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# Sensor Data and Perception: Can Sensors Play 20 Questions

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# Plant, Animal, or Mineral



## Rules of 20 Questions

- questioner thinks of a word
- questioner may ask 20 yes/no questions
- questioner wins if they are able to guess the word



**20 Questions demonstrates effective problem solving strategies applicable in many domains, such as cognitive psychology, artificial intelligence**



# 20 Questions as a metaphor to talk about the domain of sensors and strategies for enabling situation awareness



# Can sensors play 20 questions



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## What are the semantics of sensor data?

- modeling, annotating, and querying sensor descriptions and observations
- interpreting sensor observations to make sense of the world and derive situation awareness



People are very good at perceiving the world and deriving situation awareness from sensor data

Thus, we should look towards cognitive models of perception to guide our way





## So, how do we play 20 Questions?

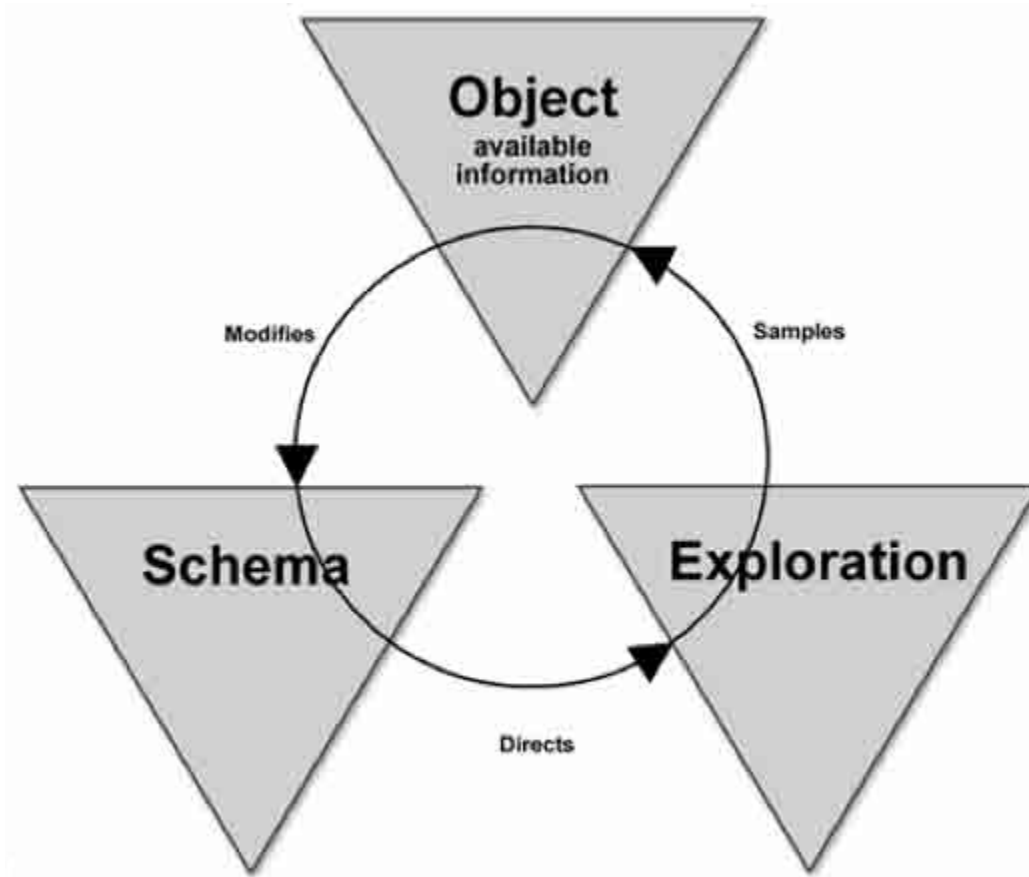
1. Ask a question
2. Analyze the answer (against possible solutions)
3. Use this new knowledge to ask the next question  
... and repeat



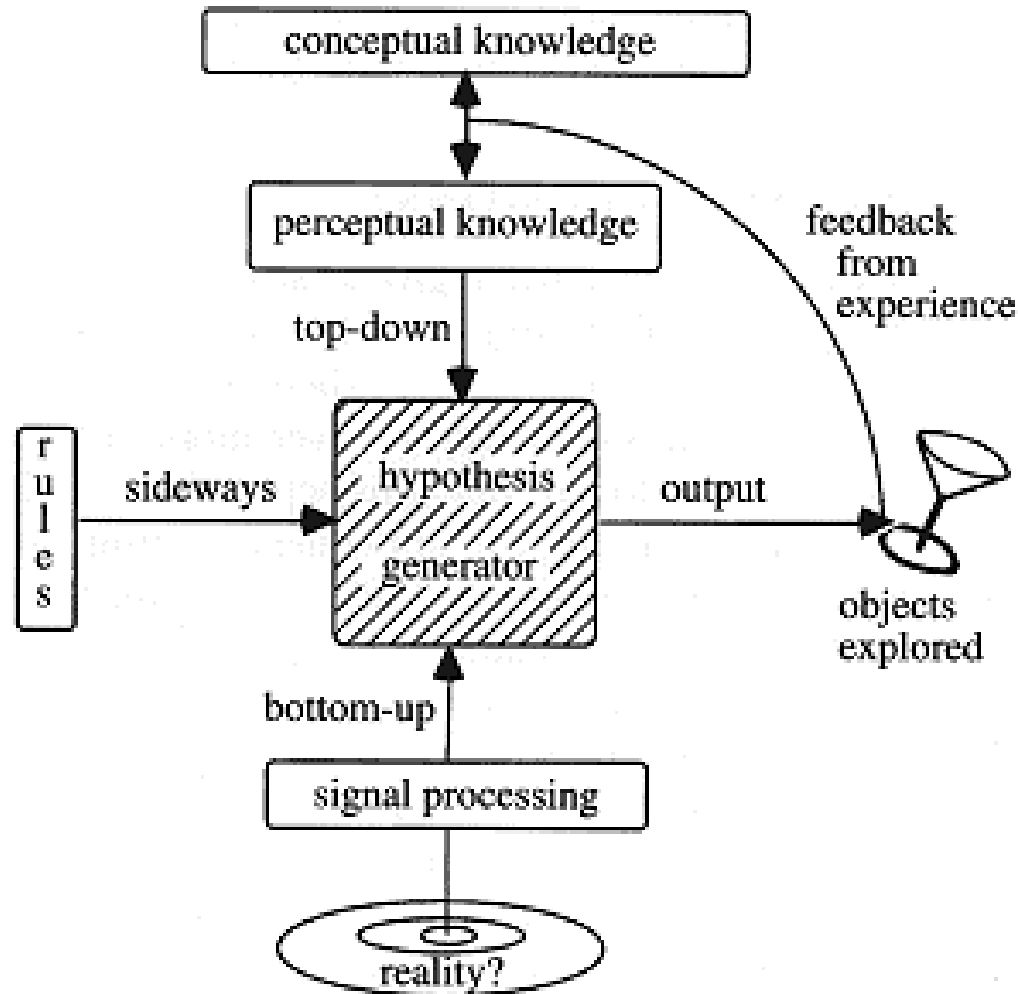
**This question/answer (or perception-action) cycle has been studied in cognitive psychology for a long time**



