Situation Theory and the Situation-Theoretic Approach to Information

PART 1: OVERVIEW

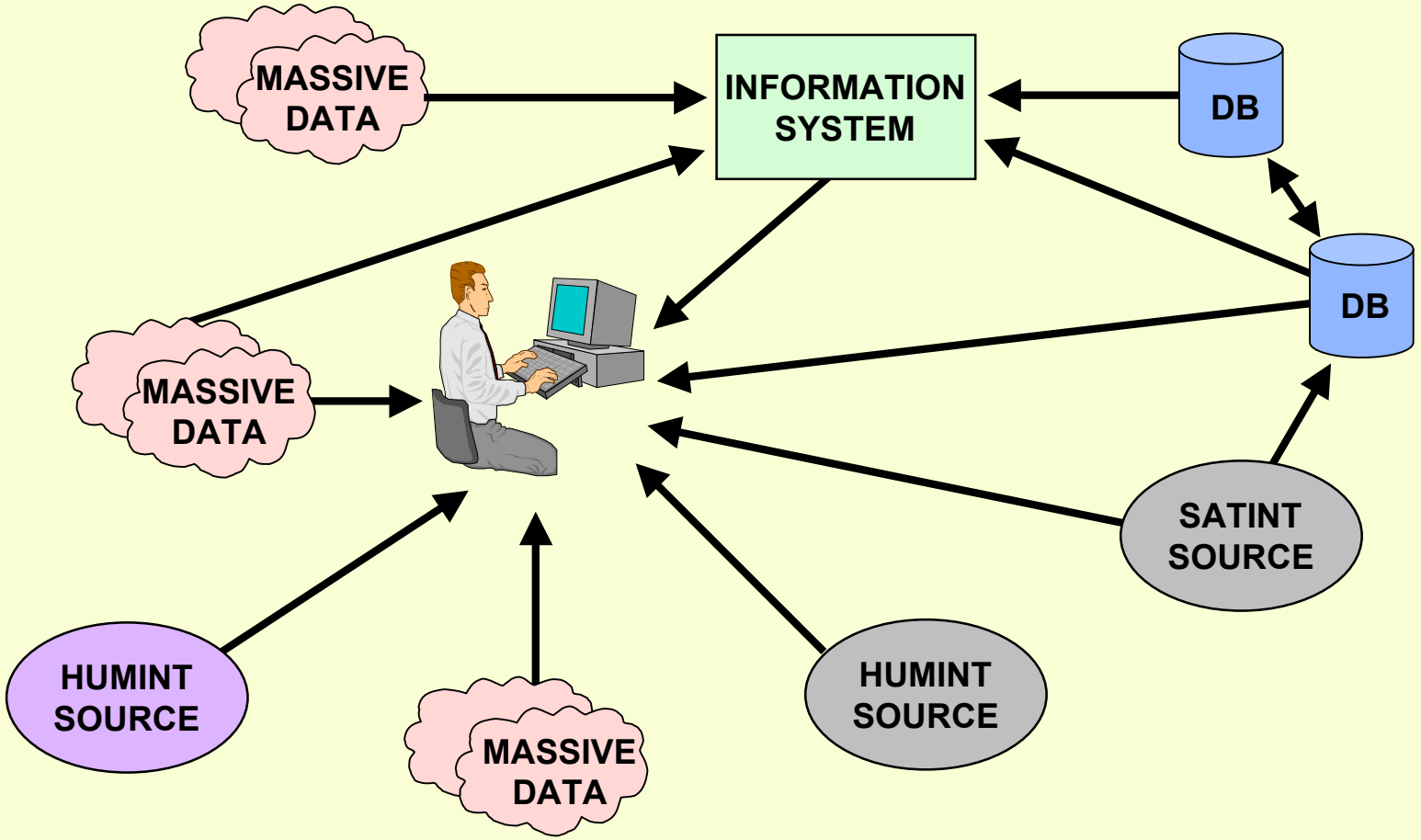
Keith Devlin

Stanford University

Situation Theory 2000

Not a theory of information; rather a framework for describing, analyzing, and understanding information flow.

Defense Intelligence Analysis



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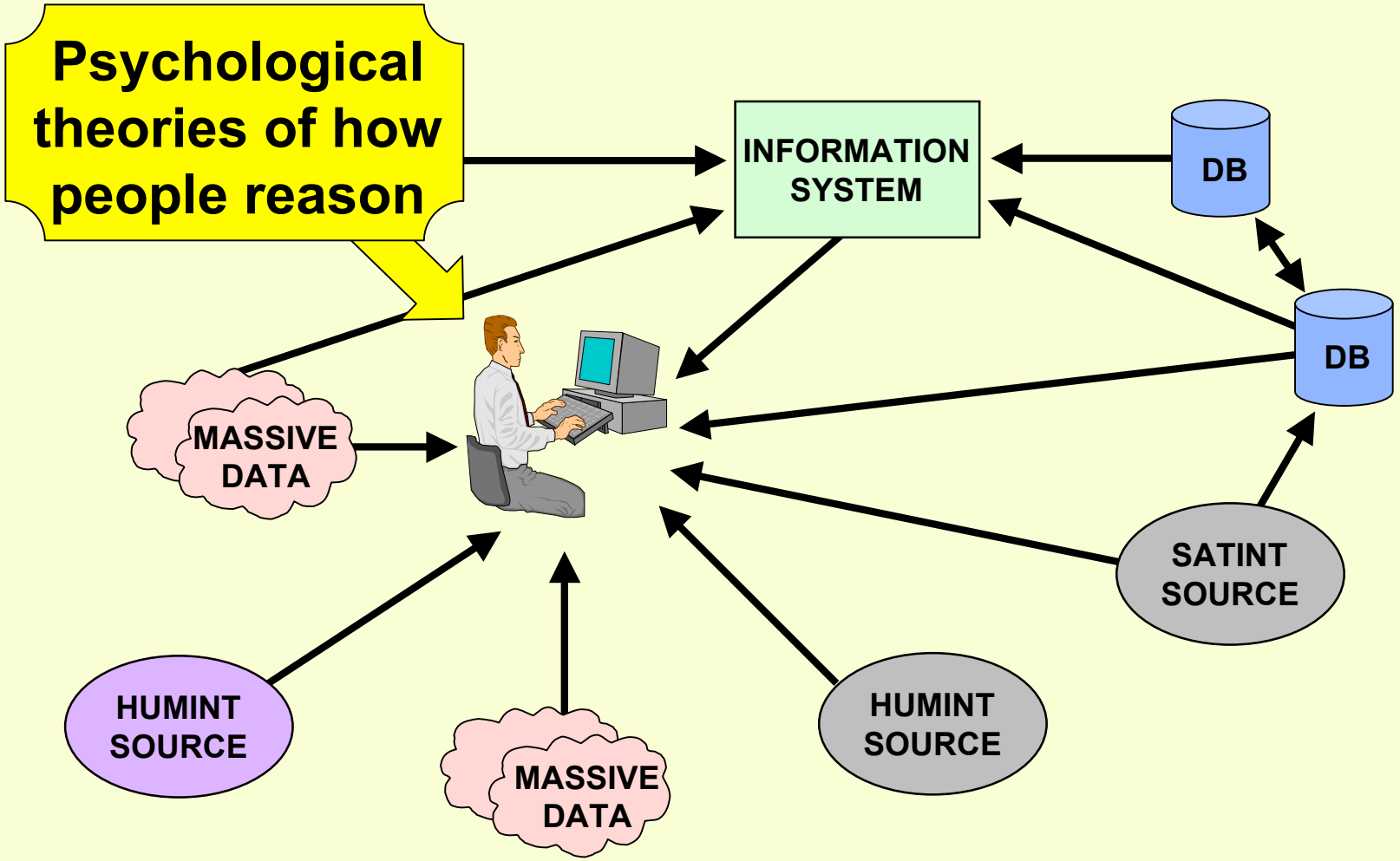

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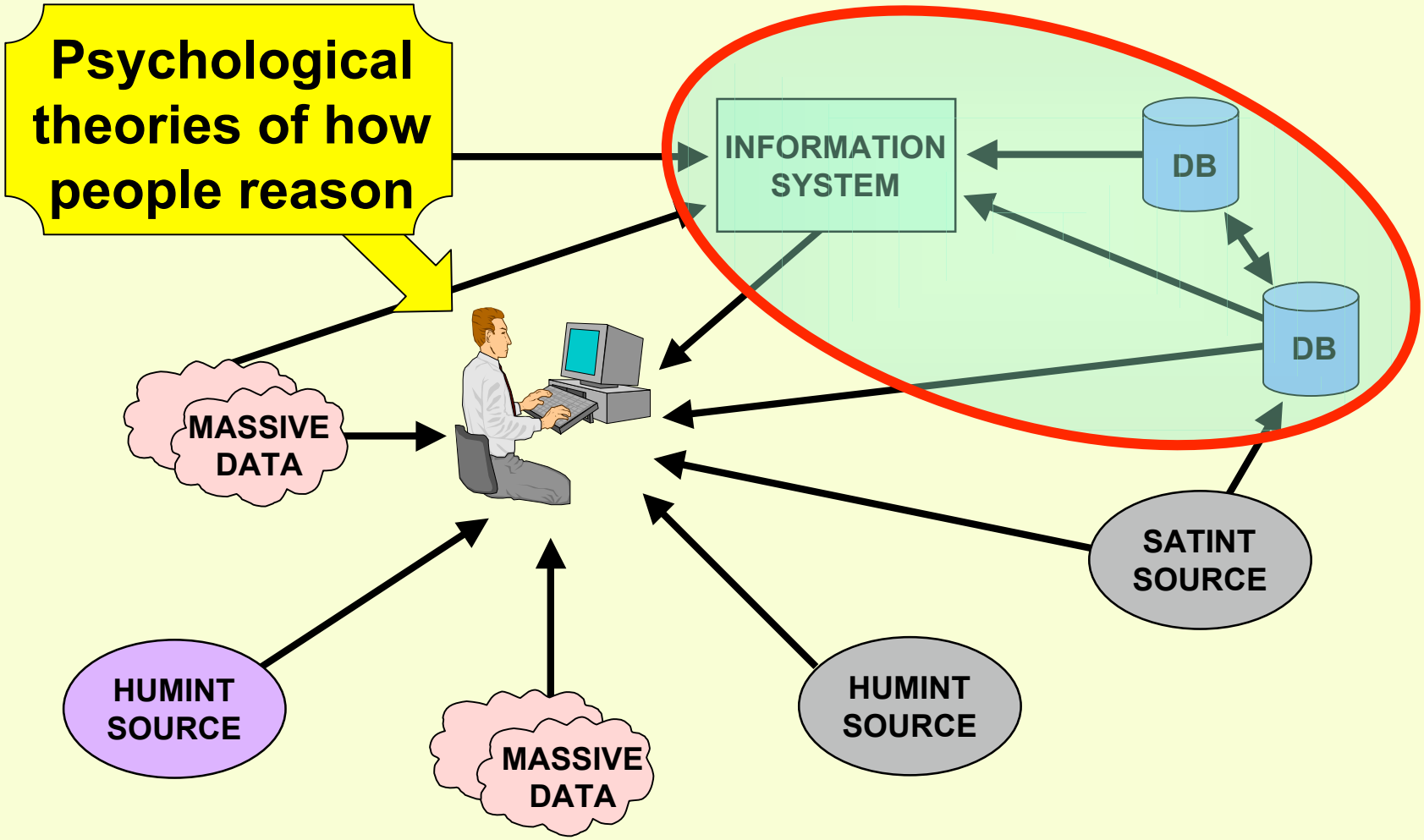

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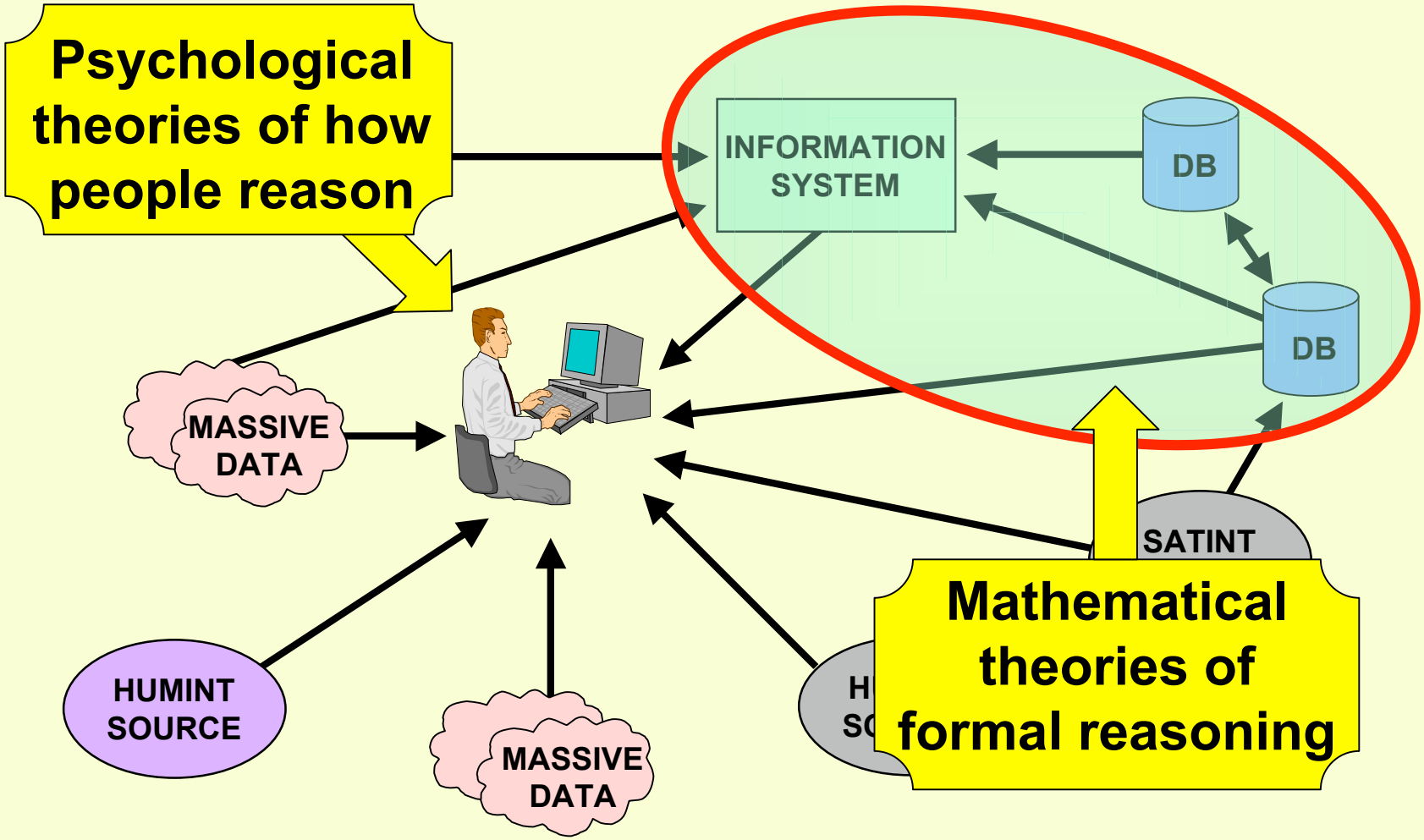

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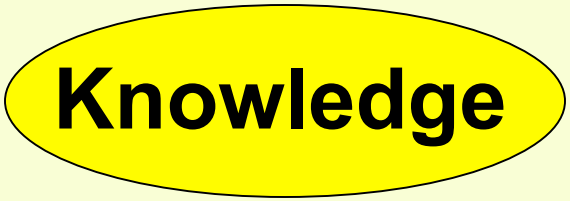

What is information?

Knowledge

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Data

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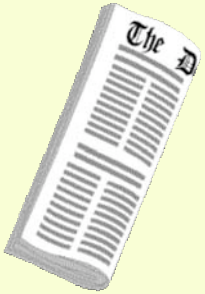

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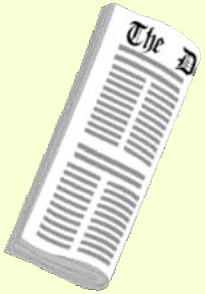

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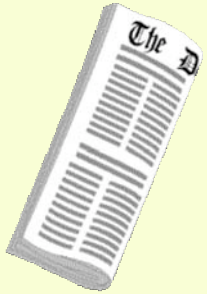

What is information?

