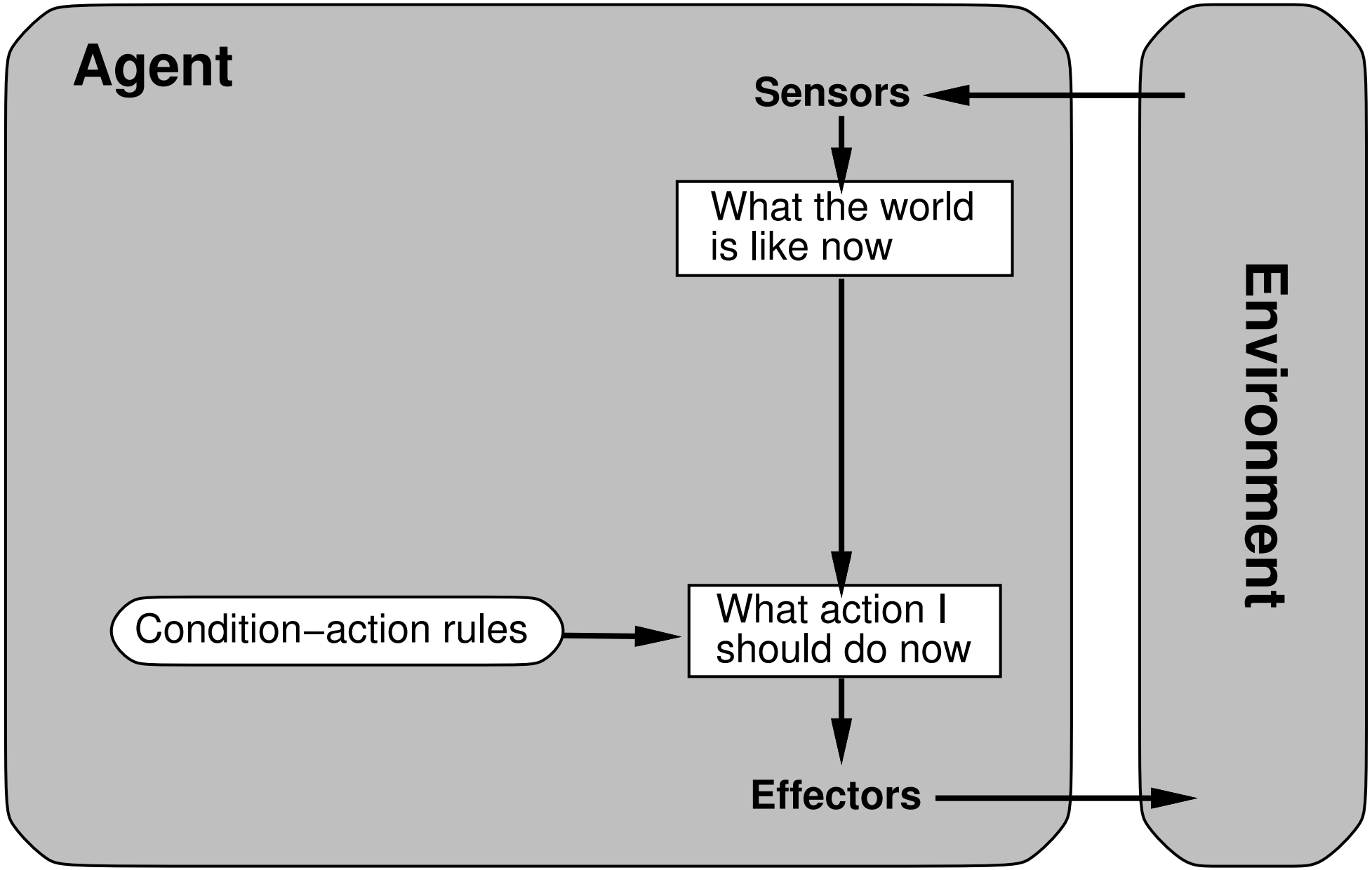
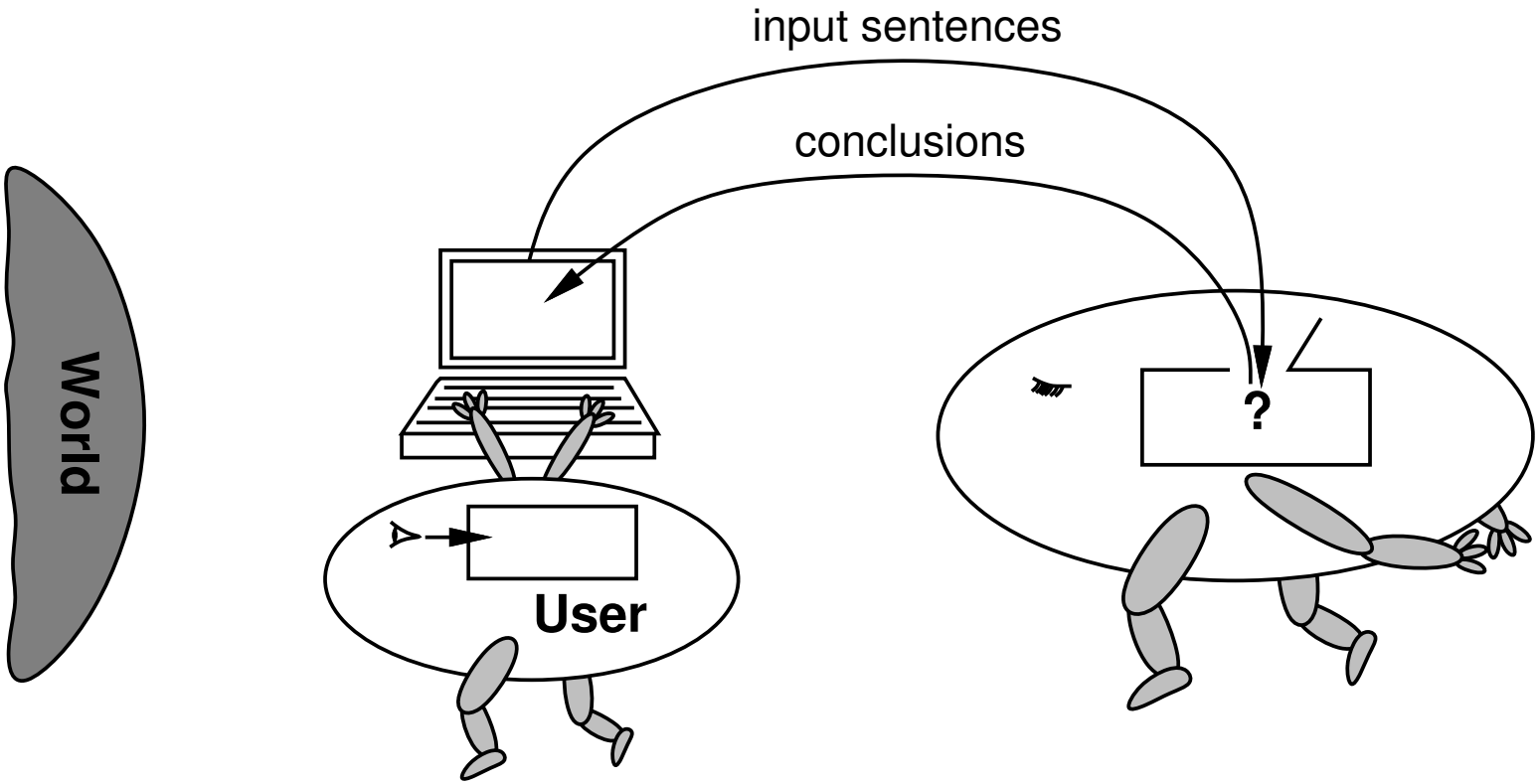
  For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance
- An Intelligent Agent as *Representation and Reasoning* module: a **logic**.
- *Logic*: a well formalized part of agent *knowledge* and *reasoning*.