# Neisser's Perceptual Cycle (1976)

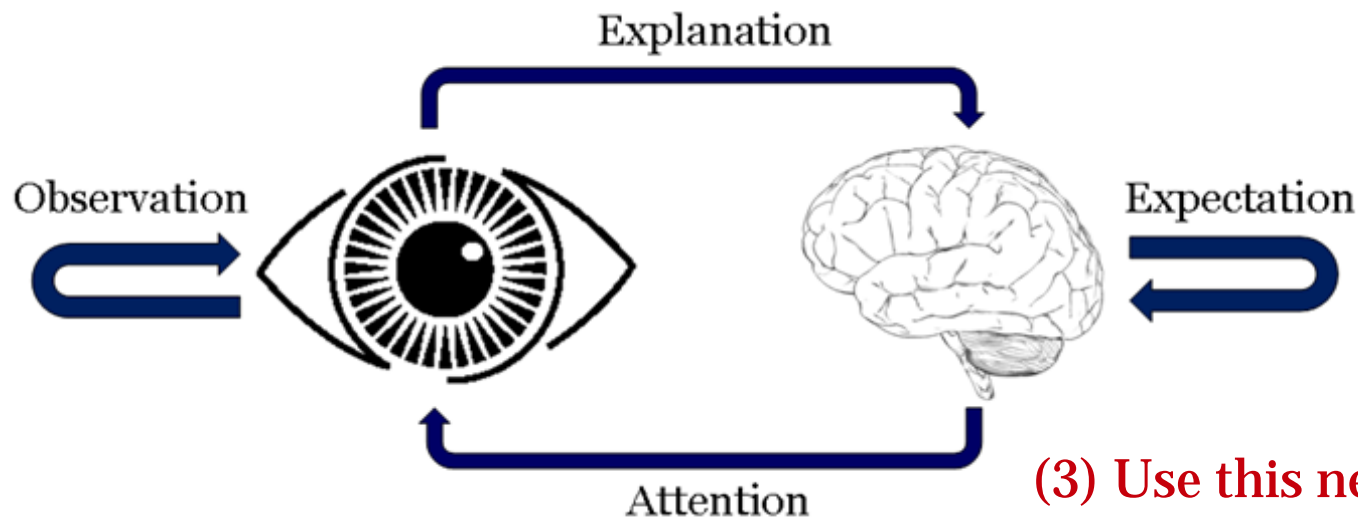


# Gregory (1997) – *Knowledge in perception and illusion*



# Active Perception\* – Shanahan (2005) – *Perception as Abduction: Turning Sensor Data Into Meaningful Representation*

(2) Analyze the answer (against possible solutions)



(1) Ask a question

(3) Use this new  
knowledge to determine  
next question



**This is great, but how does the questioner know which questions to ask to best narrow down the set of possible concepts?**

**Details of implementation are left out of the perception models**



## Intellego Perception – Norwich (1991) – *On the Fundamental Nature of Perception*

- *inter*: between, *lego*: to choose
- cognitive model of perception based on choosing between alternative explanations
- also called, Entropy Theory of Perception



# Information Theory

- *Entropy* is a measure of uncertainty
- *Information Gain* is a measure of how much a new piece of evidence decreases the uncertainty





# Active Perception + Intellego Perception

- provides a model describing how to actively iterate through the sensor search space (*active perception*) in order to choose the best alternative explanation (*intellego perception*)



## Modified Rules (for sensors)

- There will be one questioner and 20 questionees.
- Each questionee is only able to answer a single question that is related to their area of expertise.
- The final solution (or "word") will always be an answer to the general question: "What is the situation?"



# Passive Perception Strategy

- The questioner (analysis engine) asks questions of each of the 20 questionees (sensors), and collects the answers (observational values)
- After receiving all 20 answers, the questioner then analyses the answers and generates the best possible solution (description of the situation)



## Active Perception Strategy

- The questioner asking a single question of one of the 20 questionees, and collecting the answer.
- The questioner then proceeds to analyse this single answer in order to generate a set of possible solutions, or descriptions of the situation.
- If there is more than one possible solution, then the questioner must ask another question.



Can sensors play 20 questions



Thank You