MAKE AVAILABLE

+ MEANING

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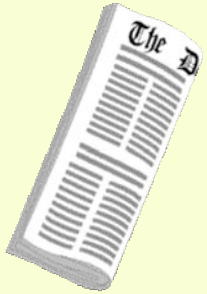

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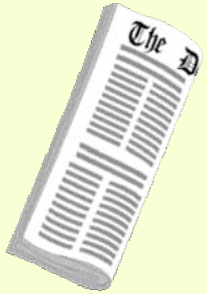

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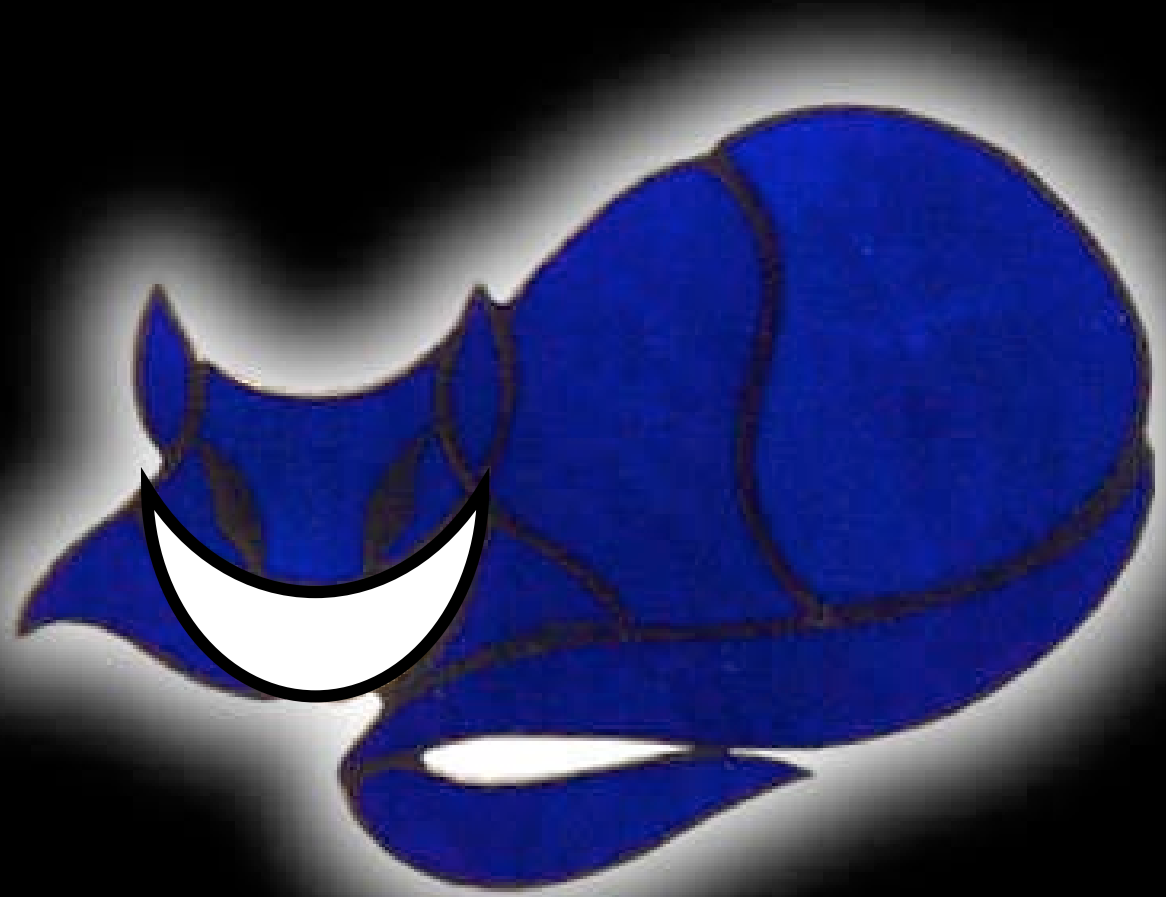

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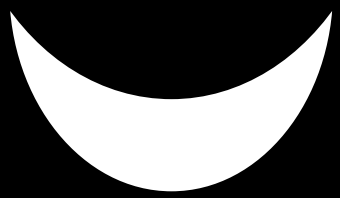

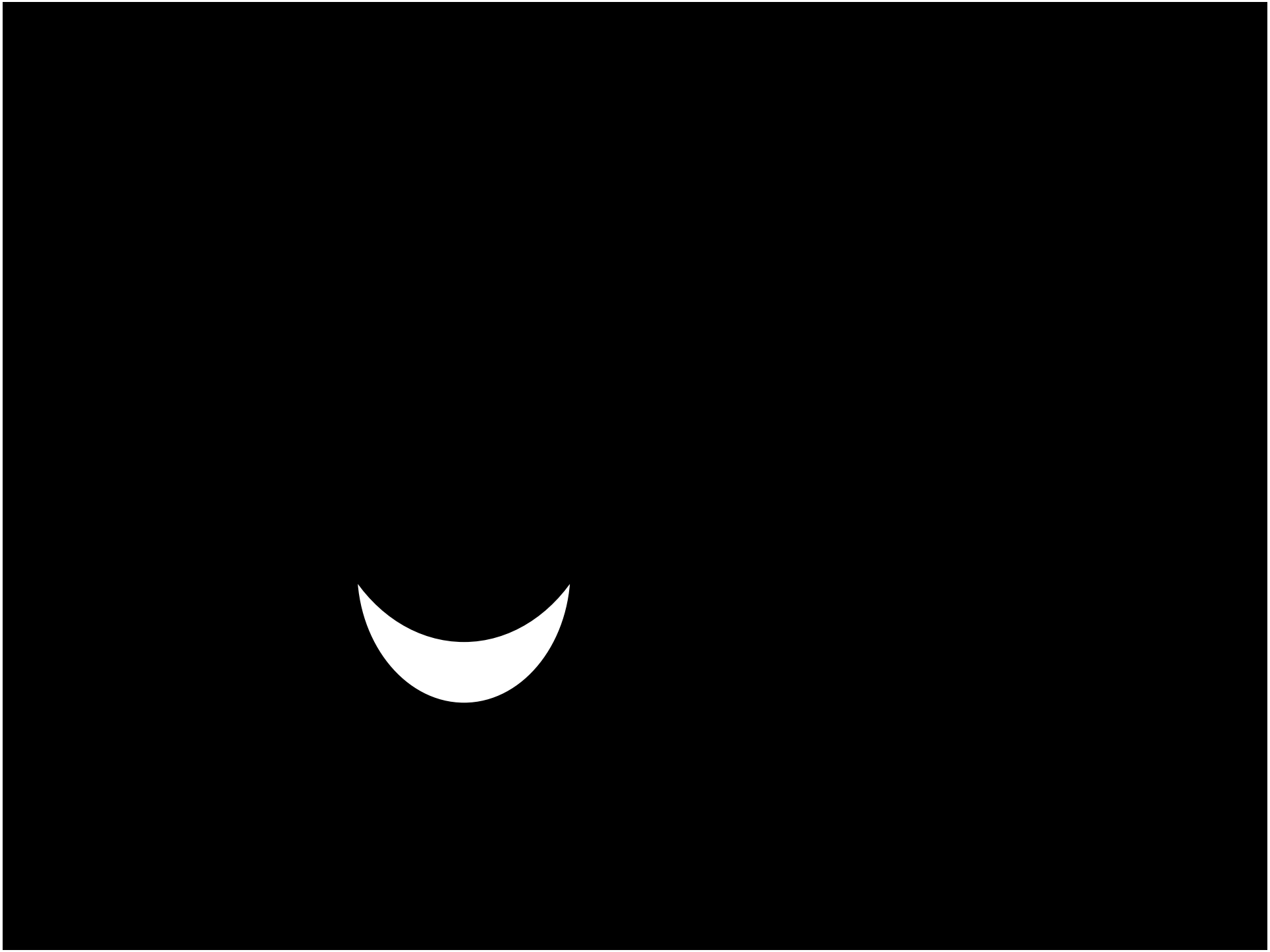

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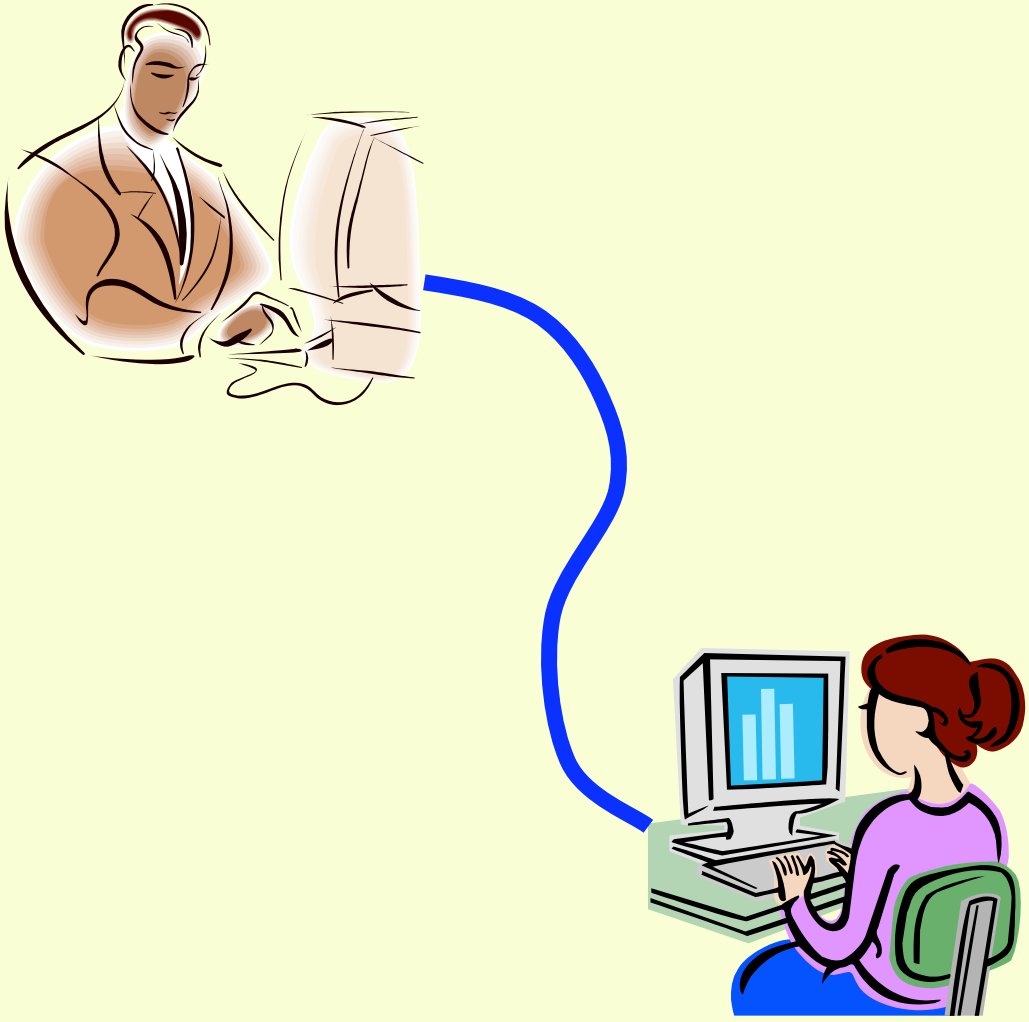

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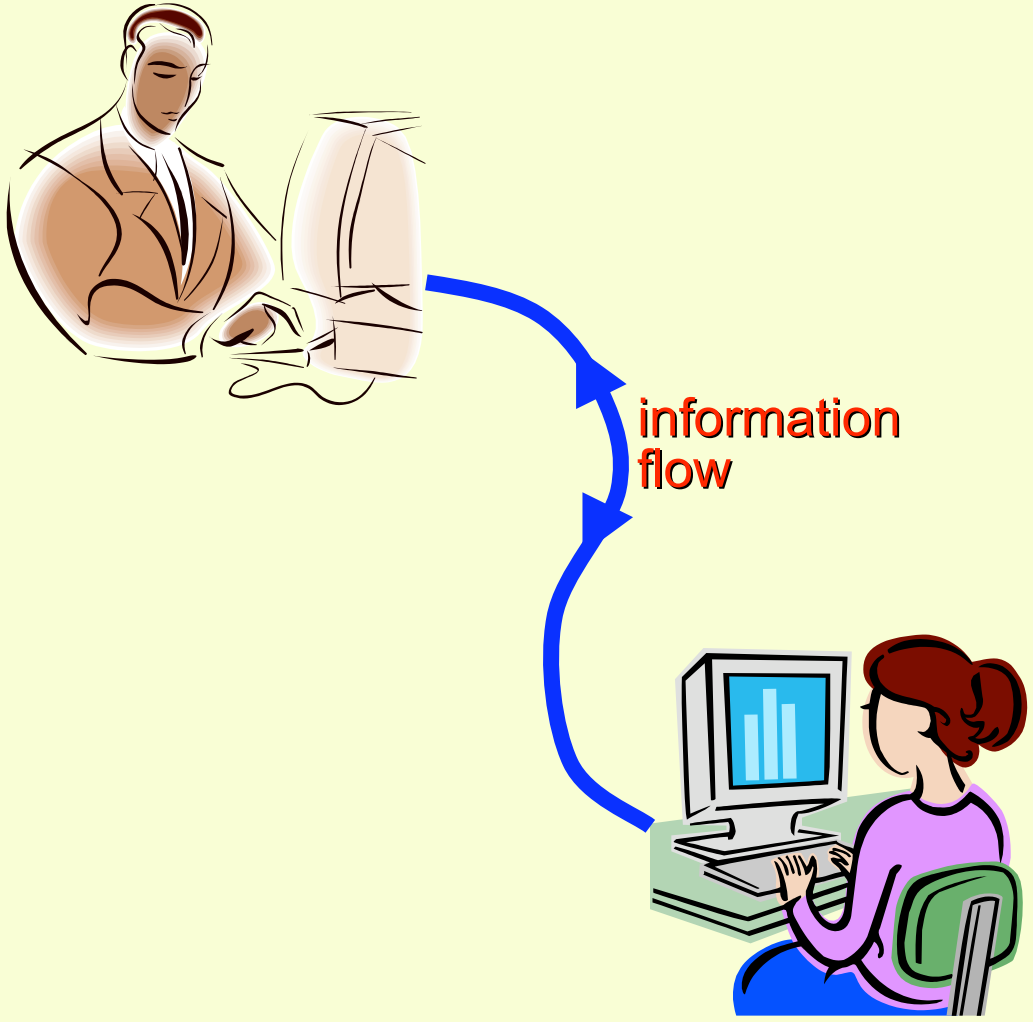
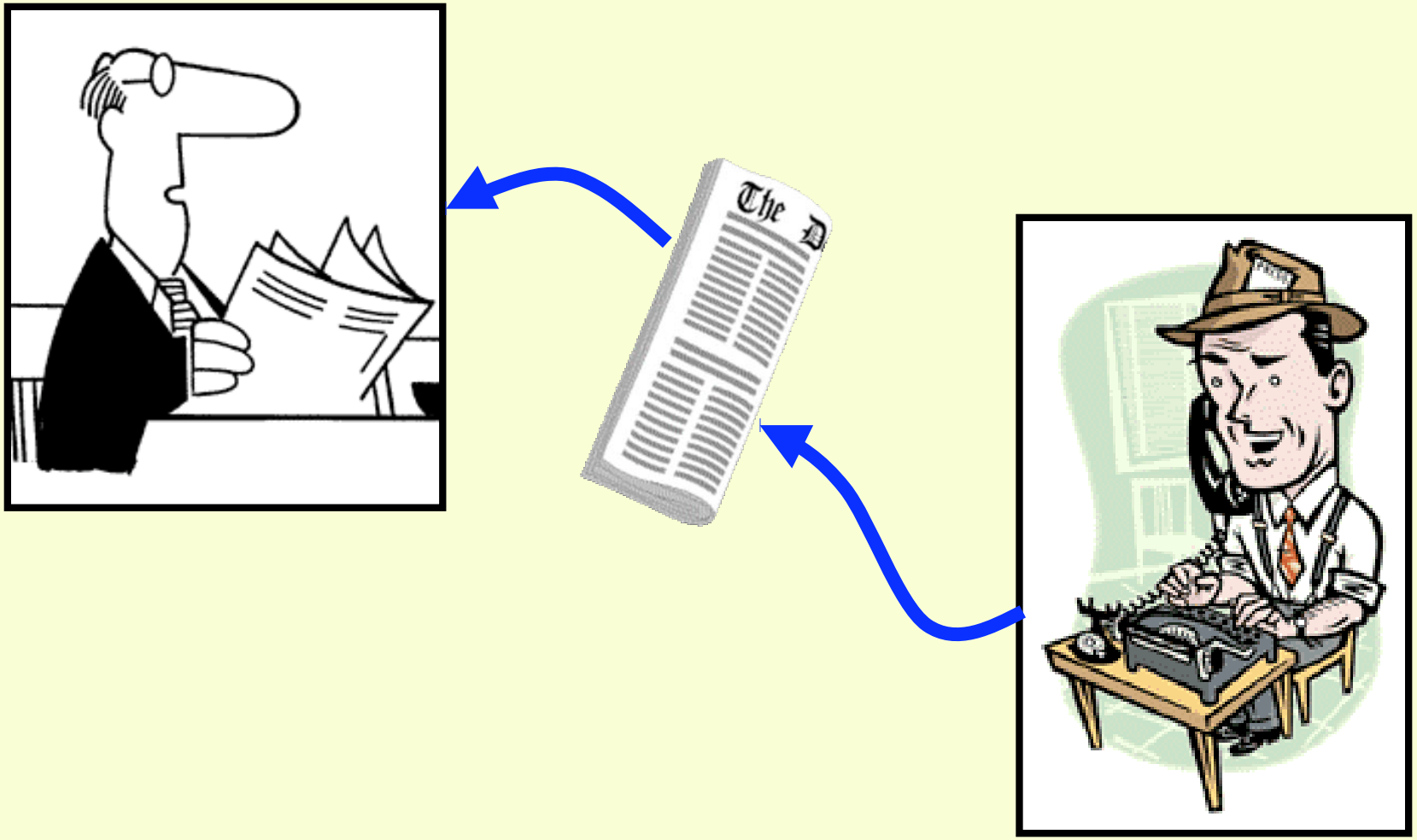


Information flow: people communicating across space and/or time



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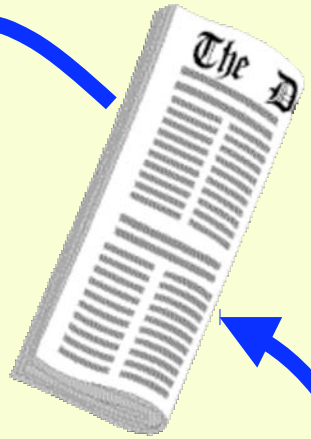

producing information

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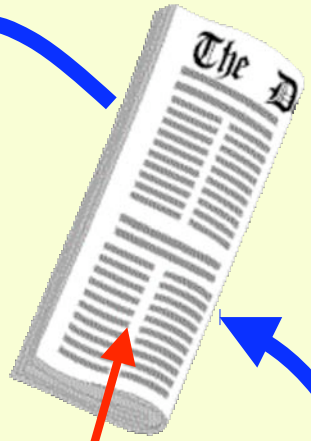
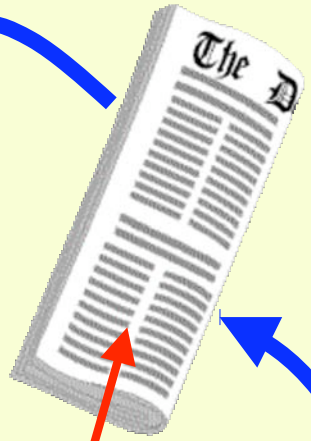


producing information

information storage

Information flow: people communicating across space and/or time

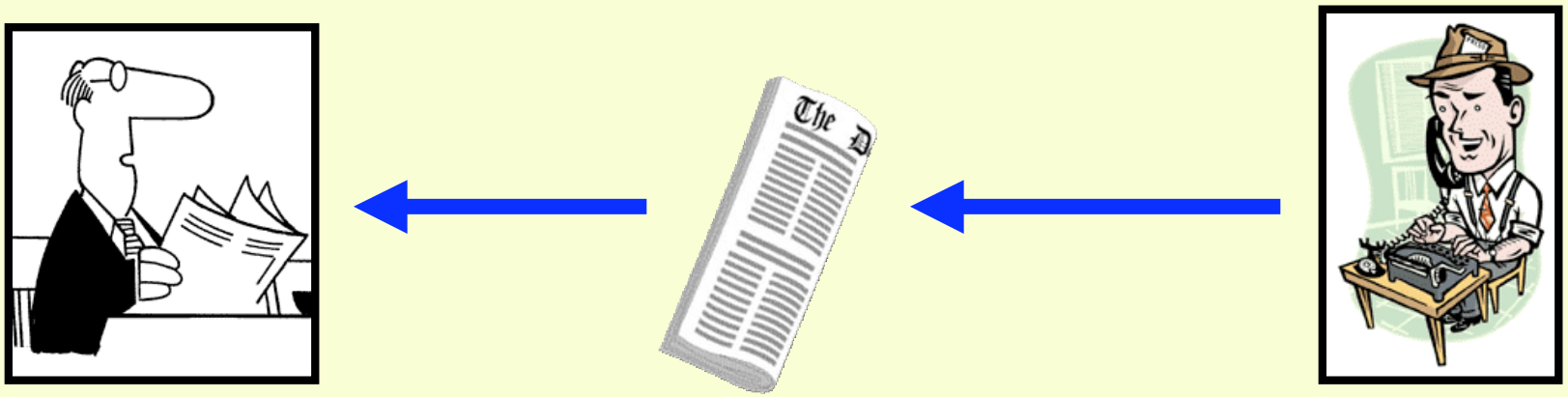
acquiring information



information storage

producing information

Why do we feel we need information?