Non-Intelligent Agents: Reflex Agents



Intelligent Information Agents



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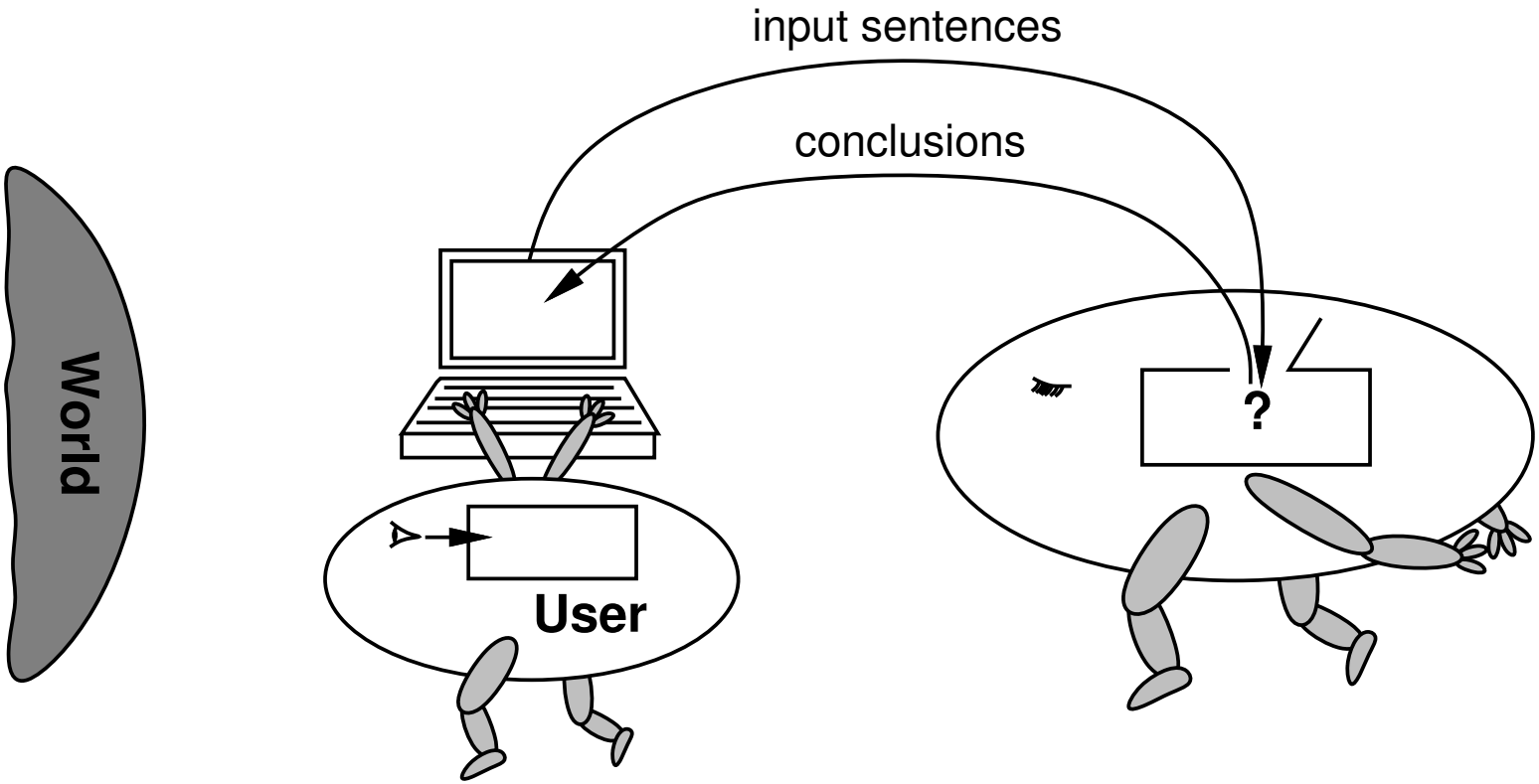
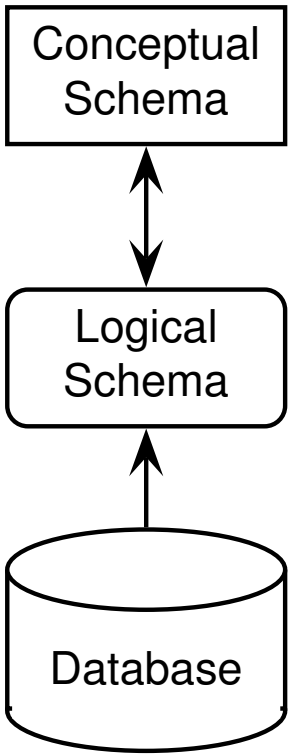


The goal of an *Intelligent Information Agent* is to manage, process, and access Information – e.g., a database system.

The Architecture of an Intelligent Information Agent



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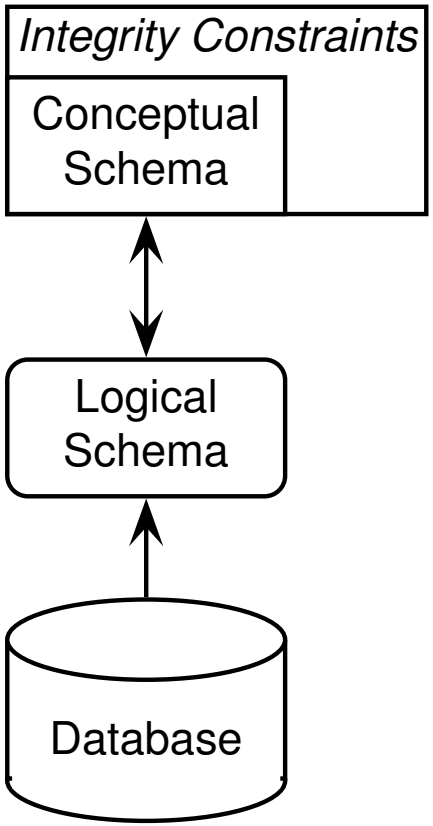

