Cognitive Dynamic System

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What is Cognitive Dynamic System?

- Dynamic system → Input-output behavior + Time
- Human cognition → Knowing, Perceiving, Act

- Cognitive Dynamic System
  → Dynamic system with
    - Perception-action cycle/ Memory/ Attention/ Intelligence
    (Four fundamental function in human cognition)

The Perception-action cycle

- Main Component: Perceptor, Actuator, Environment
  - Perceptor: Information acquisition / Analysis
  - Actuator: Decision making / Control the environment
- Continually update the knowledge from environment
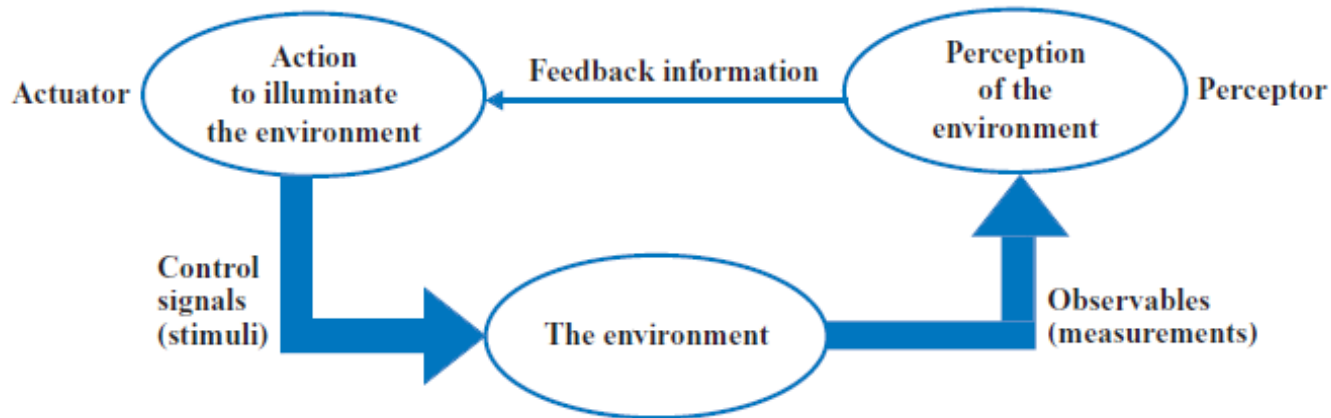- Predict the Consequences of action

Figure 1.1. The perception–action cycle of a cognitive dynamic system in its most generic sense.
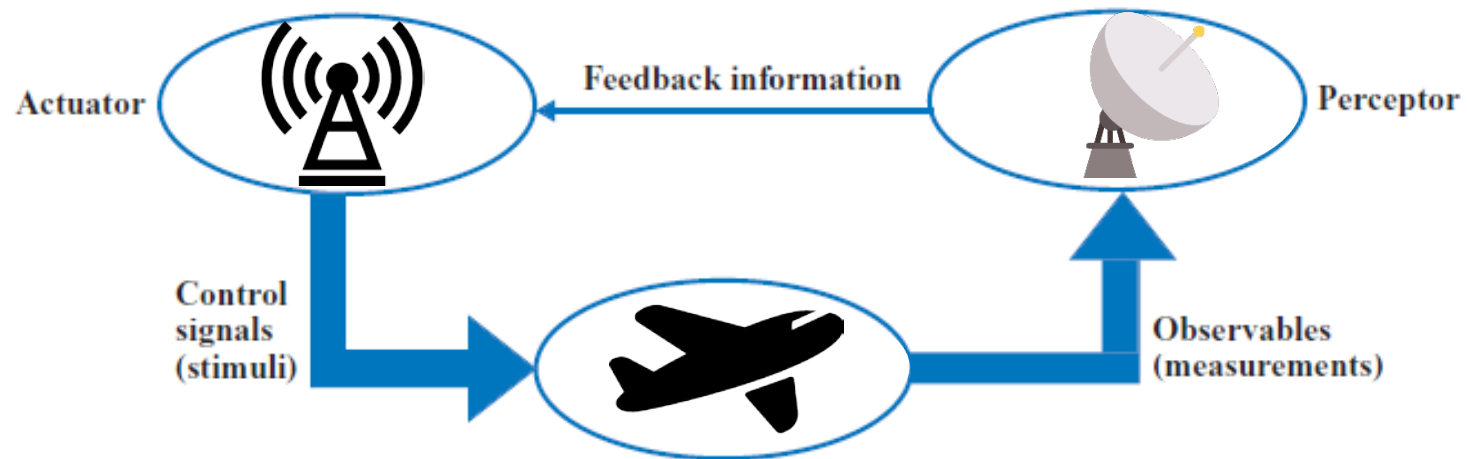
Application to engineering system