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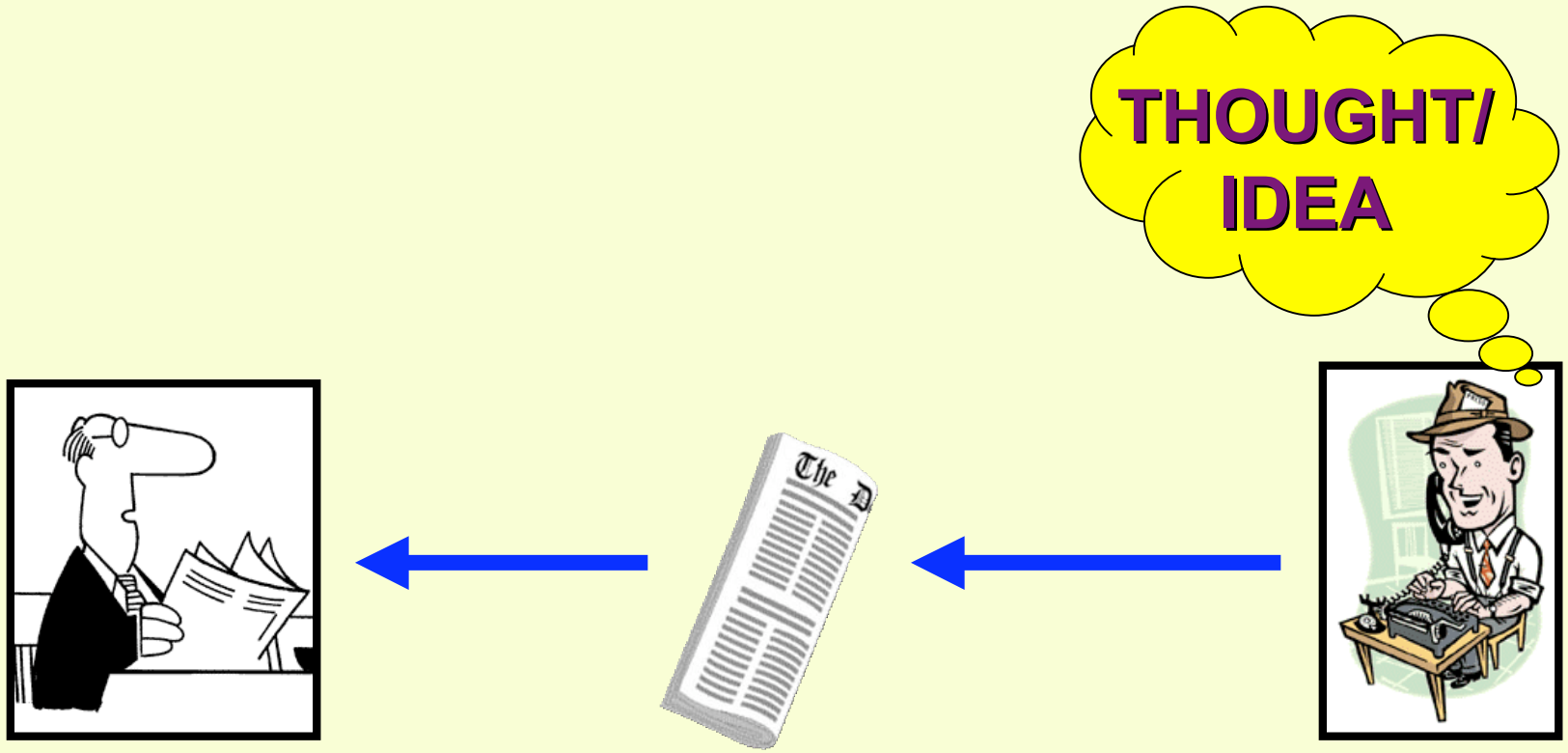

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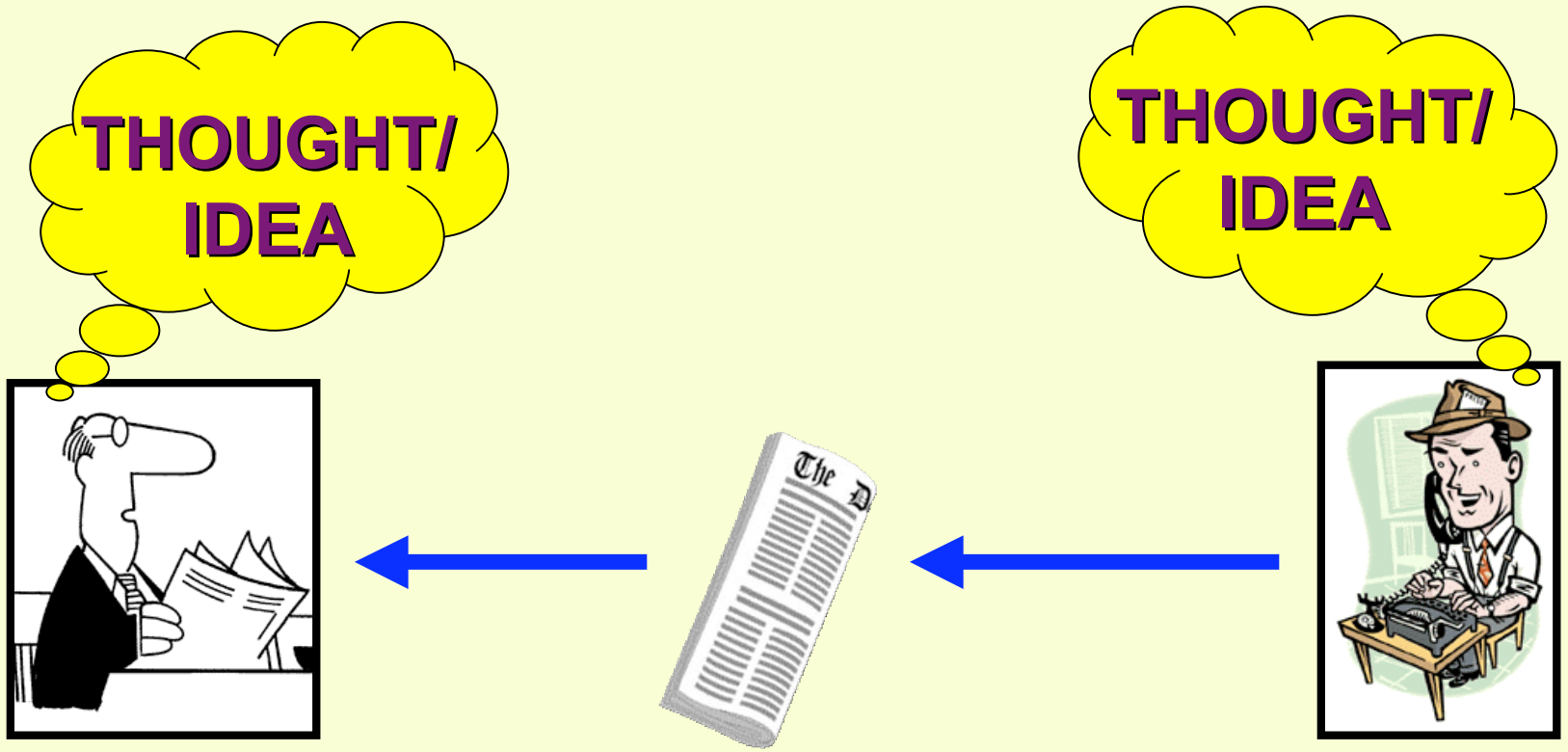

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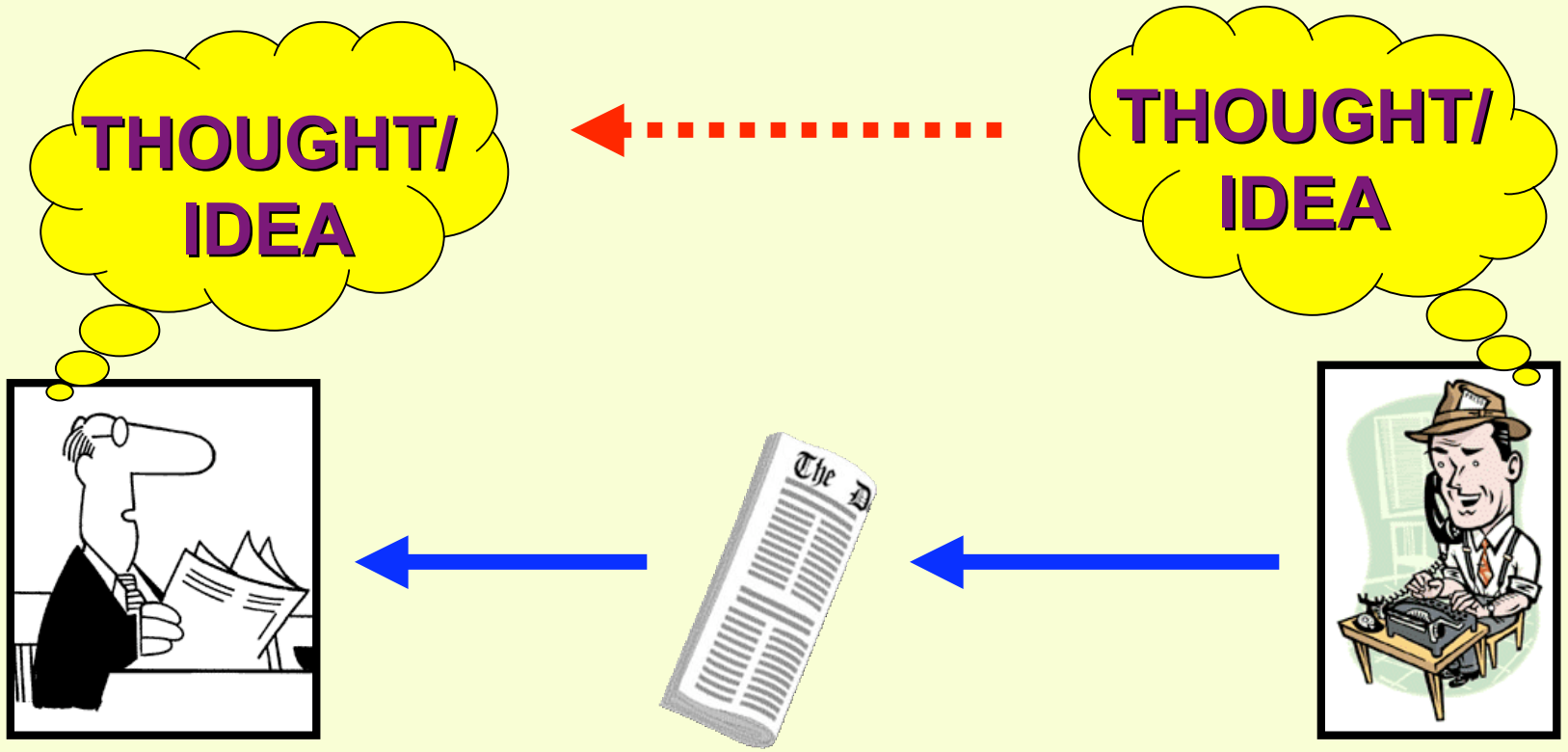

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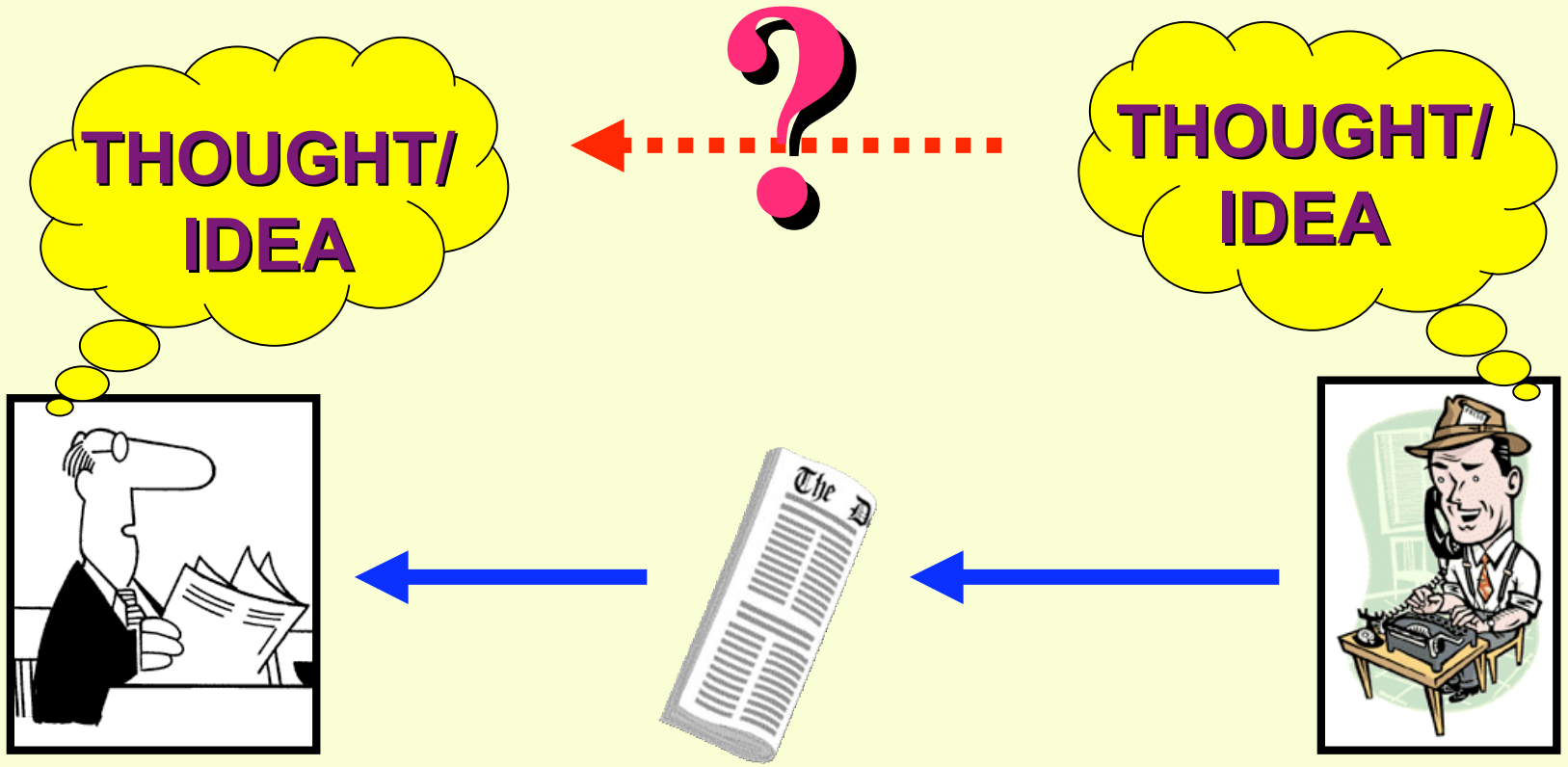

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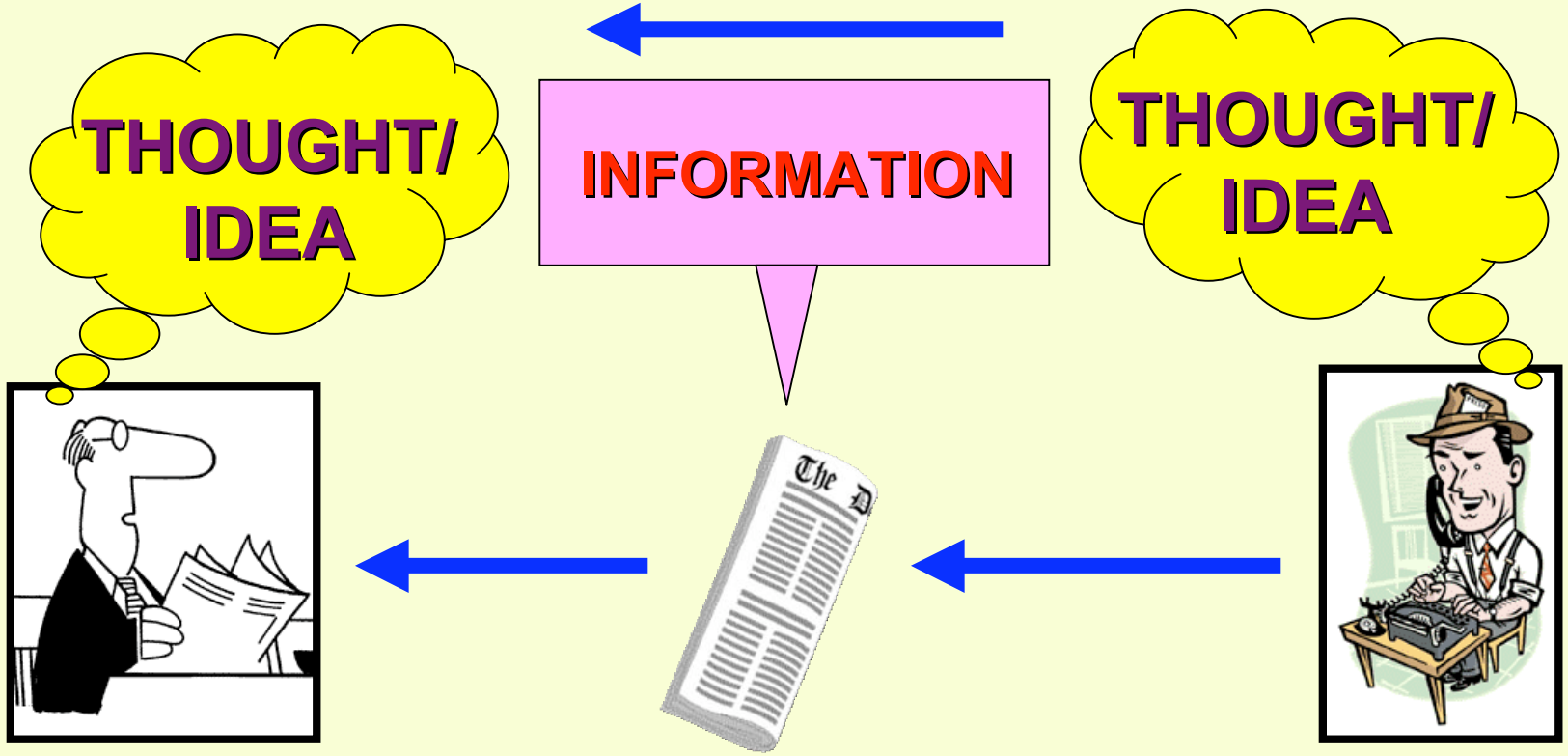

But . . .

there is a problem.