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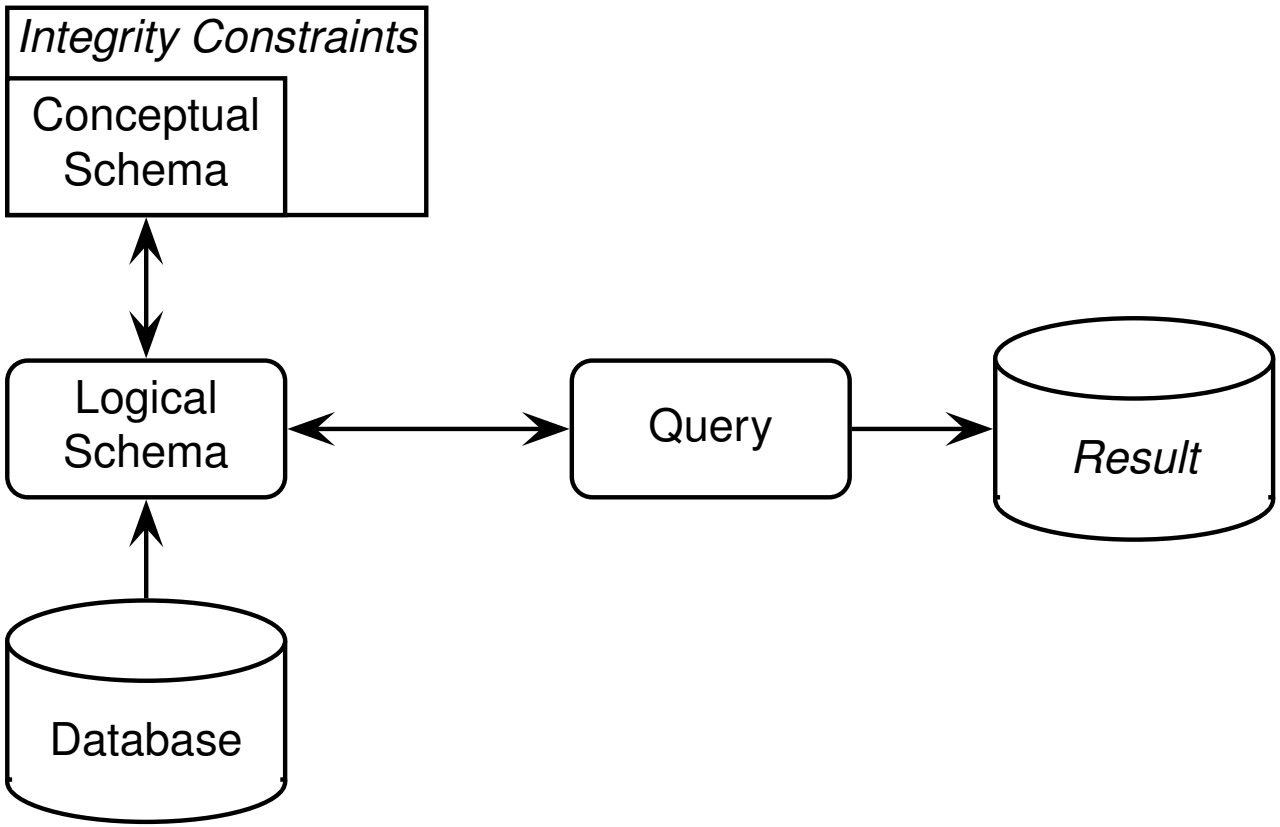

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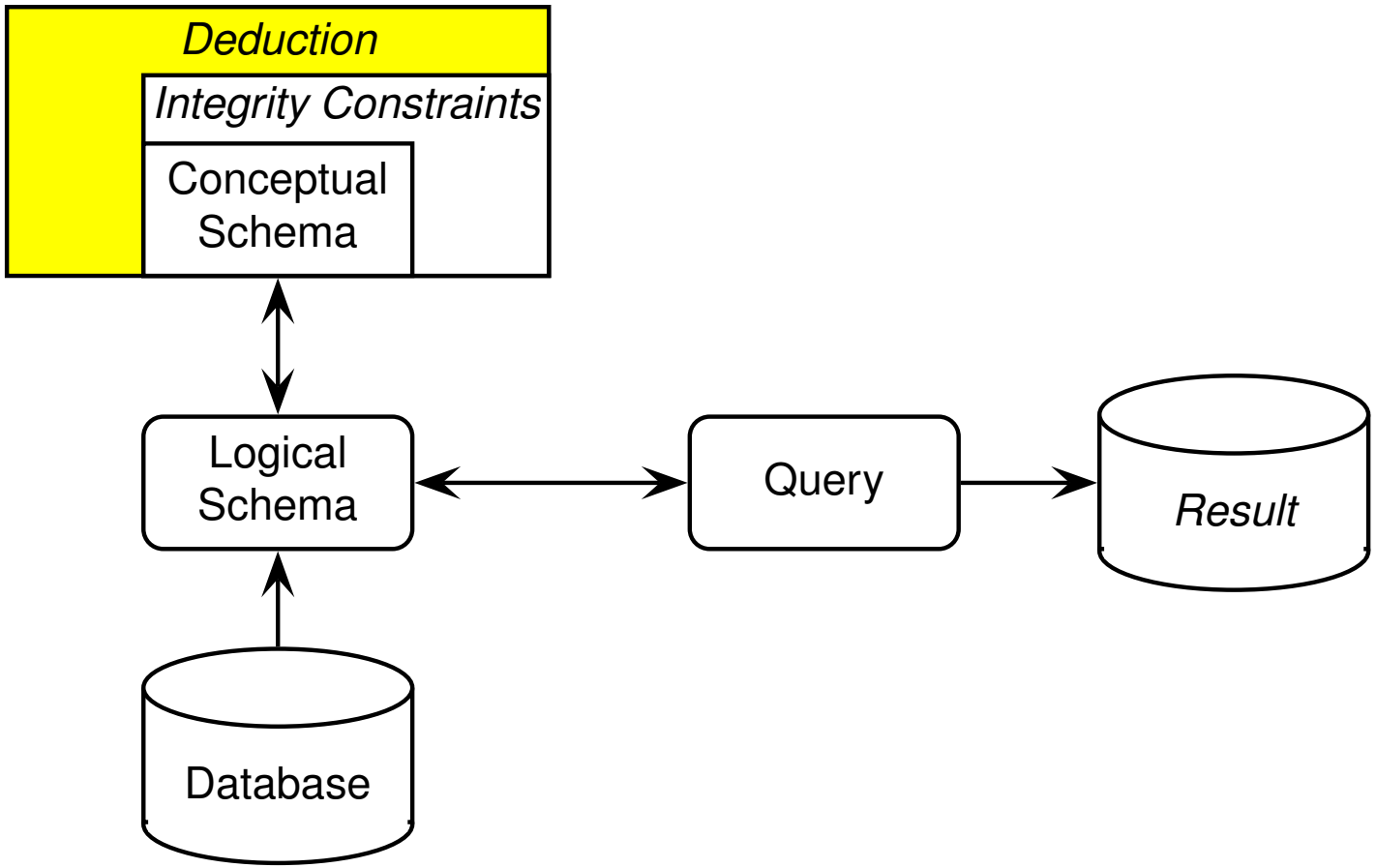