- Cognitive radar

Objectives: Target detection & tracking

Signal receiver → Perceptor / Target information analysis

Signal transmitter → Actuator / Wave injection control
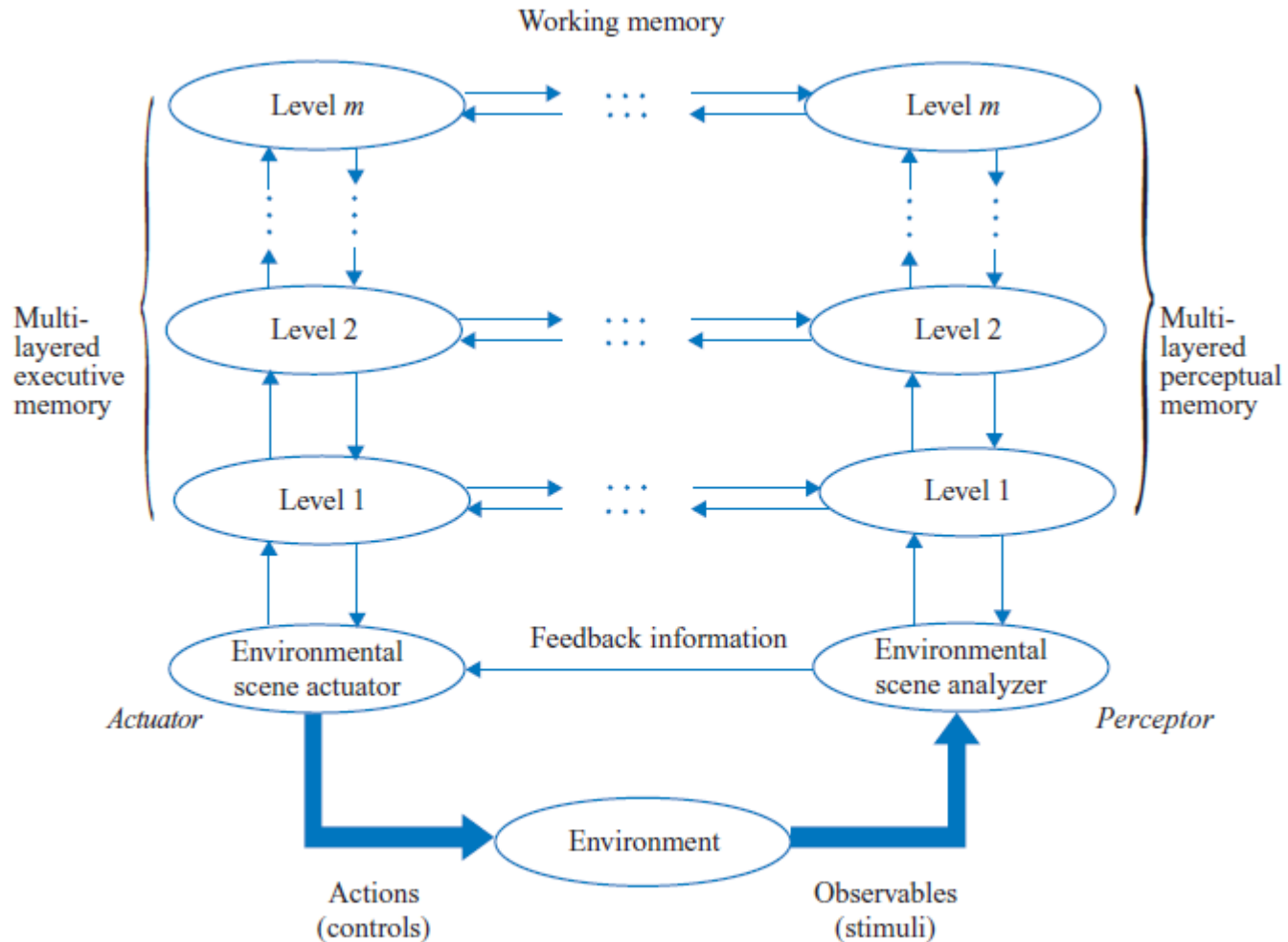
Structure of perception-action cycle

Figure 2.1. Directed information-flow diagram in the perception–action cycle of a cognitive dynamic system with hierarchical memory. (This figure is inspired by Fuster (2003).)

Perception

- **Composition**
  - Perceptual memory + Environmental scene analyzer

- **Function**
  - Recognition and acquisition of environment relevant info.
  - Analysis of data: Especially classification of a new set of data

- **Functional integration-across-time property**
  - Time separate the sensory input signals

Memory

- ## Knowledge vs Memory
  - Knowledge never changes with time
  - Memory continually changes with time

- ## Perceptual memory
  - Supplied with internal library: different models for environment
  - Reciprocally coupled to environmental scene analyzer
  - Bottom-up link: retrieval of old memory/ updating old memory
  - Top-down link: acquisition of new memory by analyzer

Memory

- ## Executive memory
  - Similar with perceptual memory
  - Internal library → different realization of control signal
  - Coupling with perceptual memory → Enables operate in synchrony

- ## Role of memory in cognition
  - Predicting consequences of actions taken by the entire system

Working memory

- Active memory that occupies a short span of time
  - Key role in attentional mechanism focused on the internal representation of resent event associated with a prospective action

Attention

- Selective allocation of available computational resources