What is the information in a message?

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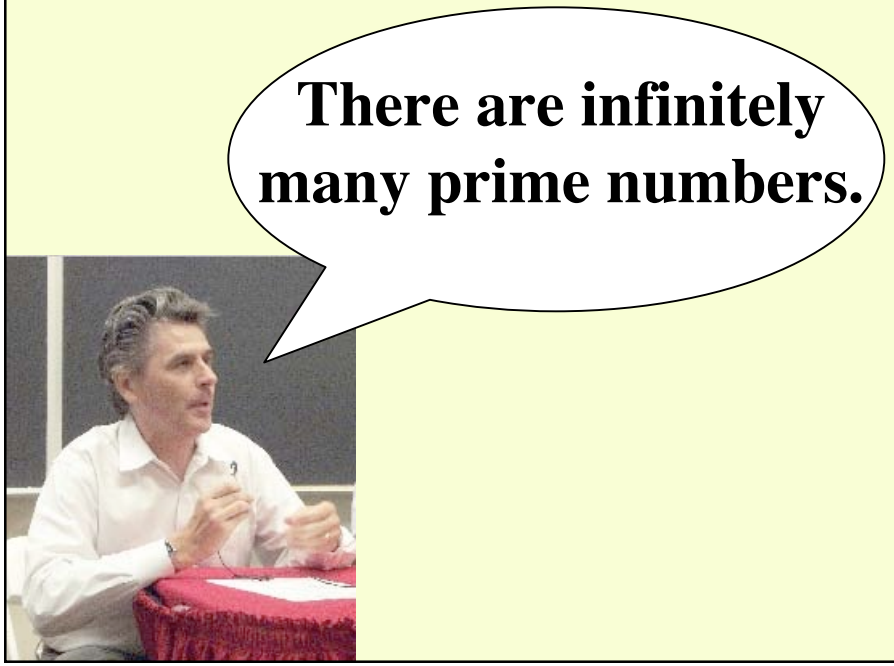
What information does my utterance convey?

What is the information in a message?



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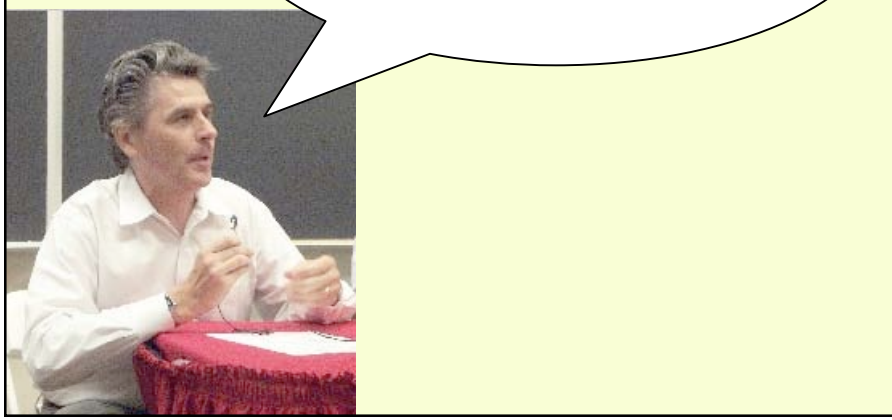
A mathematical fact.



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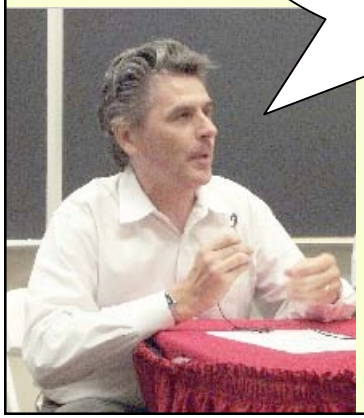

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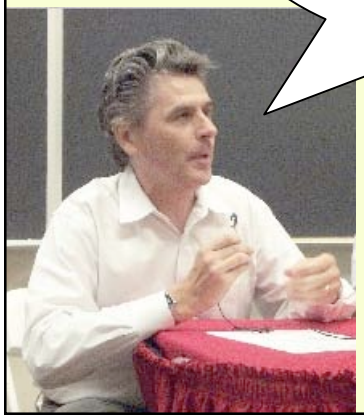

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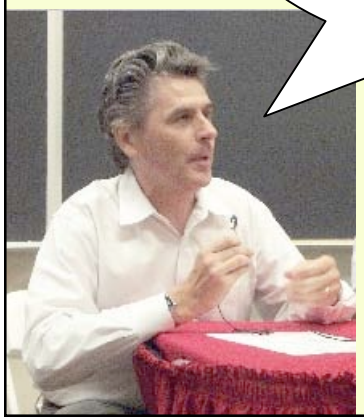

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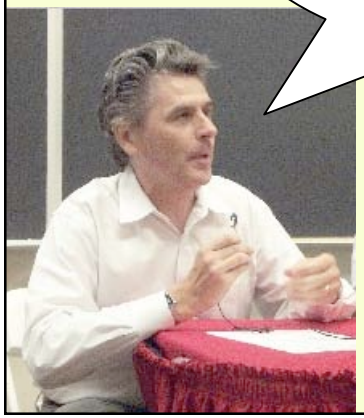

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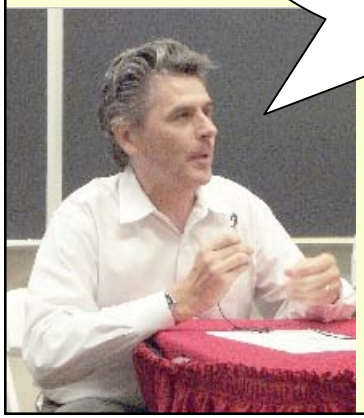

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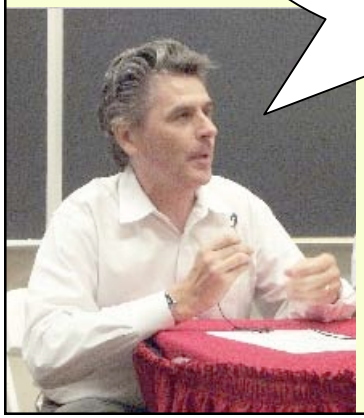

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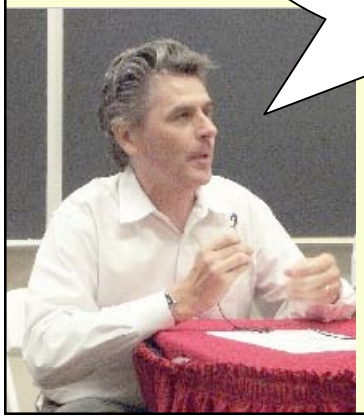

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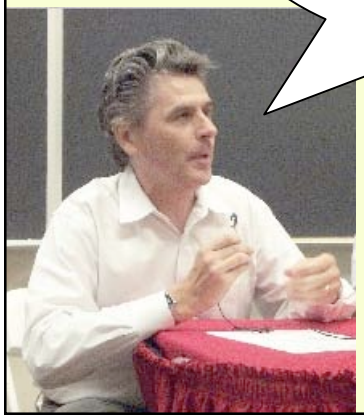

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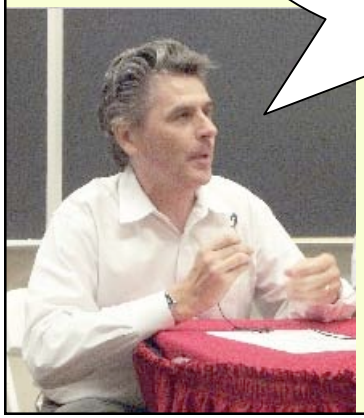

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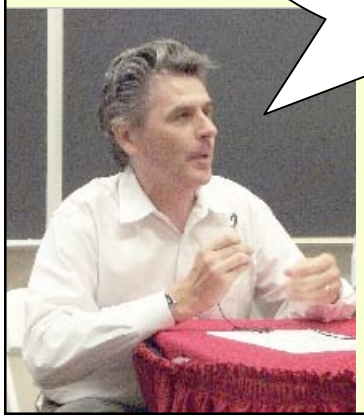

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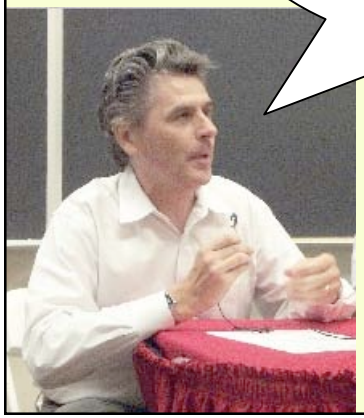

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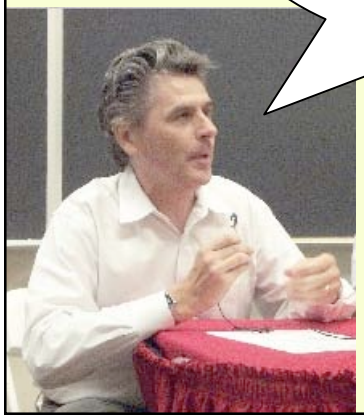

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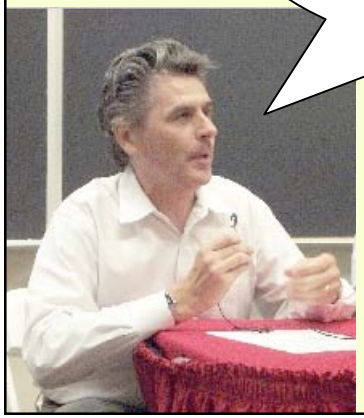

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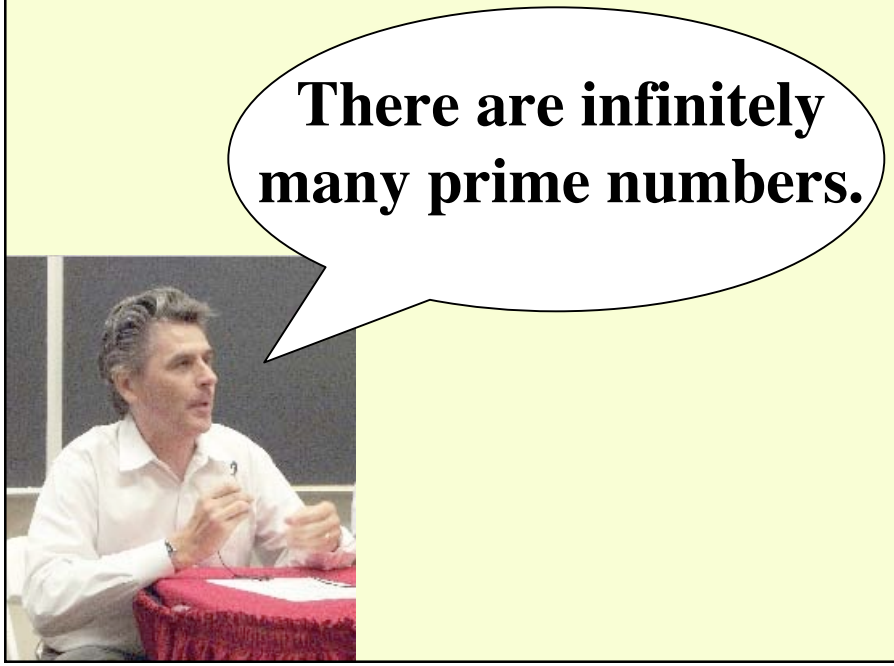

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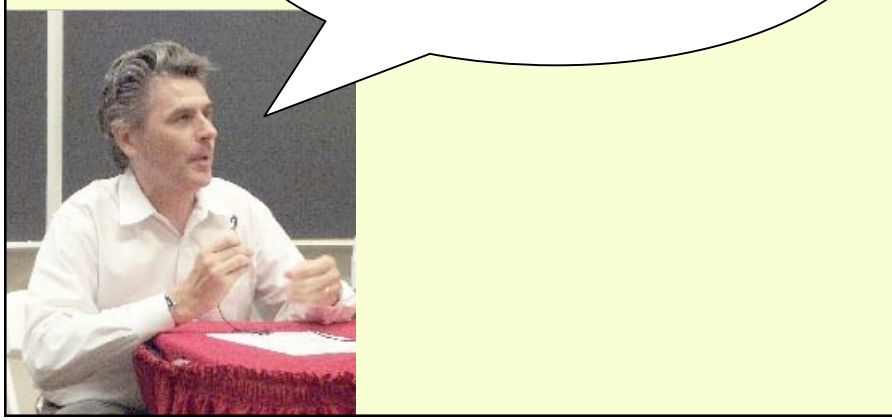
No single unique answer.



What is the information in a message?

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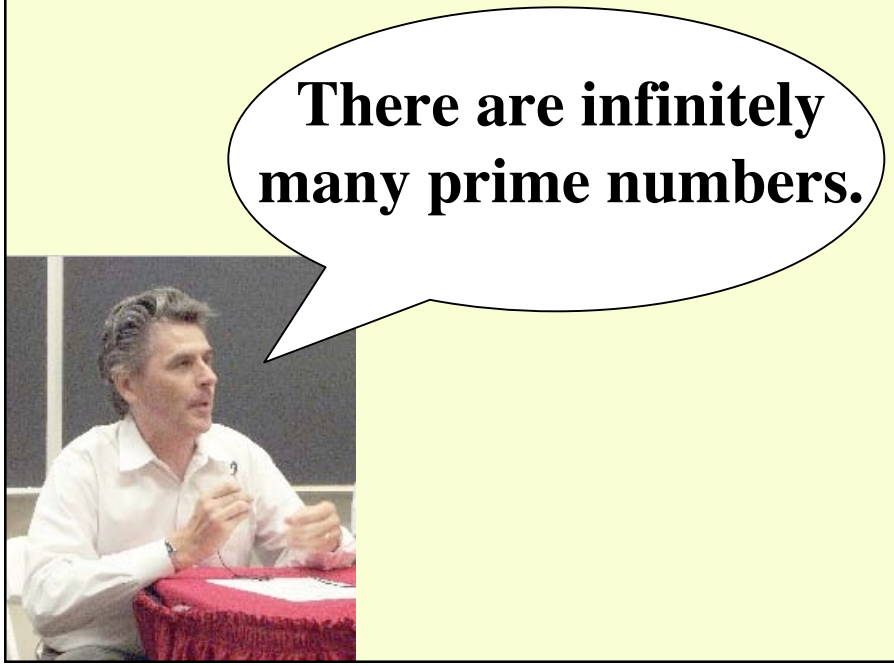
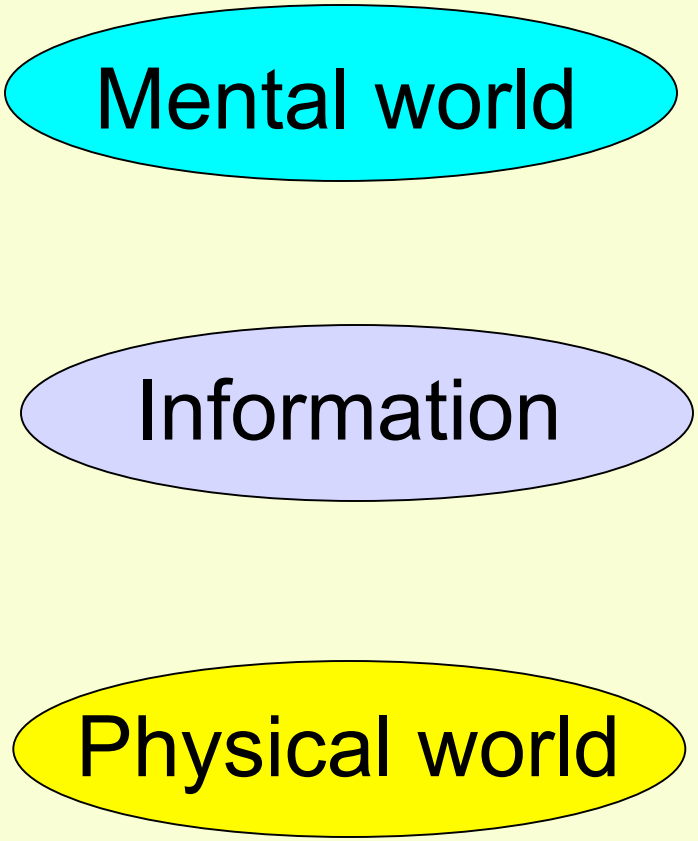


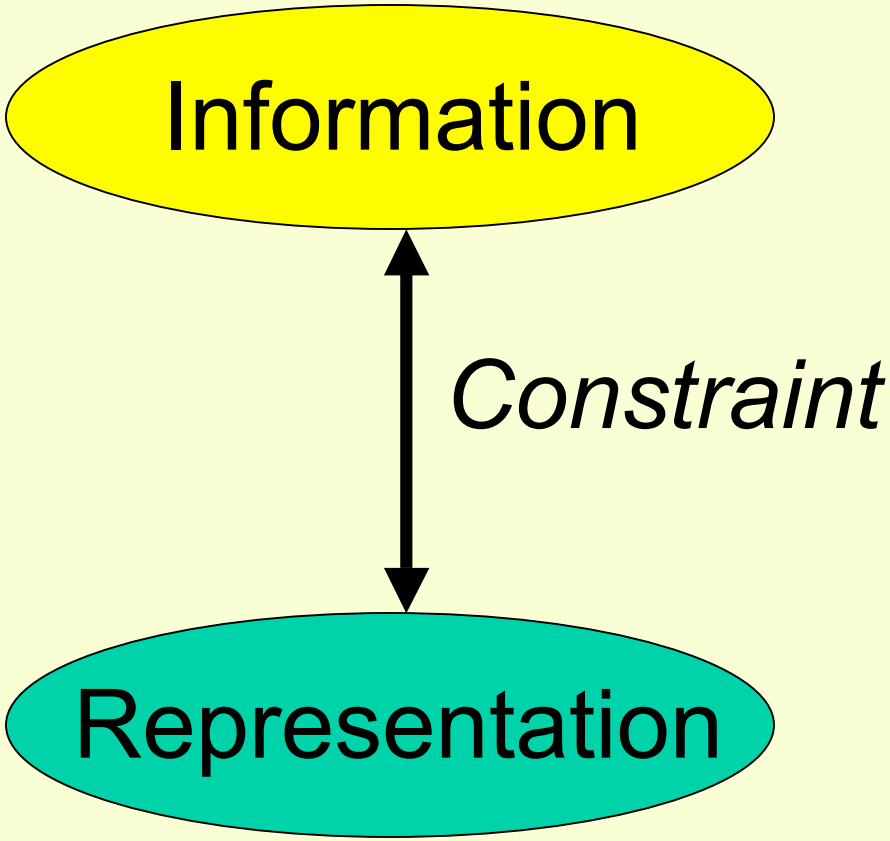
A lot depends on the recipient and his/her circumstances.