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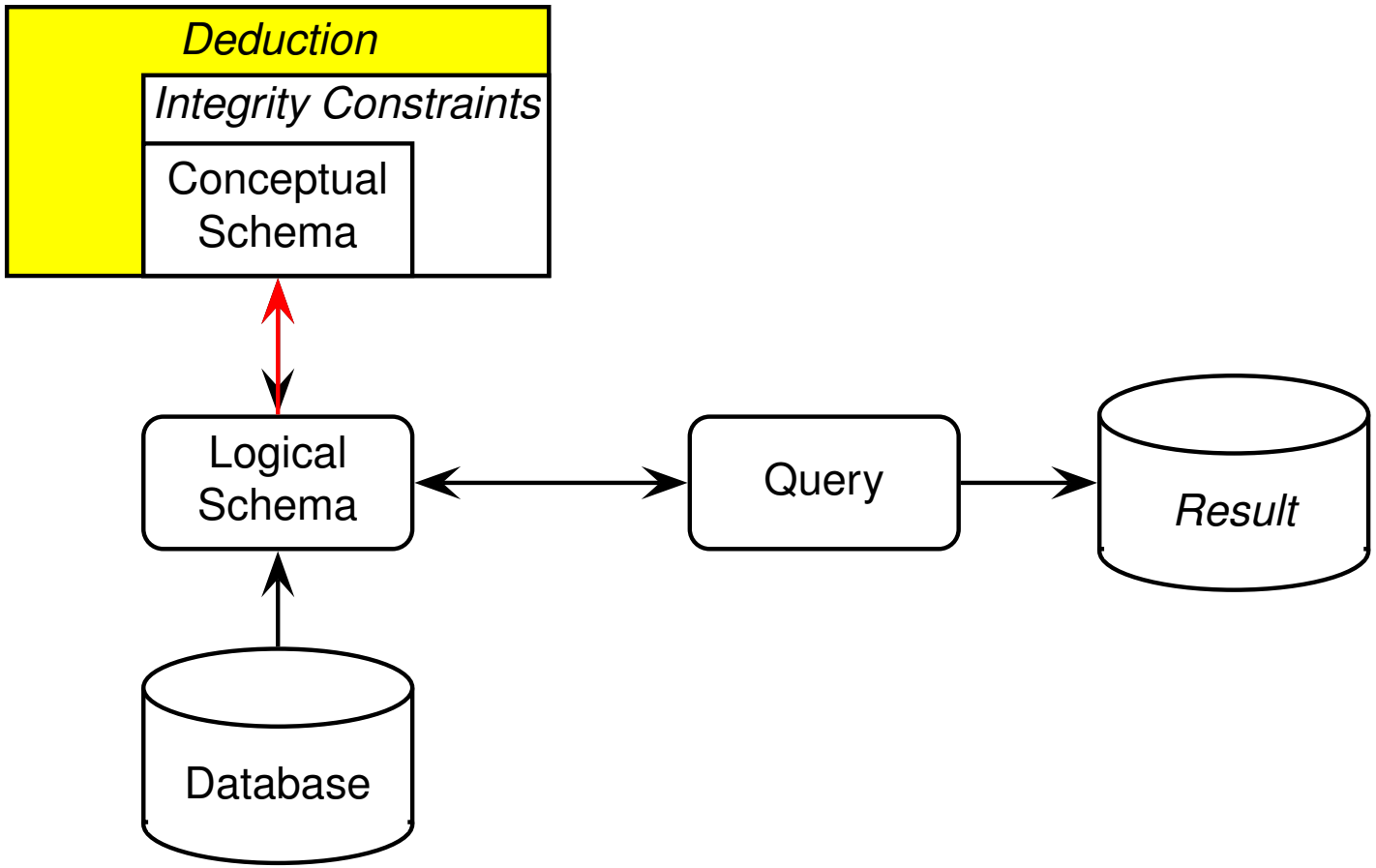

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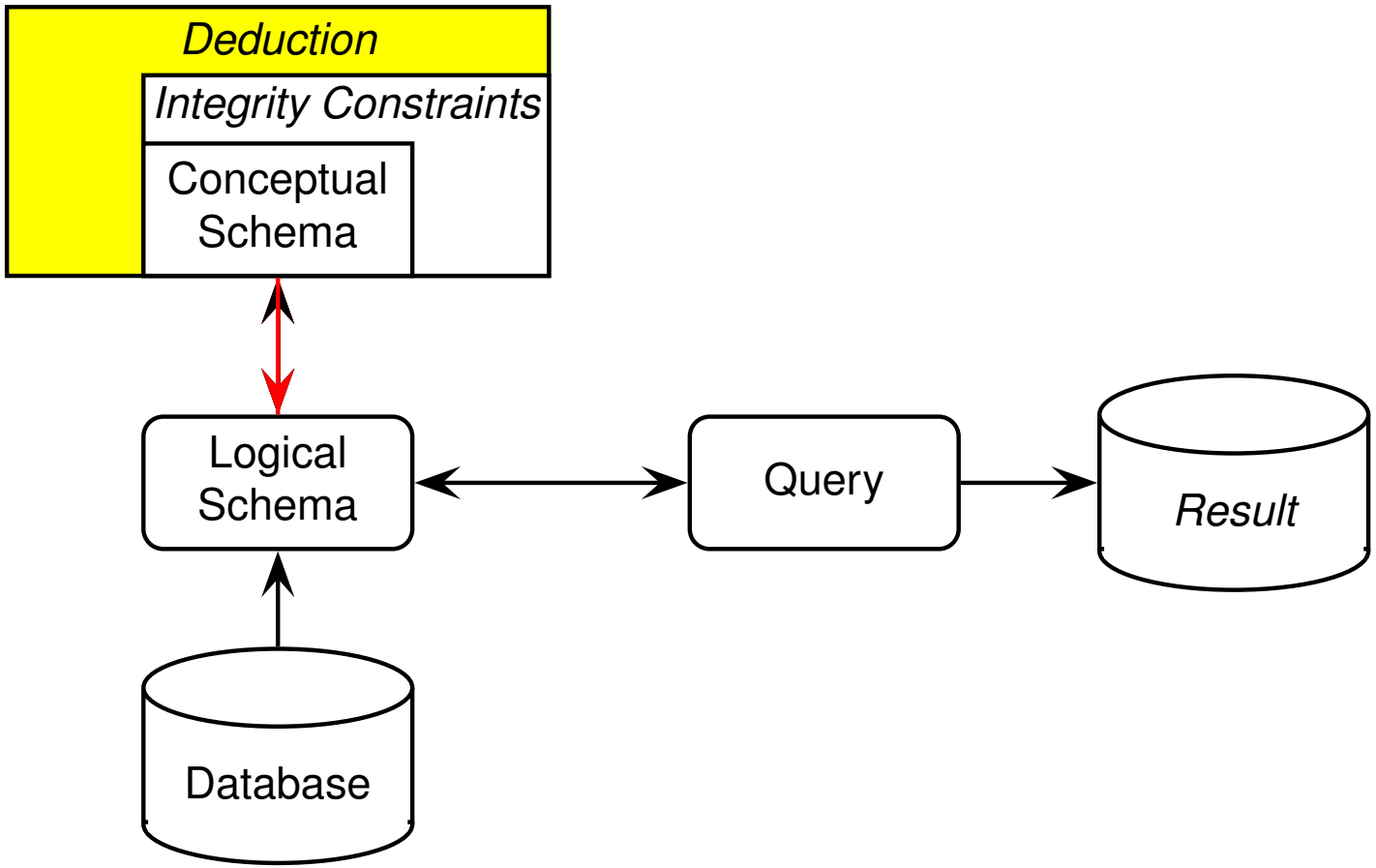

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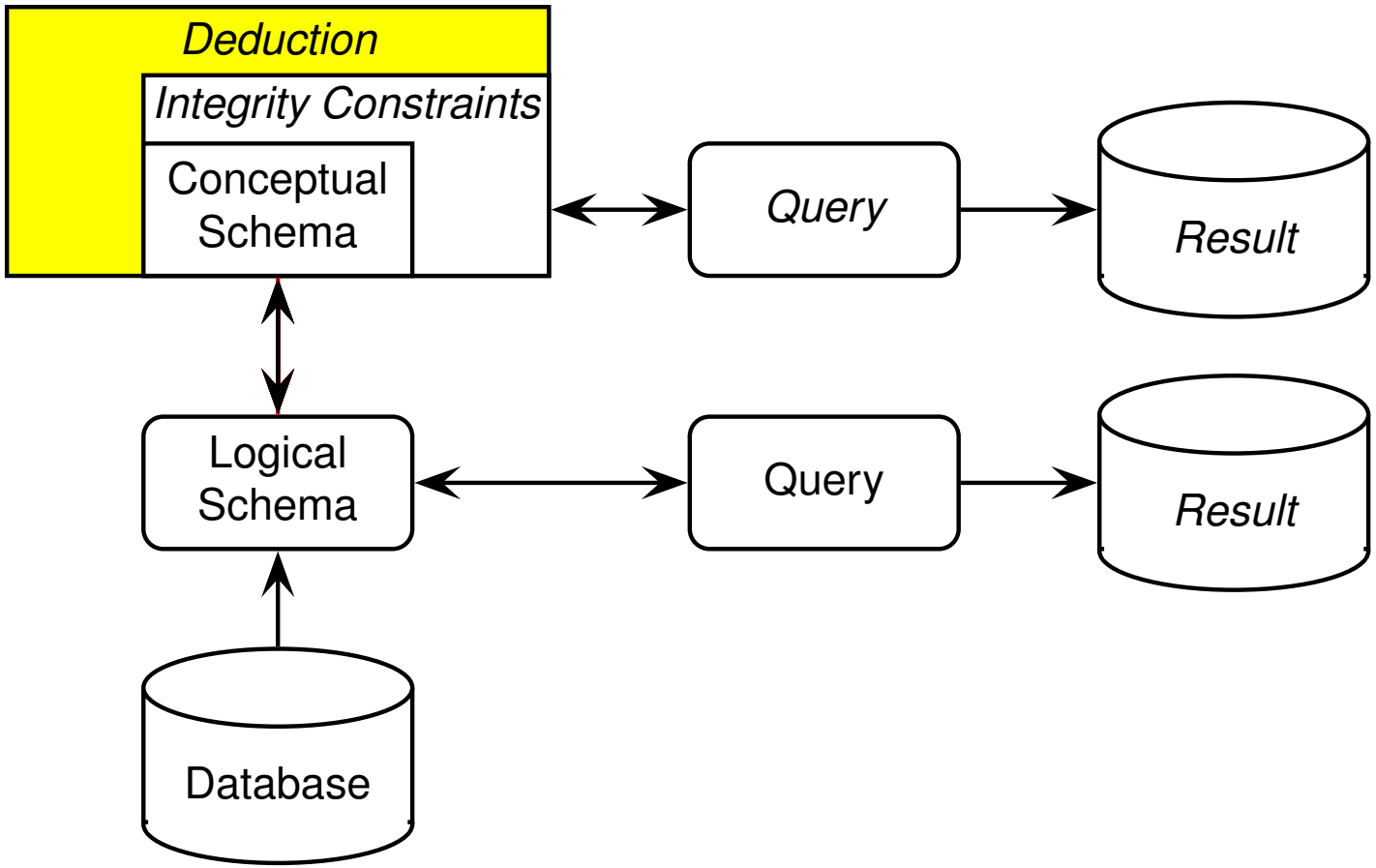

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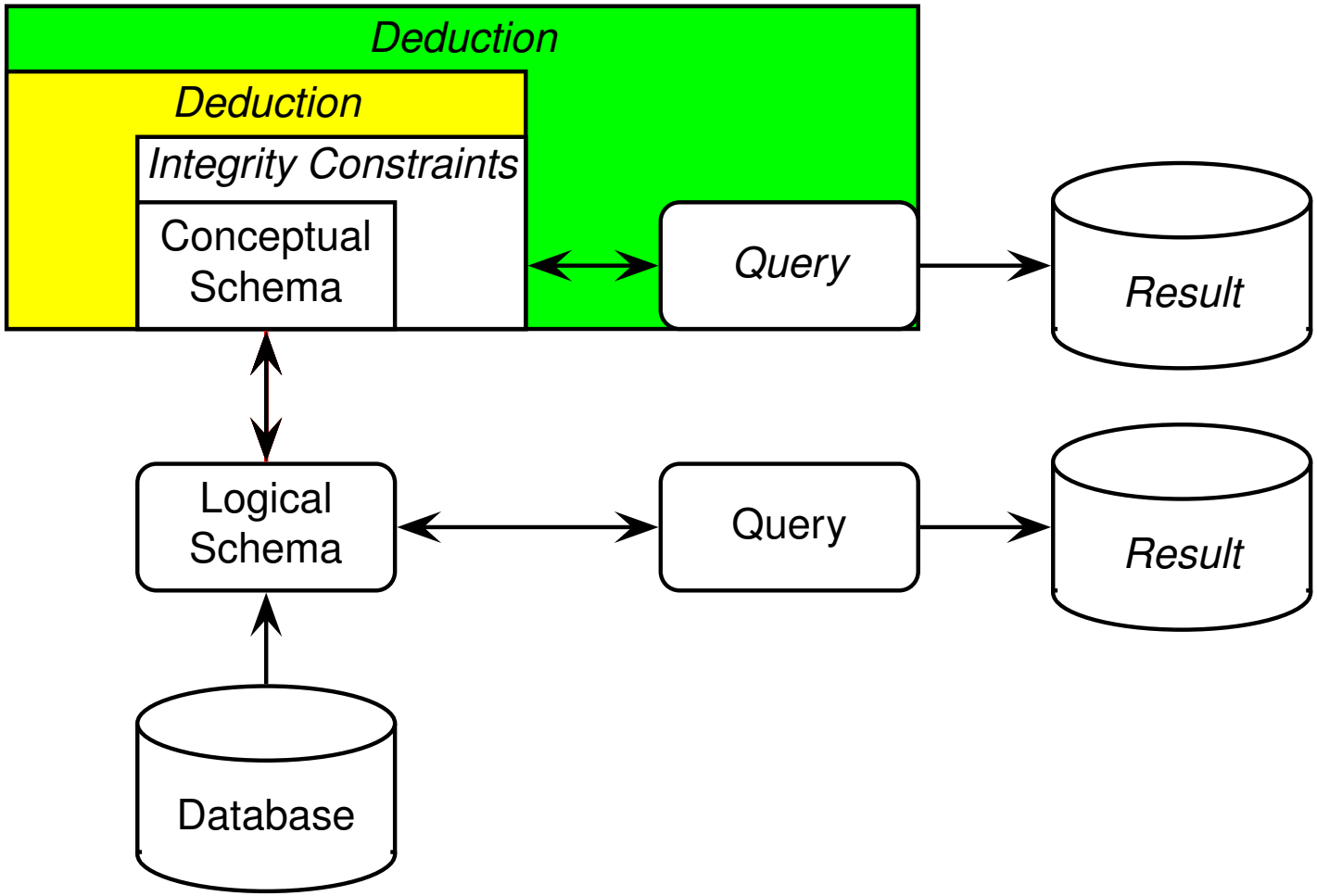