How does information arise?

The information level



The representation of information



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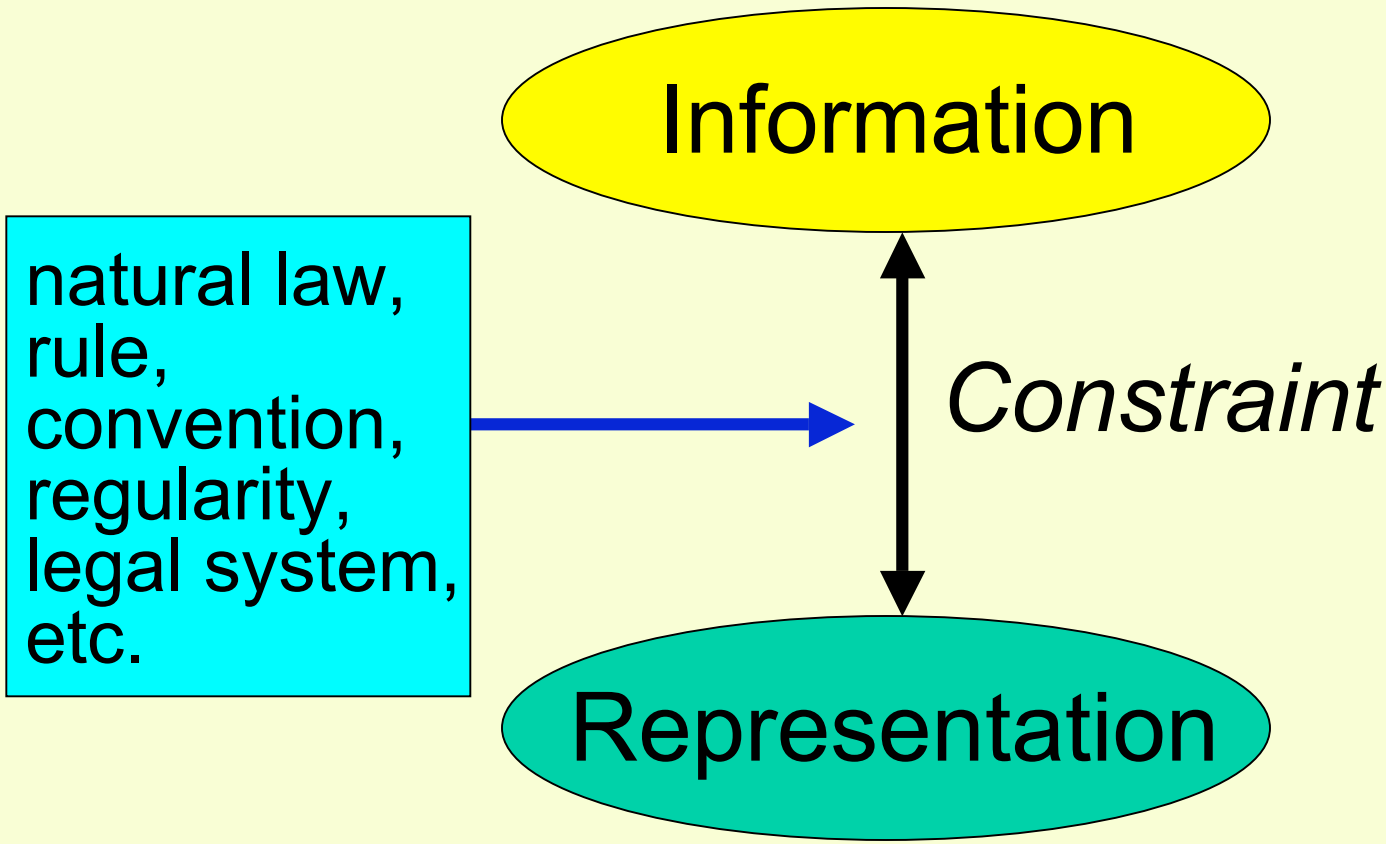

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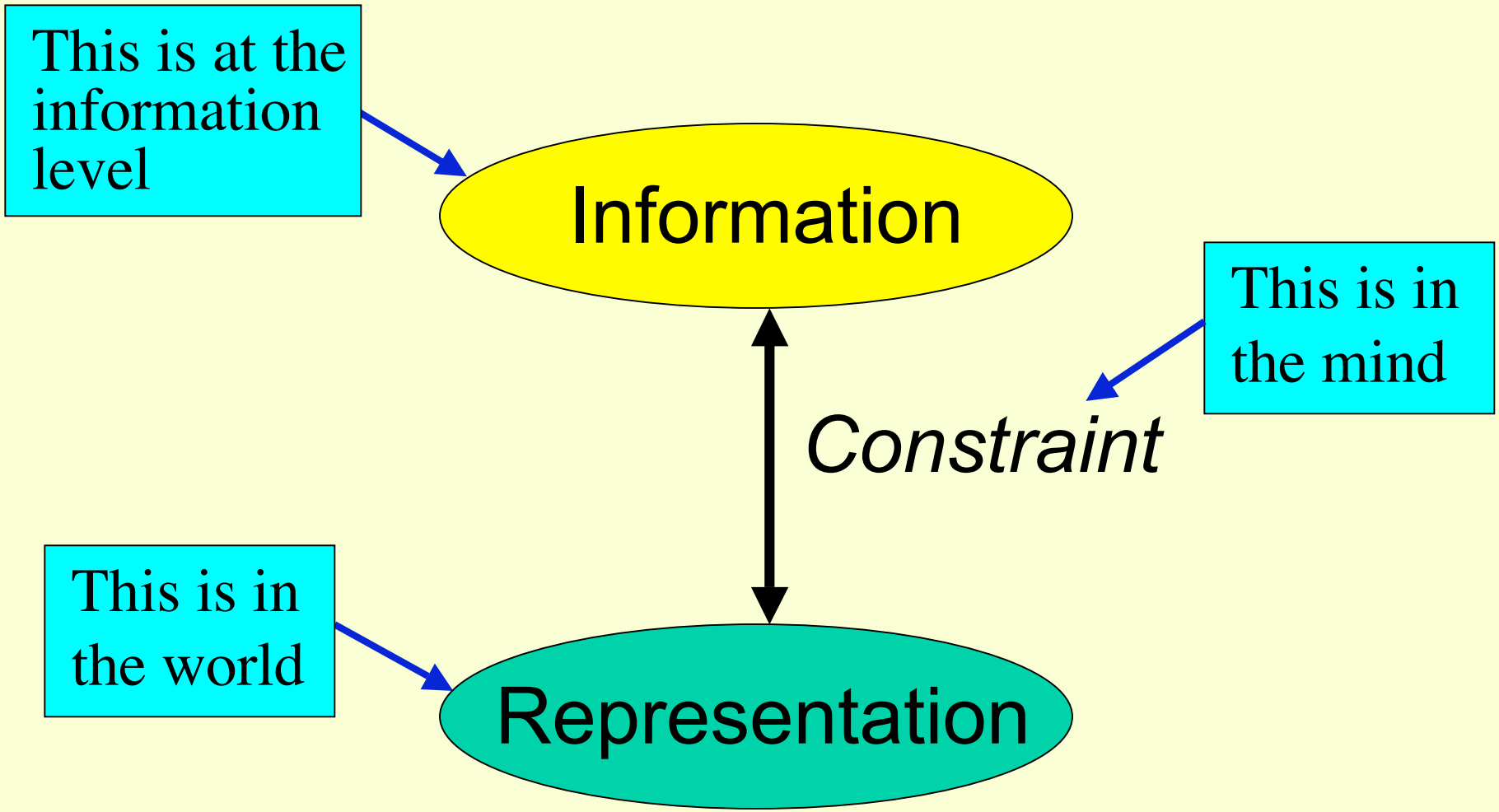

Task

We have to develop a framework to analyze the way signals encode (represent) information.

Situation theory

In the early 1980s, Jon Barwise and John Perry introduced a new mathematical theory — situation theory — to support an analysis of the way things in the world can represent and convey information.

Situation theory

- Basic framework (ontology) consists of: individuals, relations, situations, types, infons.
- Individuals are unanalyzed.
- Relations are complex, structured objects, and are not identified with sets of *n*-tuples.
- Situations are limited parts of the world; it may often be impossible to specify them extensionally.
- Cognitive agents use types to classify the world.
- Infons are items of information.

Infons

$$\sigma = \langle\!\langle R, a_1, \ldots, a_n, i \rangle\!\rangle$$

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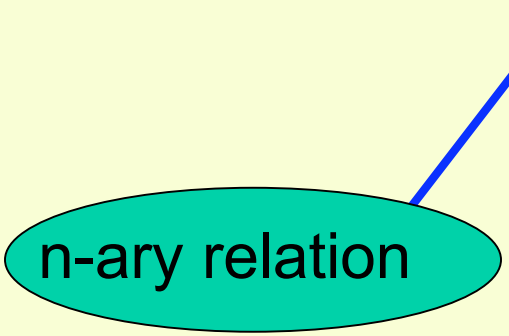

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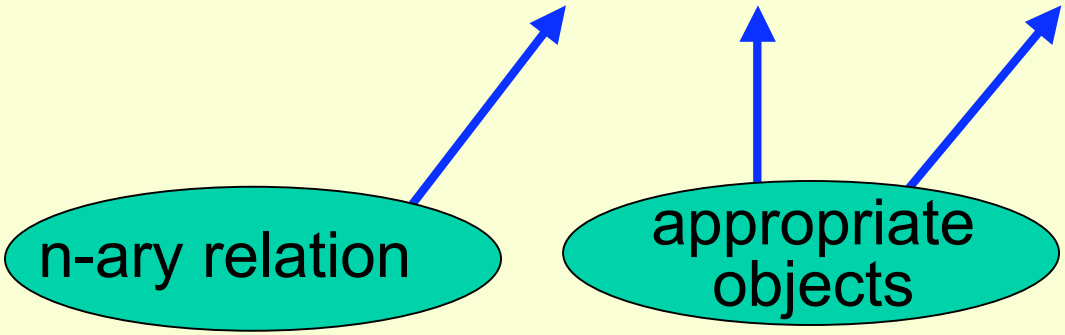

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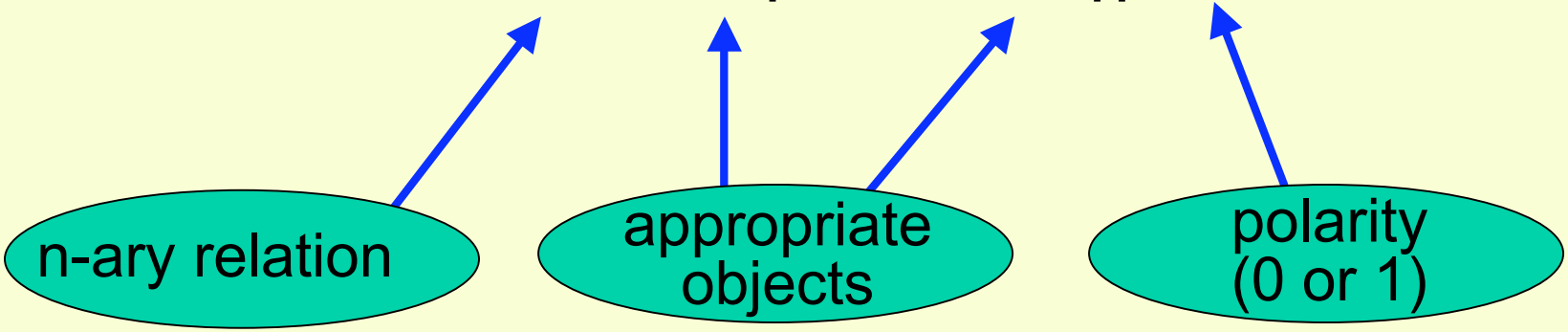

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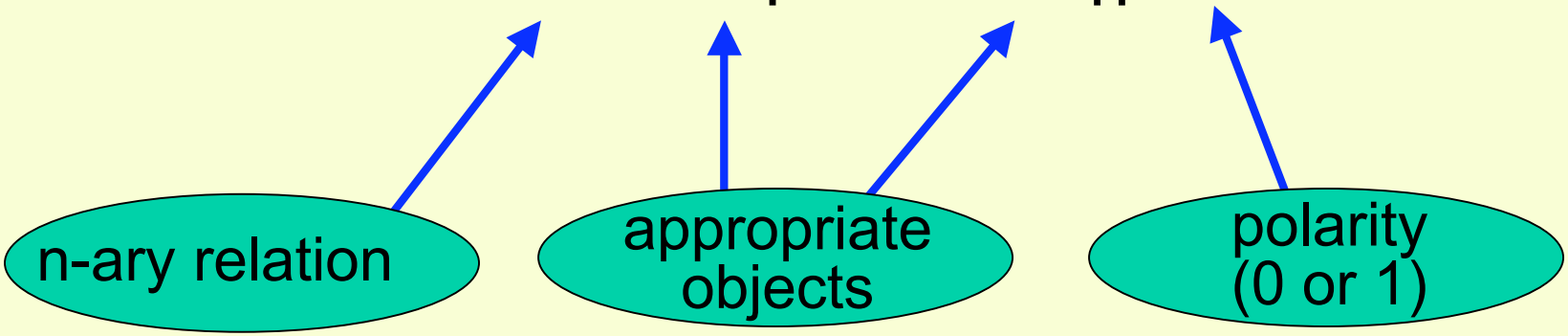

Infons may be combined using AND, OR, and situation-bounded quantification.

Situation Theory

- Classification (entities can be typed):

$$s : T$$

Situation Theory

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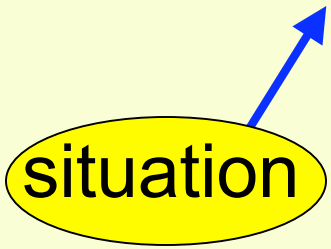

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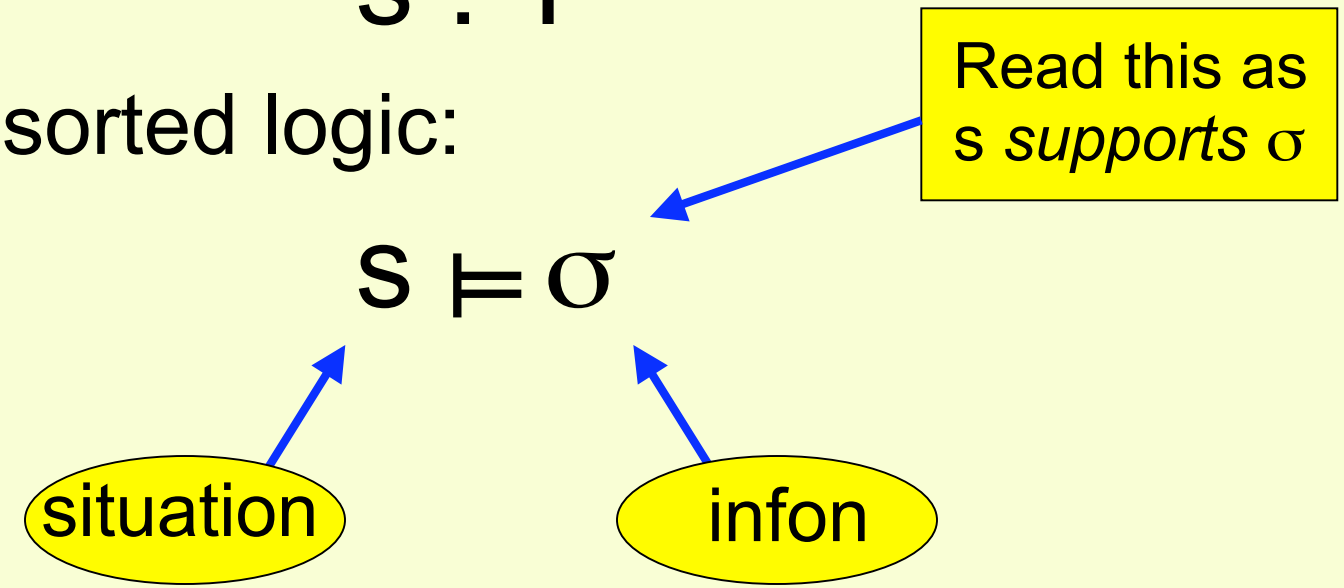

Deductions

σ_1

σ_2

σ_3

$\vdots$

σ_n

Deductions

$$s_1 \models \sigma_1$$

$$s_2 \models \sigma_2$$

$$s_3 \models \sigma_3$$

$$\vdots$$

$$s_n \models \sigma_n$$

Deductions

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$\vdots$

$s_n \models \sigma_n$

infons

σ_i is the *target* information

Deductions

situations
s_i is the context for σ_i

$$s_1 \models \sigma_1$$
$$s_2 \models \sigma_2$$
$$s_3 \models \sigma_3$$
$$\vdots$$
$$s_n \models \sigma_n$$

infons
σ_i is the *target* information

Deductions

$$s_1 \models \sigma_1$$

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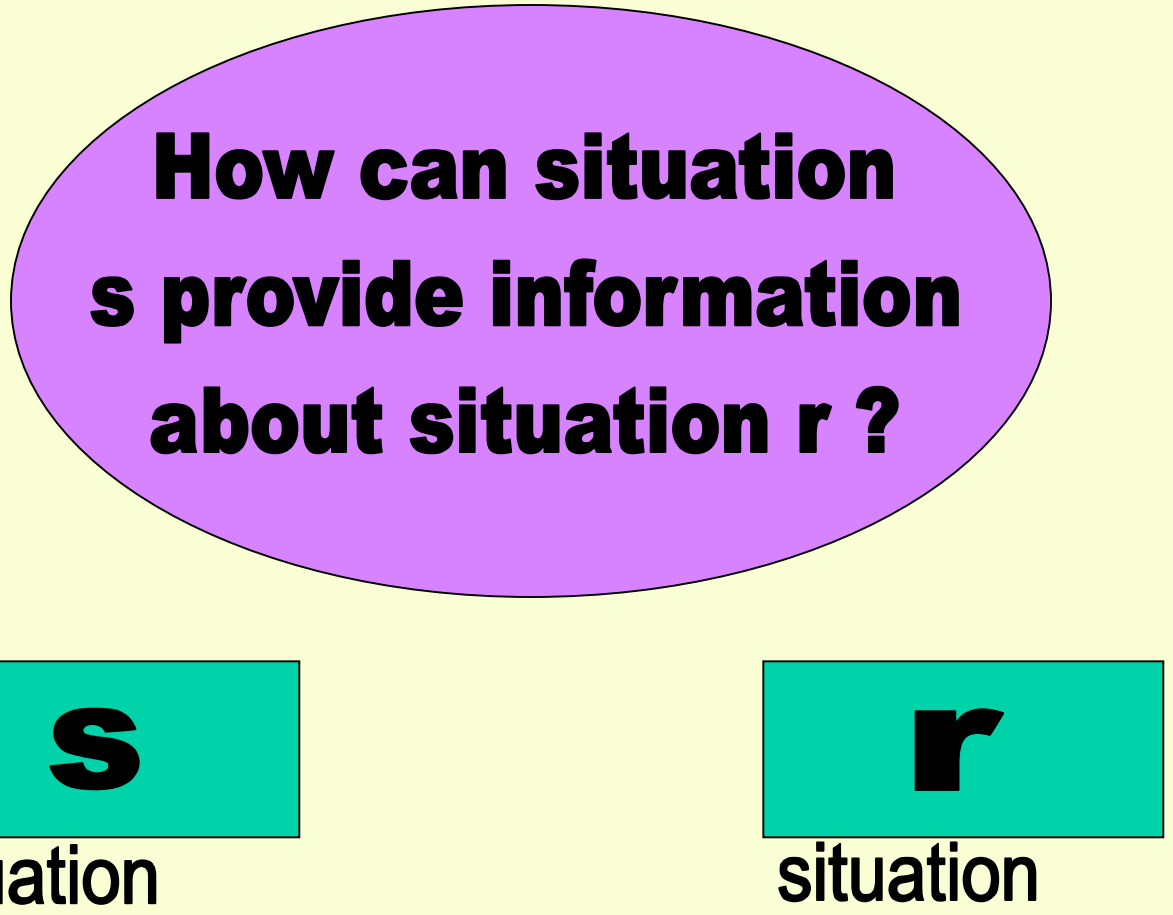
$$\vdots$$

$$s_n \models \sigma_n$$

Types and information flow

Types and information flow



Types and information flow

s

situation

Types and information flow

Me, reading a newspaper article about the launch of a rocket to Mars.