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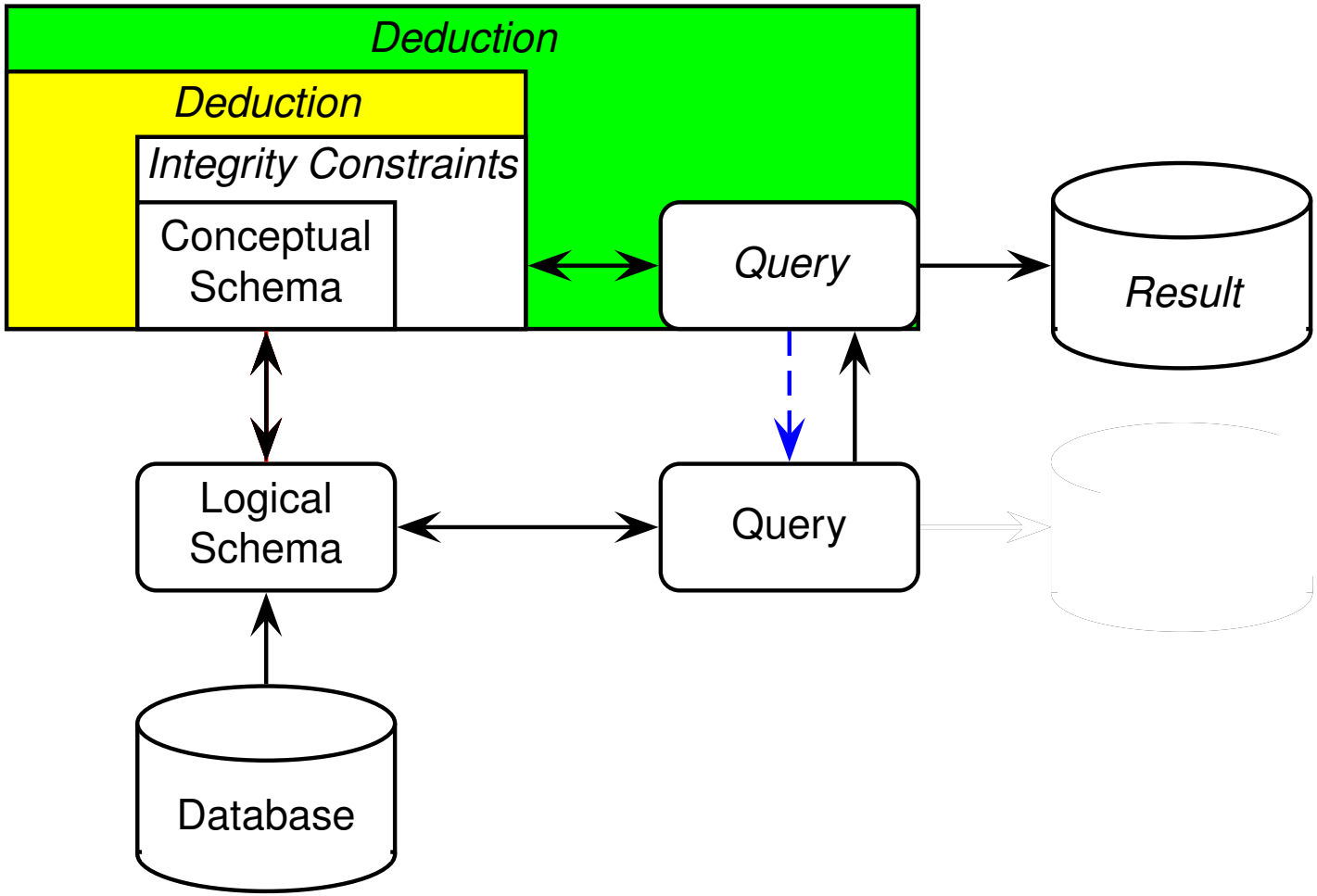

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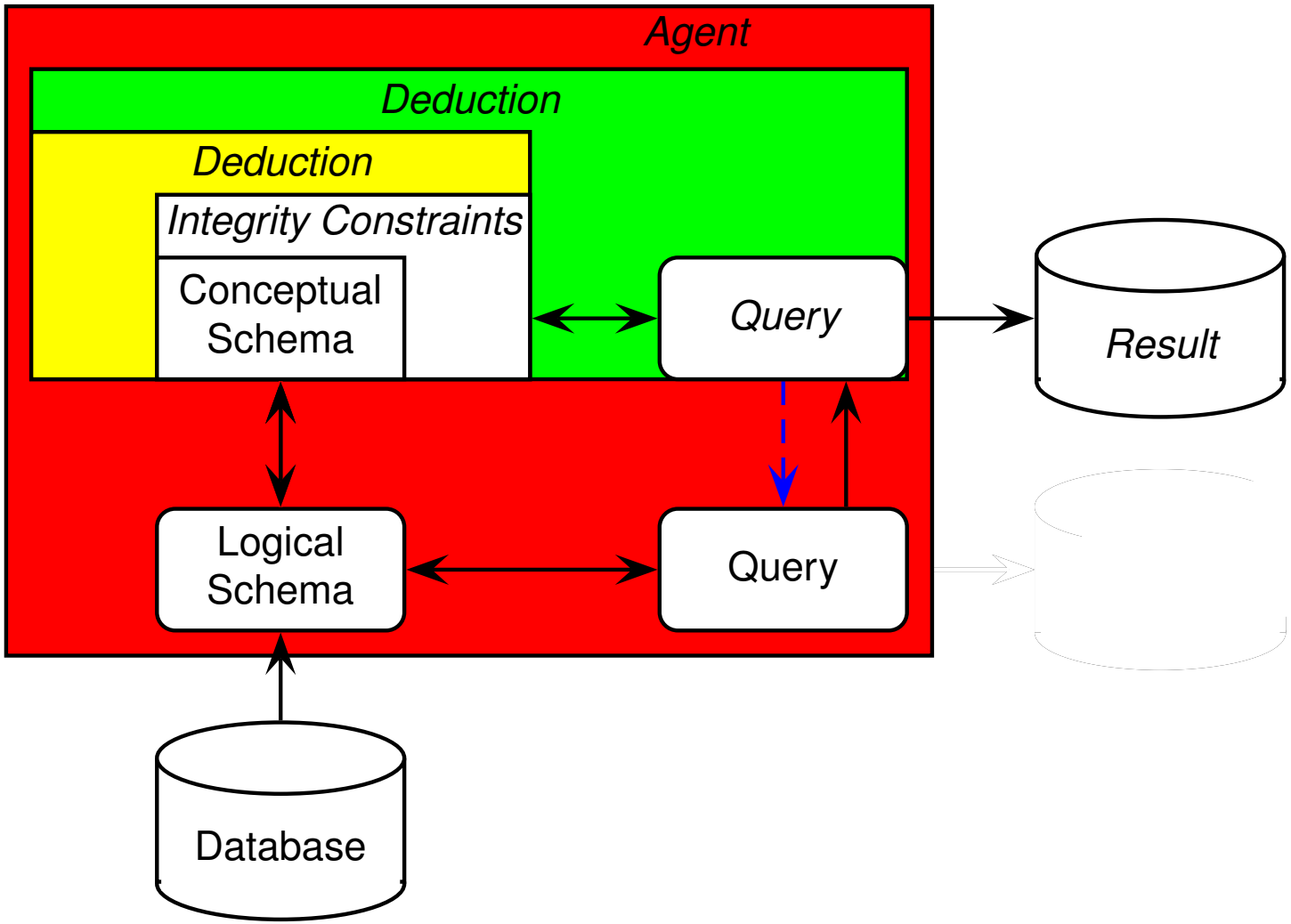

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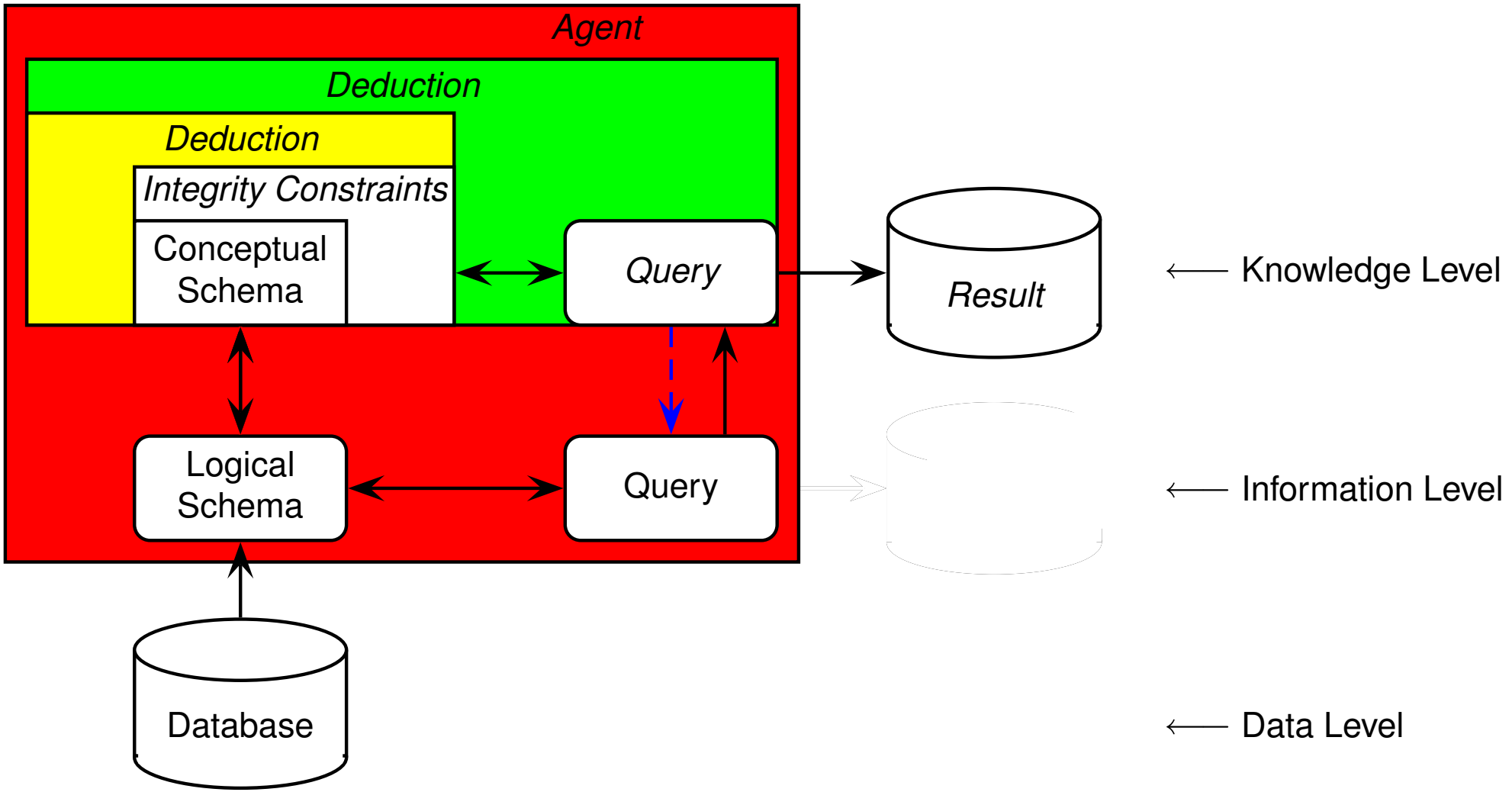
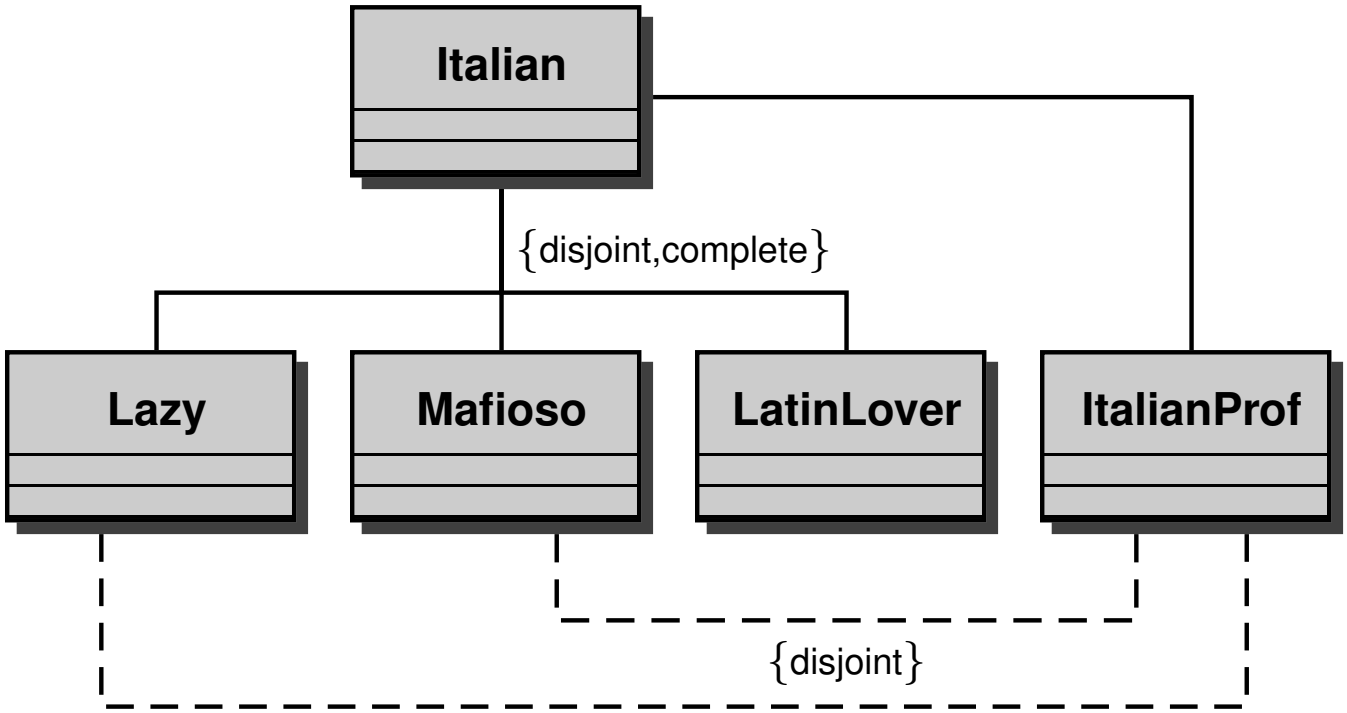