s

situation

Types and information flow

s

situation

r

situation

Types and information flow

Information

s

situation

r

situation

Types and information flow

Information

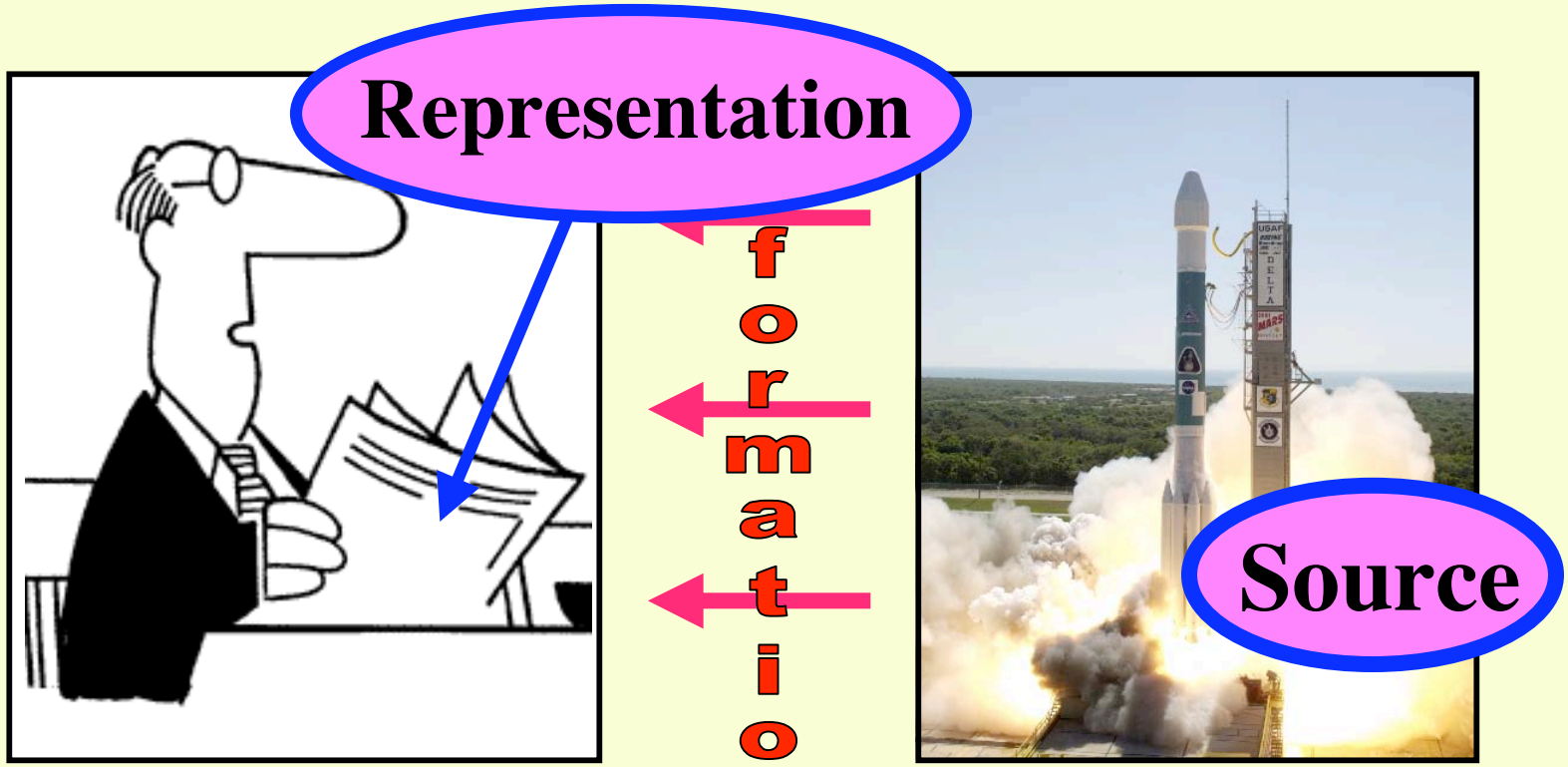
s

situation

r

situation

Types and information flow



Types and information flow

Information

Palo Alto

Florida

Types and information flow

Information

Palo Alto

Florida

Something about this

Types and information flow

Information

Palo Alto

Florida

Something about this gives me information

Types and information flow

Information

Palo Alto

Florida

Something about this gives me information about that.

Types and information flow

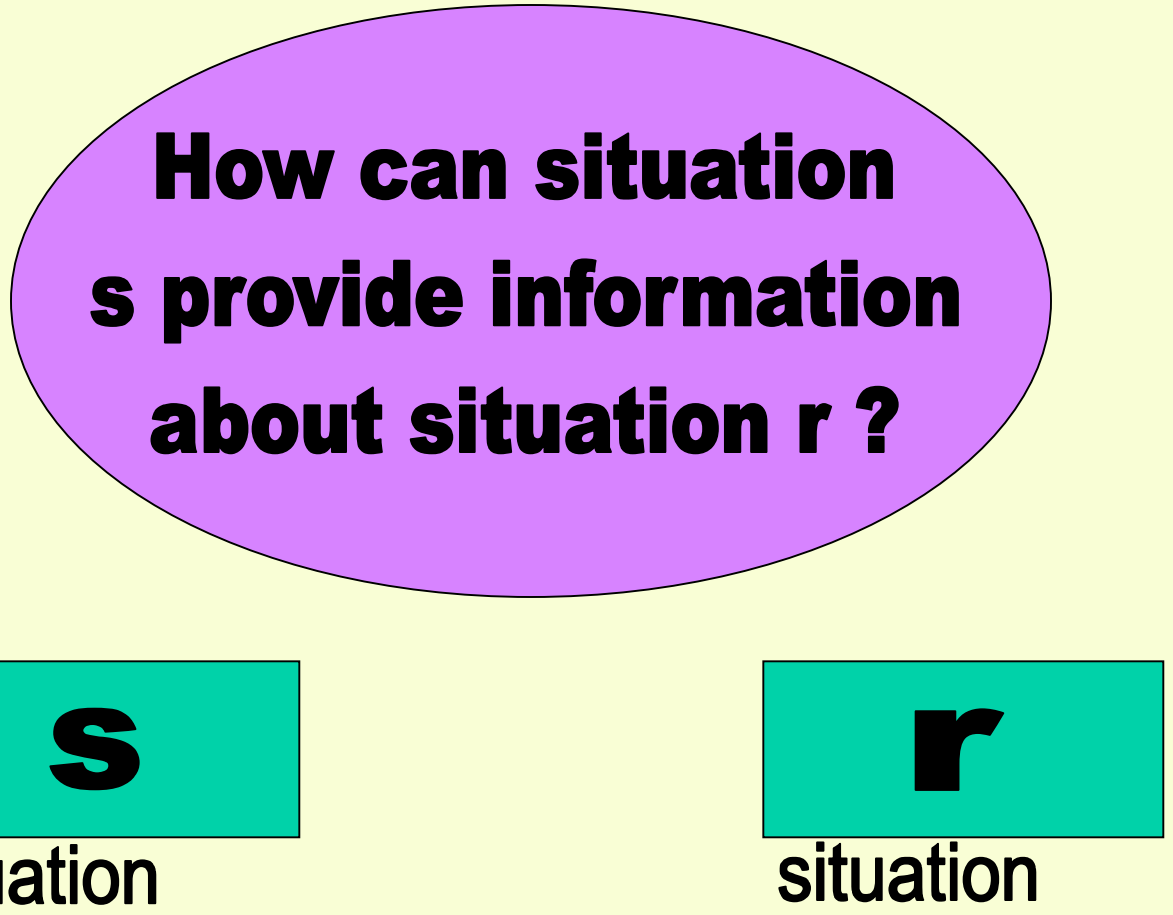
Information

Palo Alto

Florida

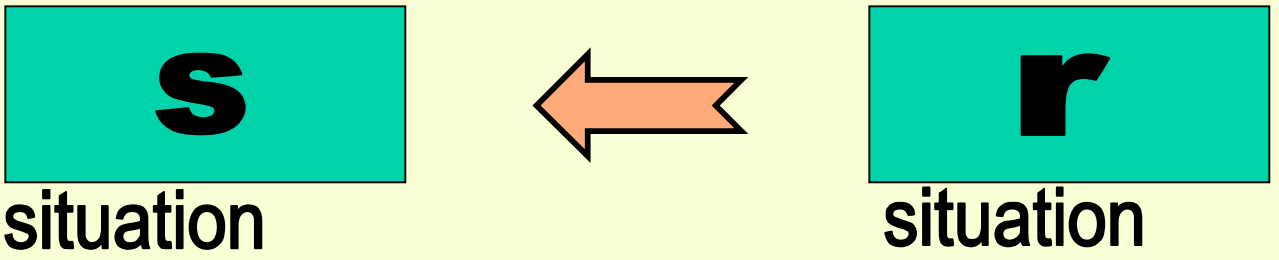
Something ← Call this something a **constraint**

Types and information flow



Types and information flow

EQUIVALENTLY
How can information flow from situation r to situation s?



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- It is by virtue of it **ringing** that the **door bell** provides information that **there is someone at the door**.
- It is by virtue of the marks on the paper **being of a certain shape (type)** that the **newspaper** provides me with information about **NASA's rocket launch**.

Inference

- Inference and reasoning are facilitated by ***constraints***.
- Constraints are binary relations between situation types.
- An informational constraint:

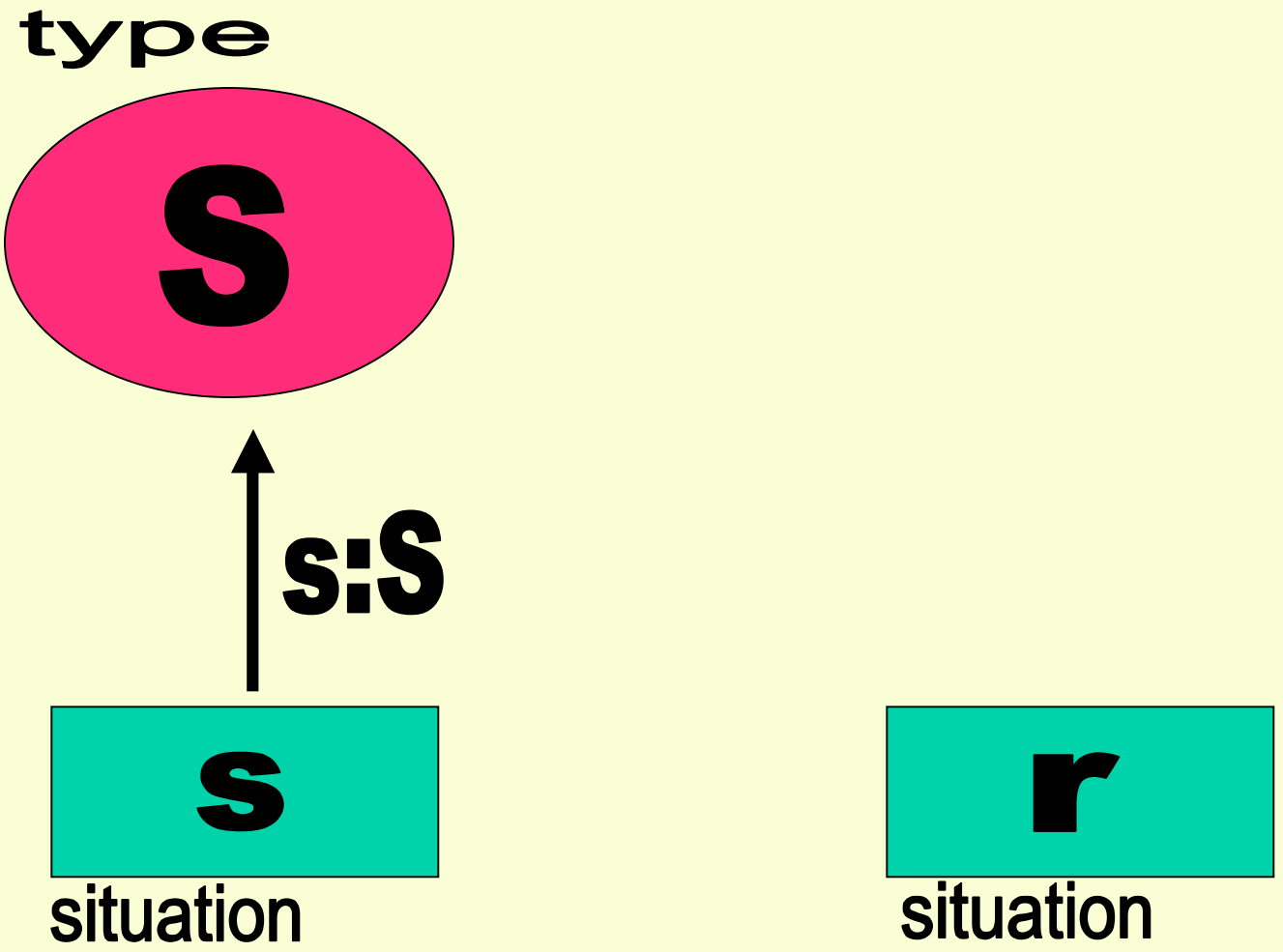
  [RINGING BELL] ⟹ [CLASS IS OVER]

- An action constraint:

  [COMMAND TO SIT] ⟹ [SITTING DOWN]

Types and information flow

Types and information flow



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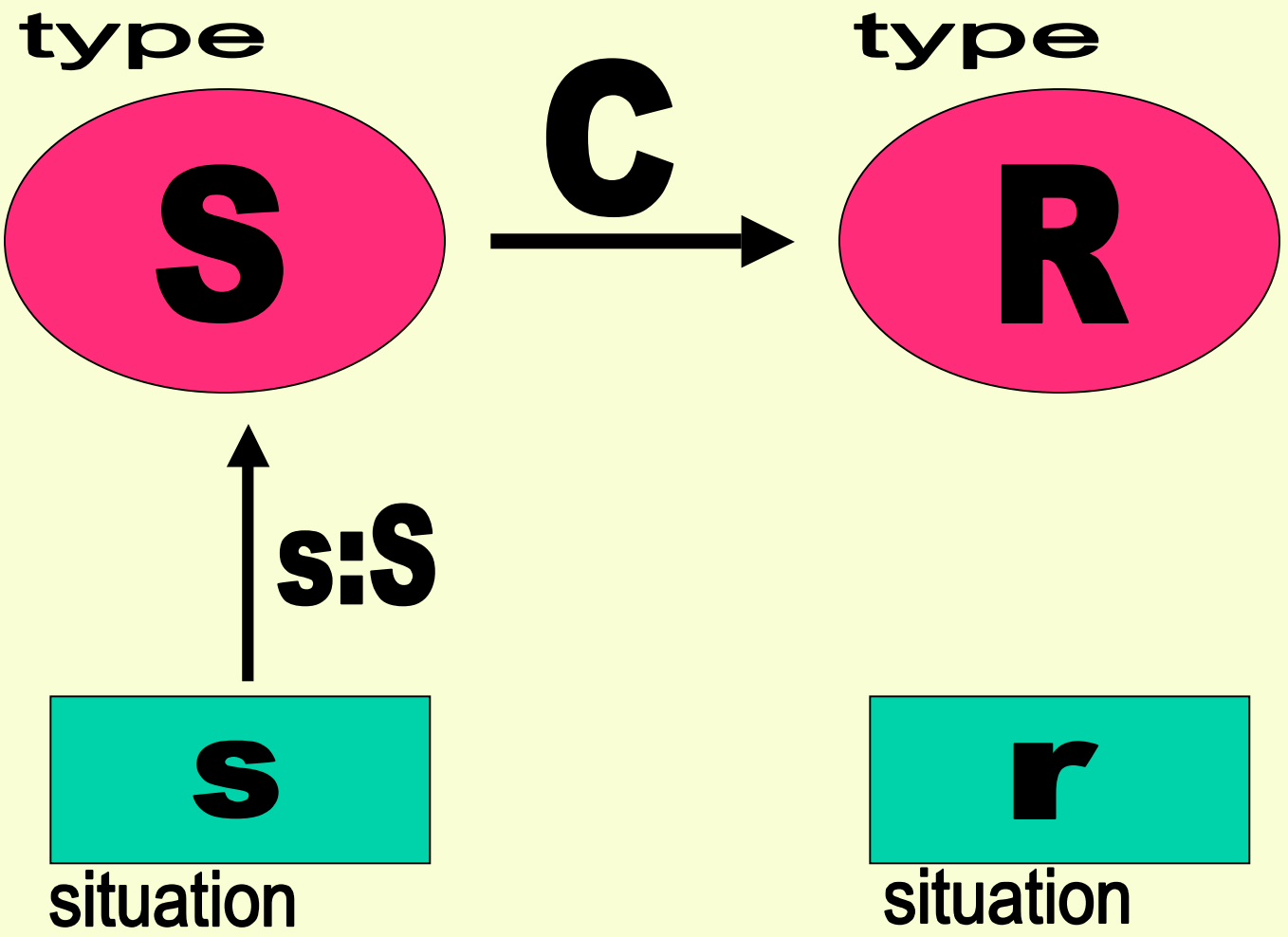

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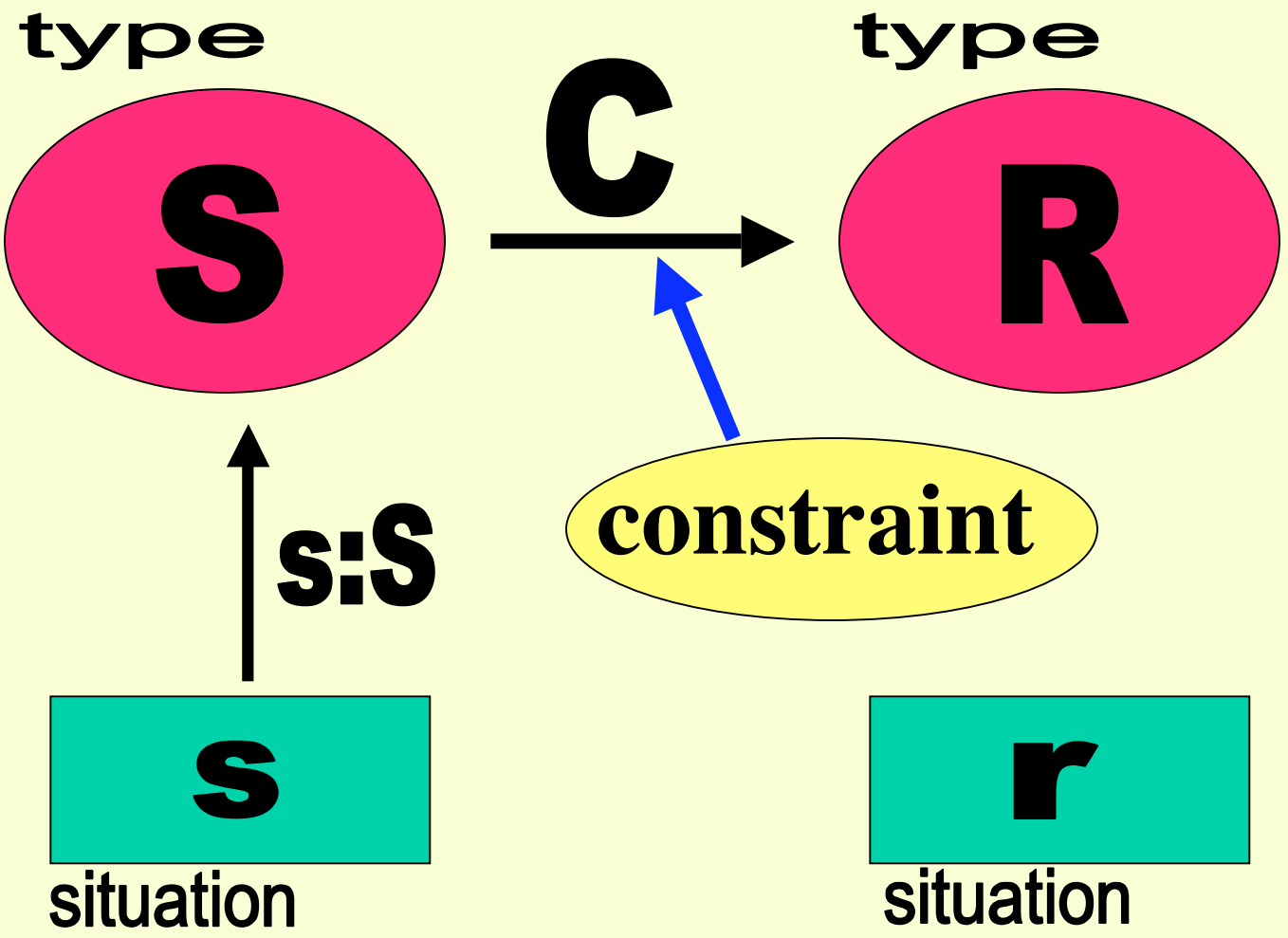

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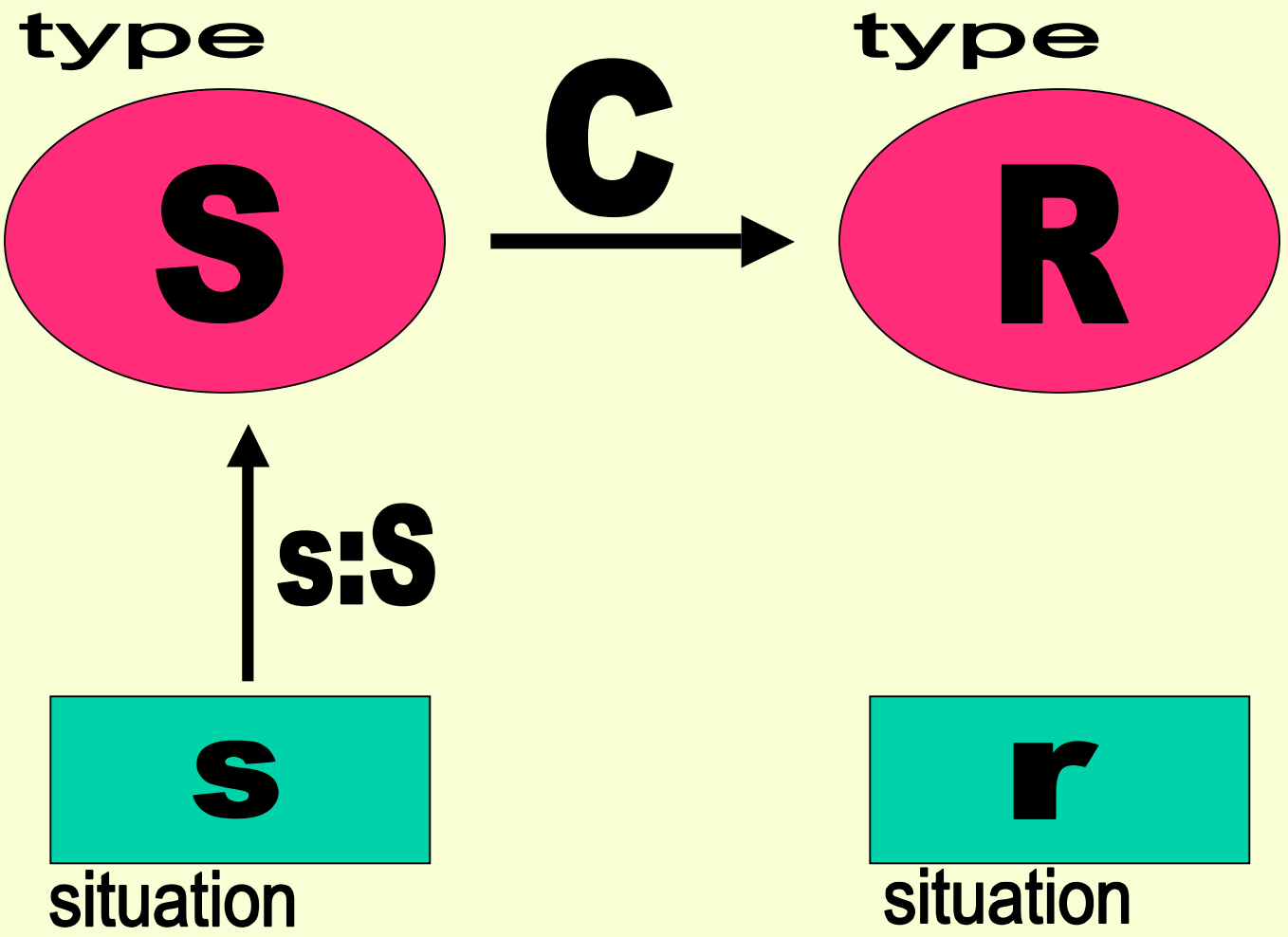

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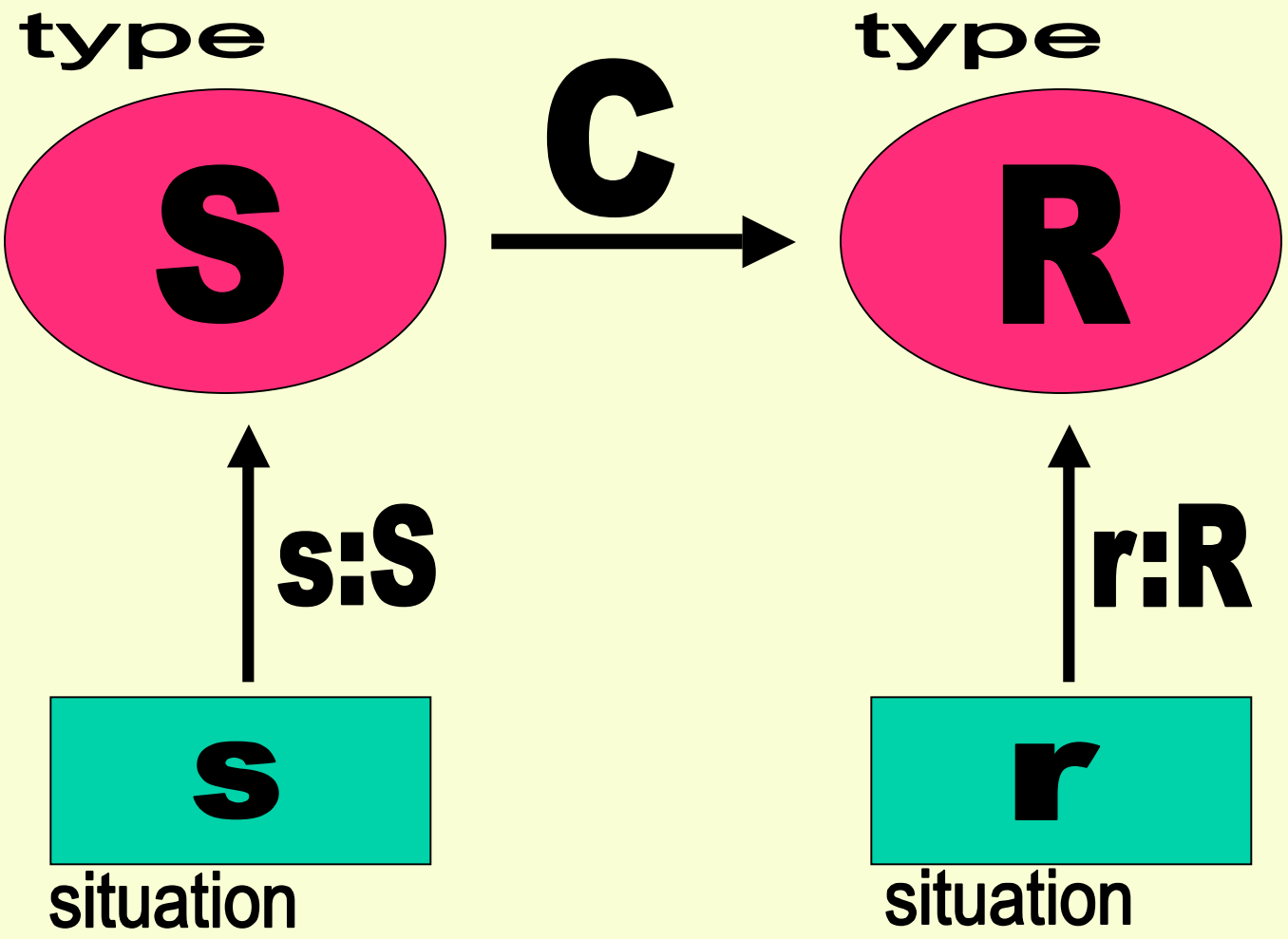
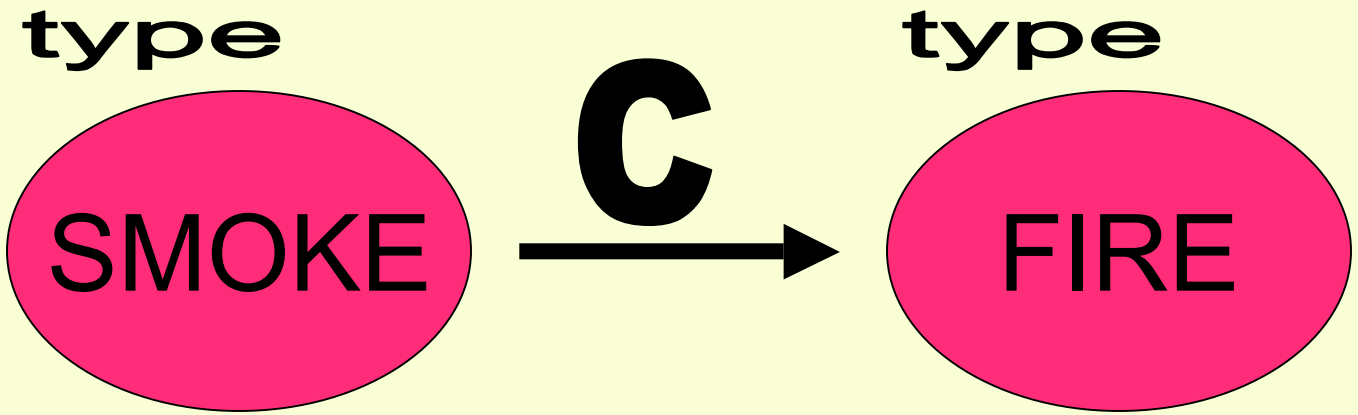


Example: Smoke implies fire



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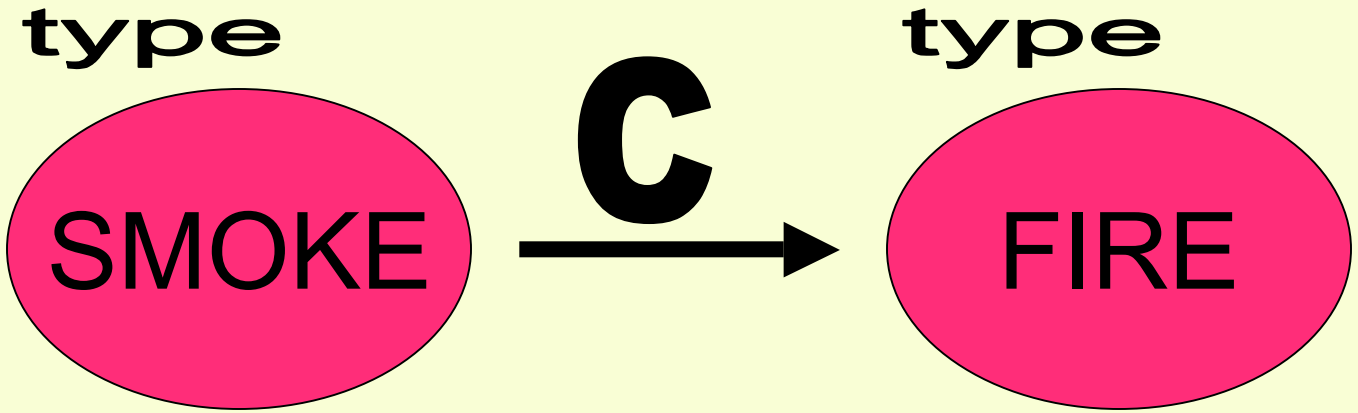

situation

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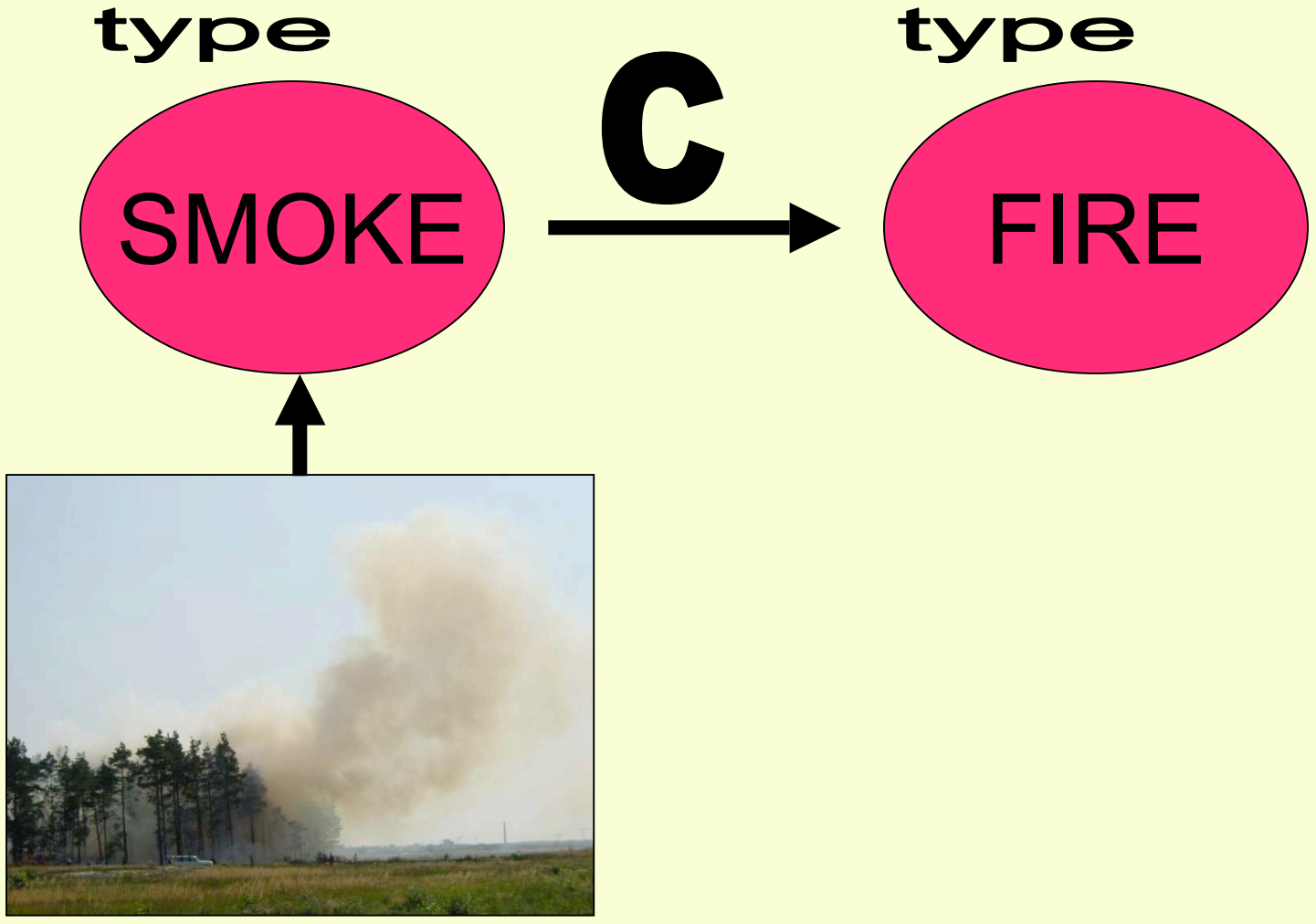