Reasoning at the Conceptual Level



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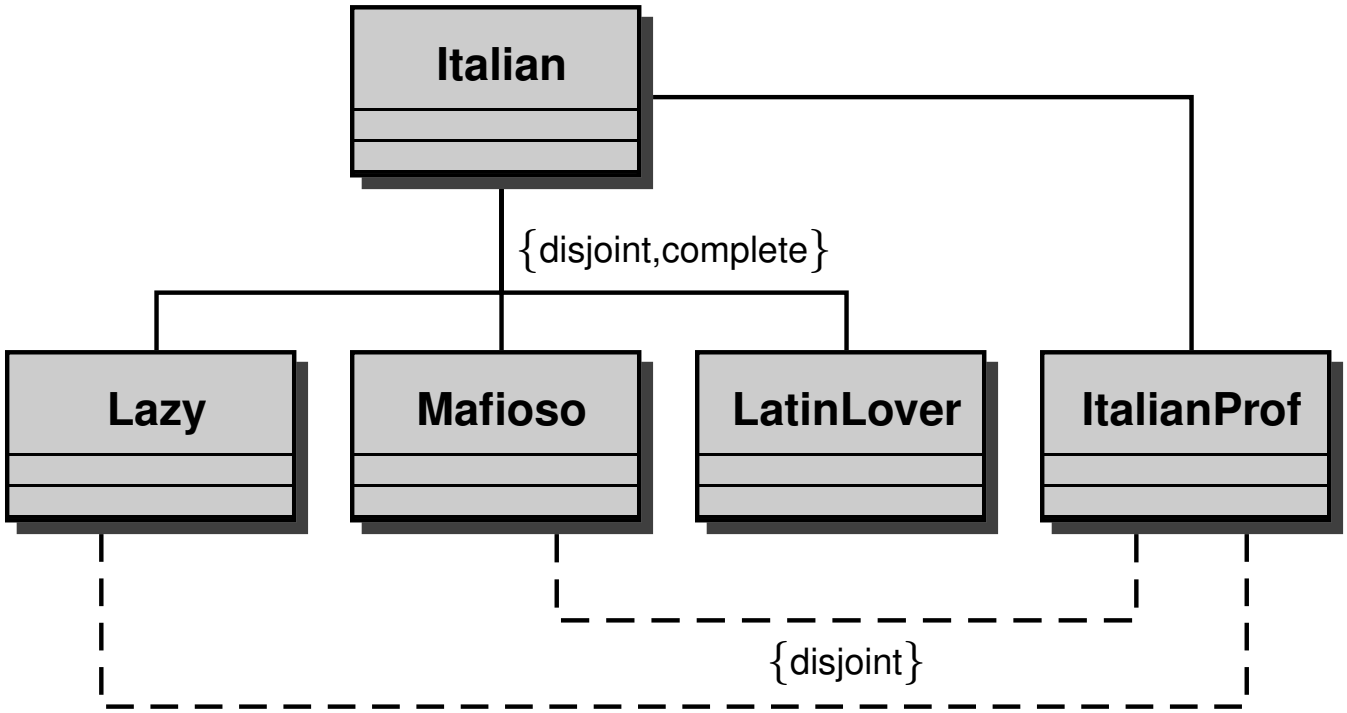


implies

ItalianProf $\Longrightarrow$ LatinLover

Processing Knowledge = “Reasoning”

Representation alone is not useful.

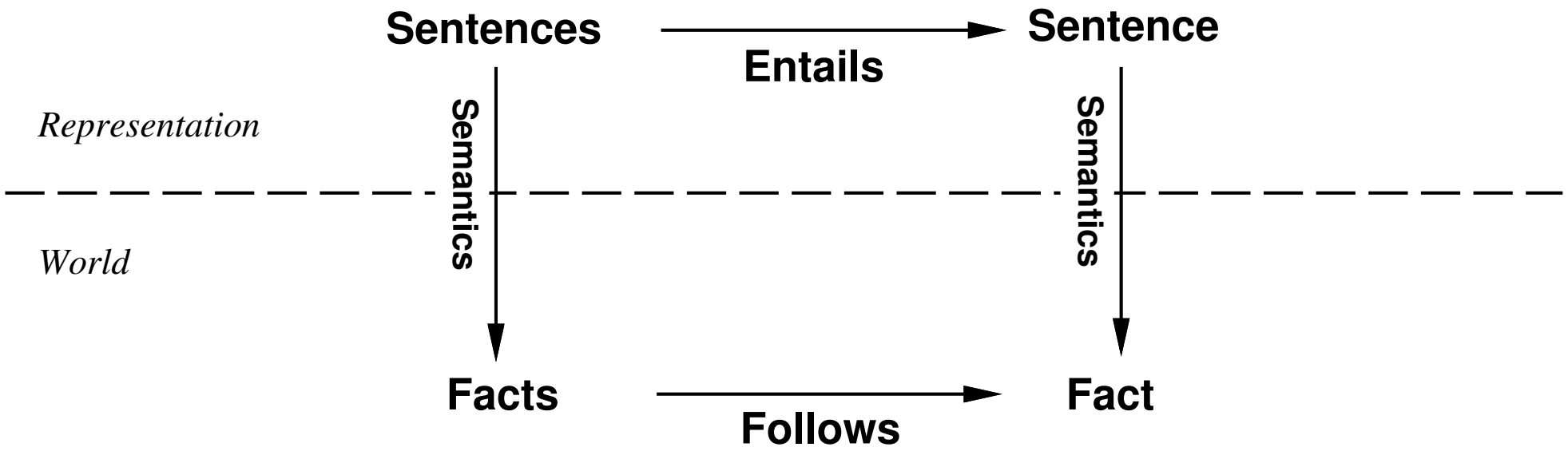
We want to be able to access represented knowledge and to *process* it.

- access alone is, in general, insufficient
- *implicit* knowledge has to be made explicit

$\rightsquigarrow$ *deduction methods*

- the results should only depend on the semantics . . .
- and not on accidental syntactic differences in representations

Logic



A logic allows the axiomatization of the domain information, and the drawing of conclusions from that information.

- Syntax
- Semantics
- Logical inference = *reasoning*

Important Questions

- **Expressive Power** of representation language

$\rightsquigarrow$ able to *represent* the problem

- **Correctness** of entailment procedure

$\rightsquigarrow$ *no false* conclusions are drawn

- **Completeness** of entailment procedure

$\rightsquigarrow$ *all correct* conclusions are drawn

- **Decidability** of entailment problem

$\rightsquigarrow$ there exists a (terminating) algorithm to compute entailment

- **Complexity**

$\rightsquigarrow$ resources needed for computing the solution

What is a Logic

Clearly distinguish the definitions of:

- the *formal language*
  - Syntax
  - Semantics
  - Expressive Power
- the *reasoning problem* (e.g., entailment)
  - Decidability
  - Computational Complexity
- the *problem solving procedure*
  - Soundness and Completeness
  - (Asymptotic) Complexity

The ideal Logic

- Expressive
- With decidable reasoning problems
- With sound and complete reasoning procedures
- With efficient reasoning procedures – possibly sub-optimal

Goals of research in the field

- Study how **declarative knowledge** can be *formally defined* using a logic-based approach.
- Give a *computational* account to it, in order to reproduce it in a computing device.

Main topics of the course

- review of Classical Logic
- Structural Description Logics
- Propositional Description Logics
- Description Logics and Logics
- Description Logics and Databases

Conclusions

- A warning
  - Rigorous and formal course

Conclusions

- A warning
  - Rigorous and formal course
- Two promises
  - Many examples
  - Only few main important topics