Example: Smoke implies fire

type

SMOKE

C

type

FIRE

situation

situation

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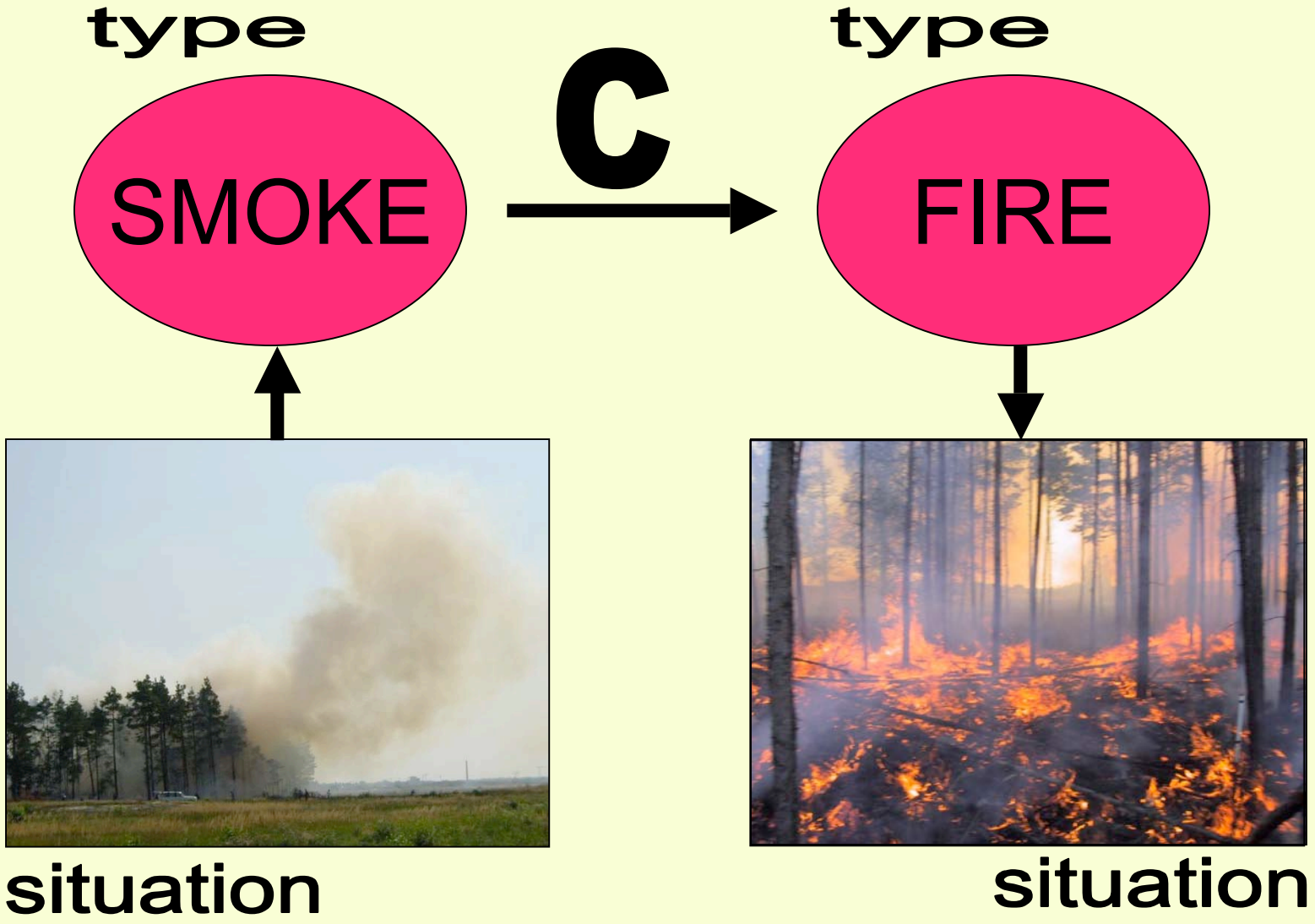

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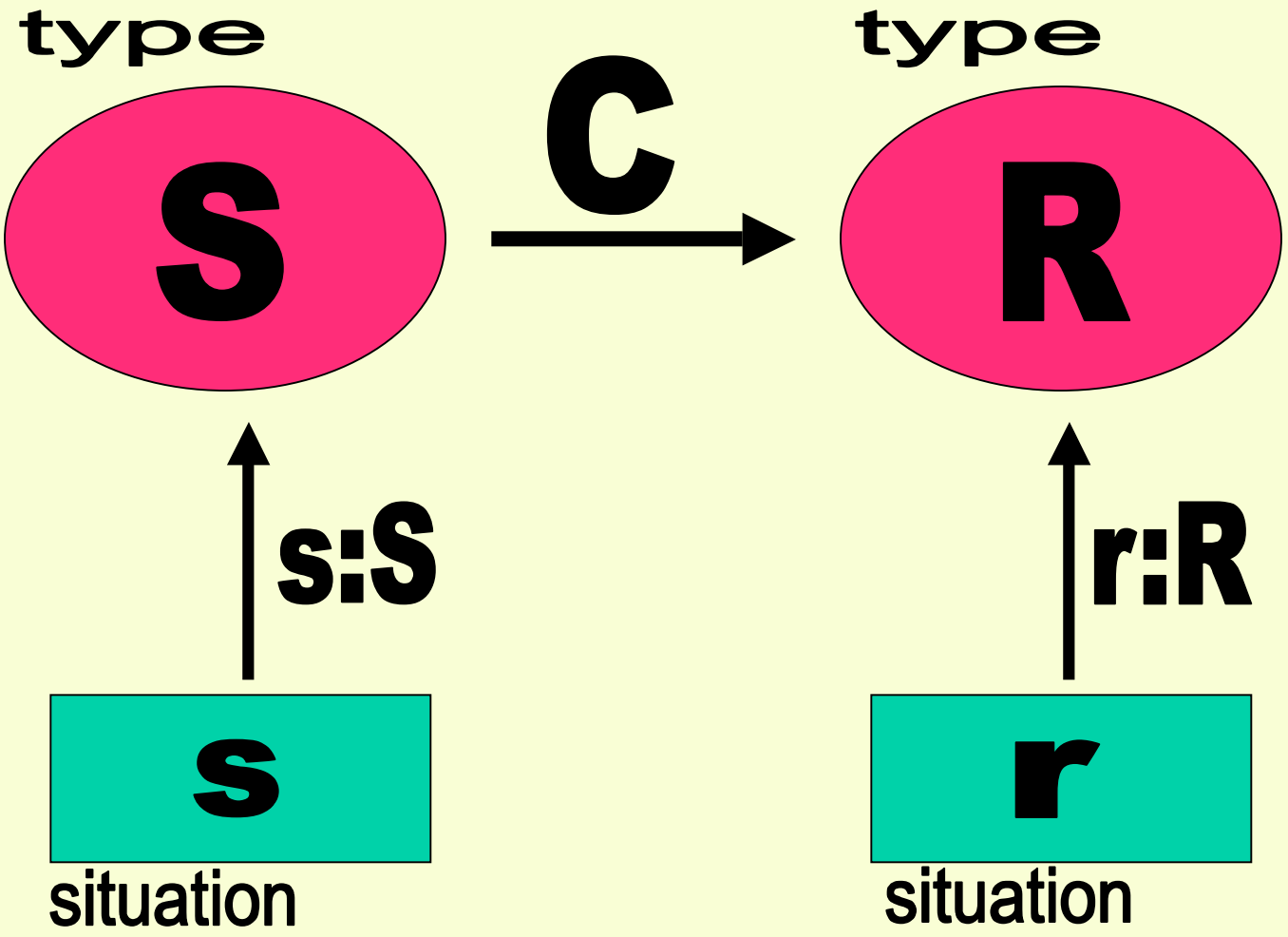
Note: *r* may be equal to *s*, or be *s* at a later time, or be some entirely separate situation.

The two levels



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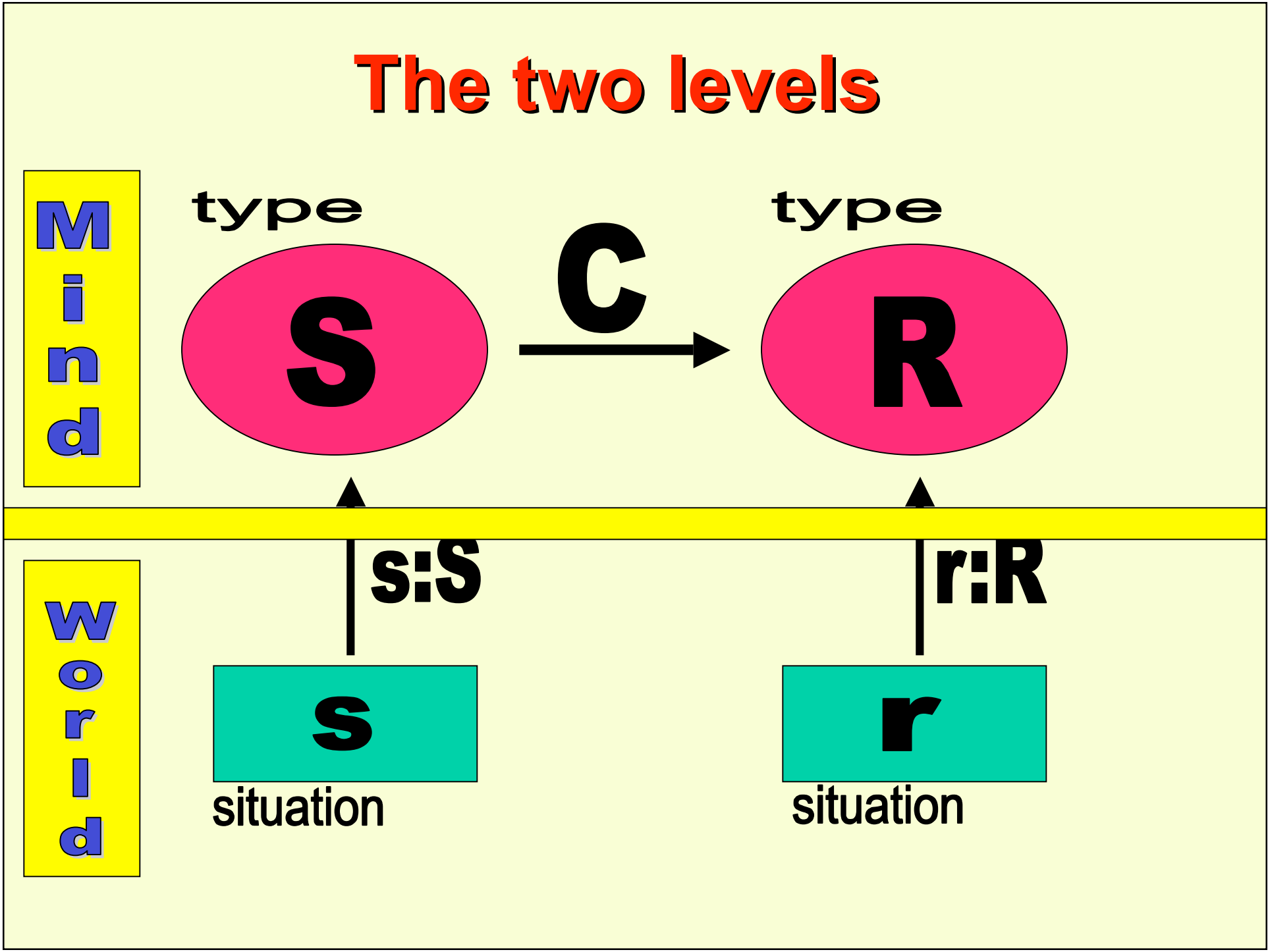

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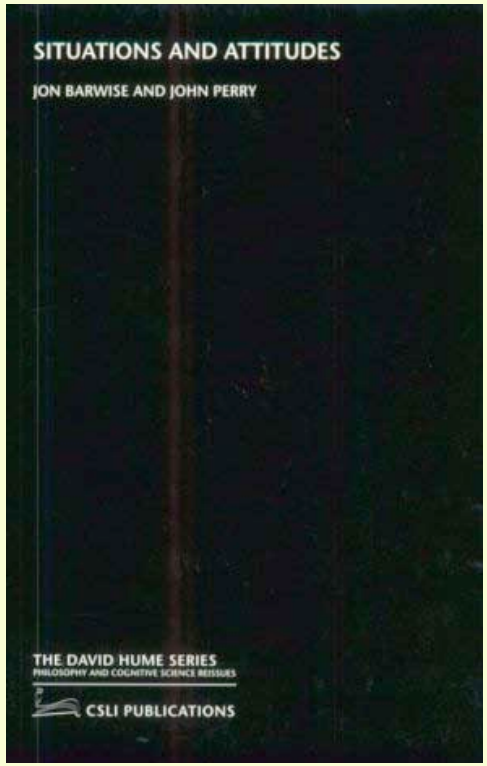
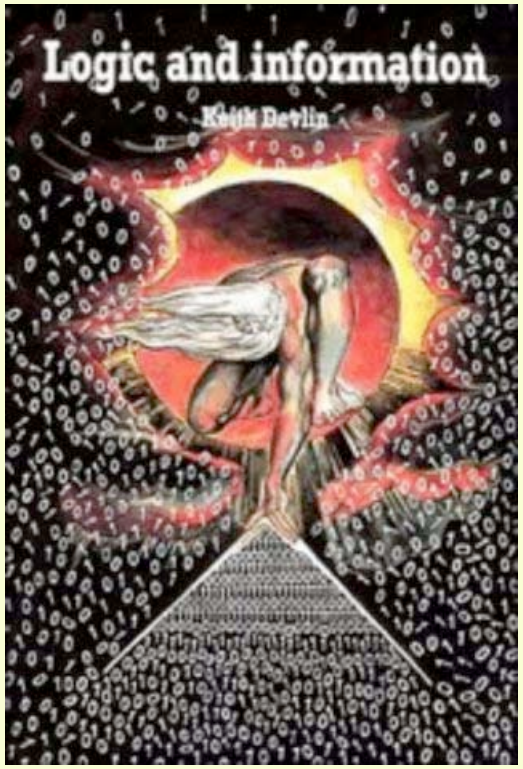
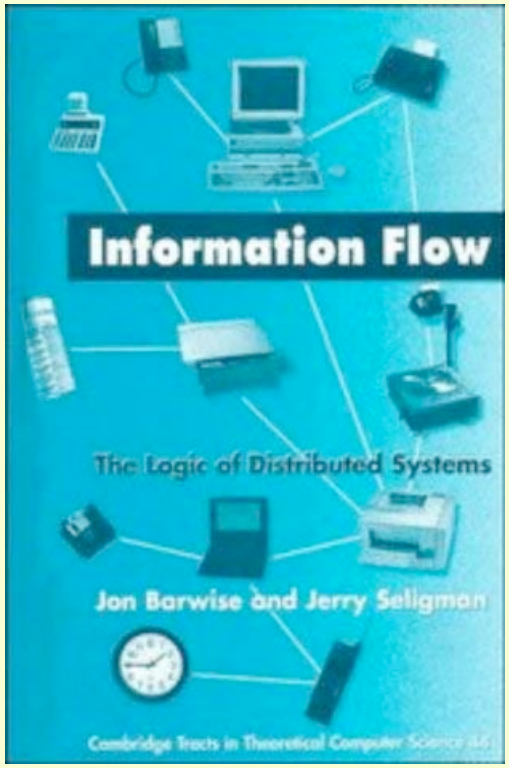
- Types/concepts/constraints/etc. are in the **mind**.

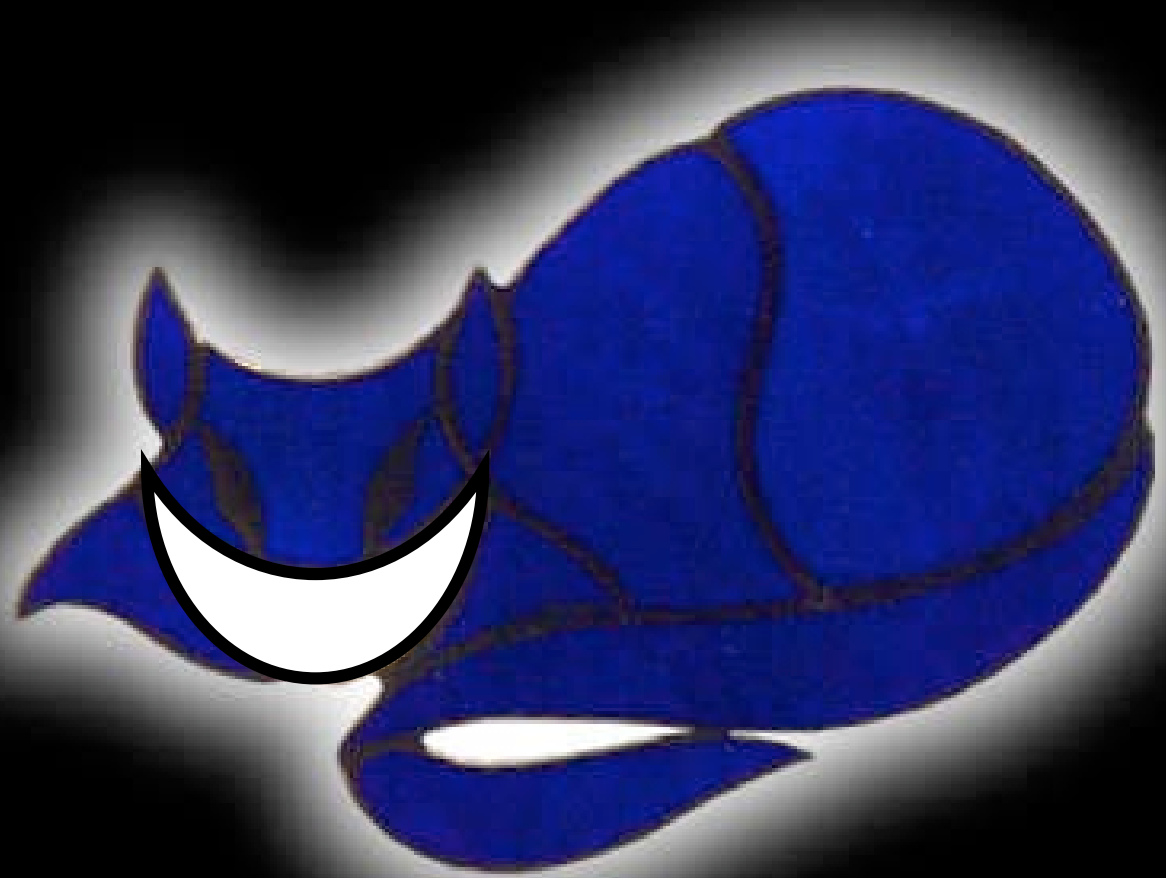
Where to find out more







Information



devlin@csli.stanford.edu