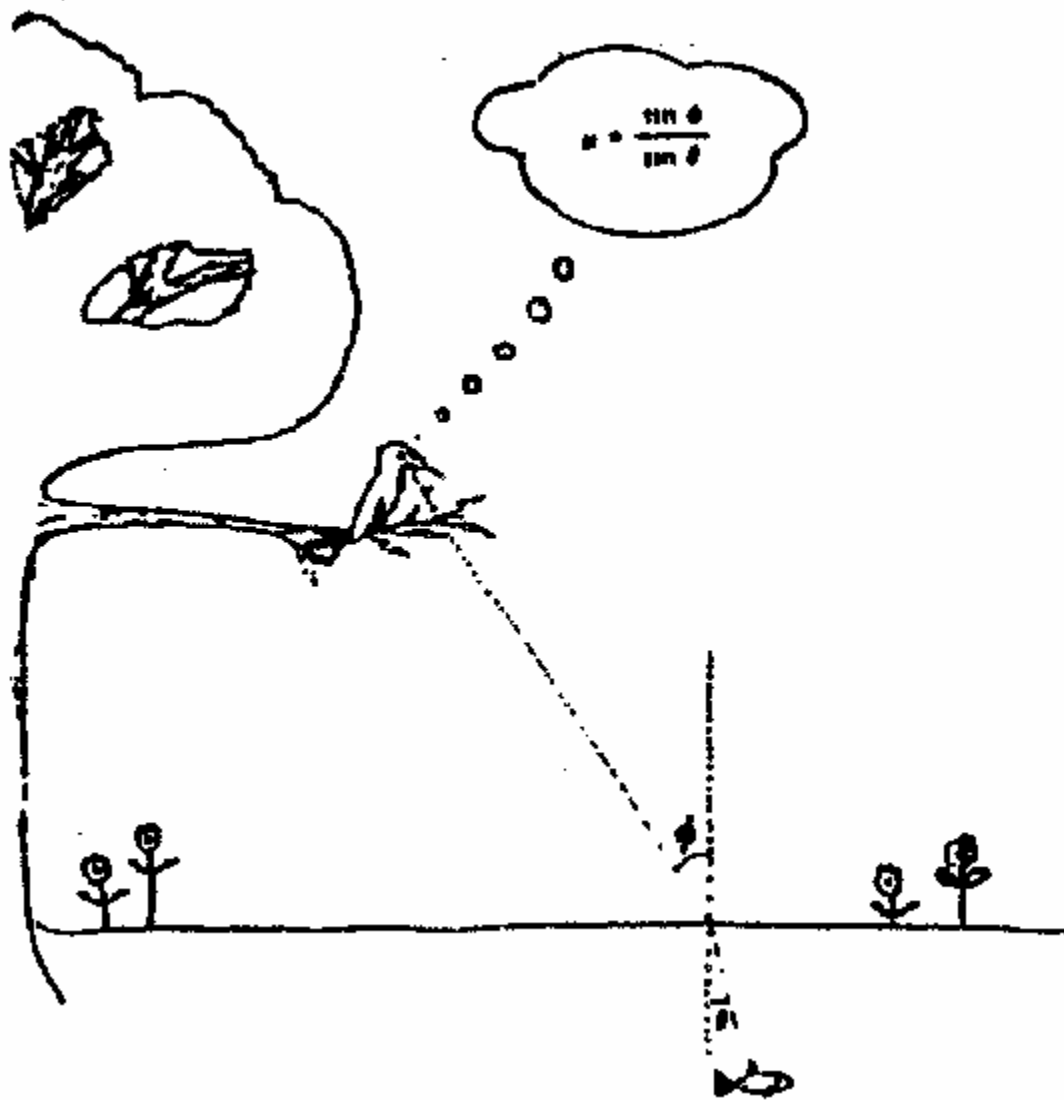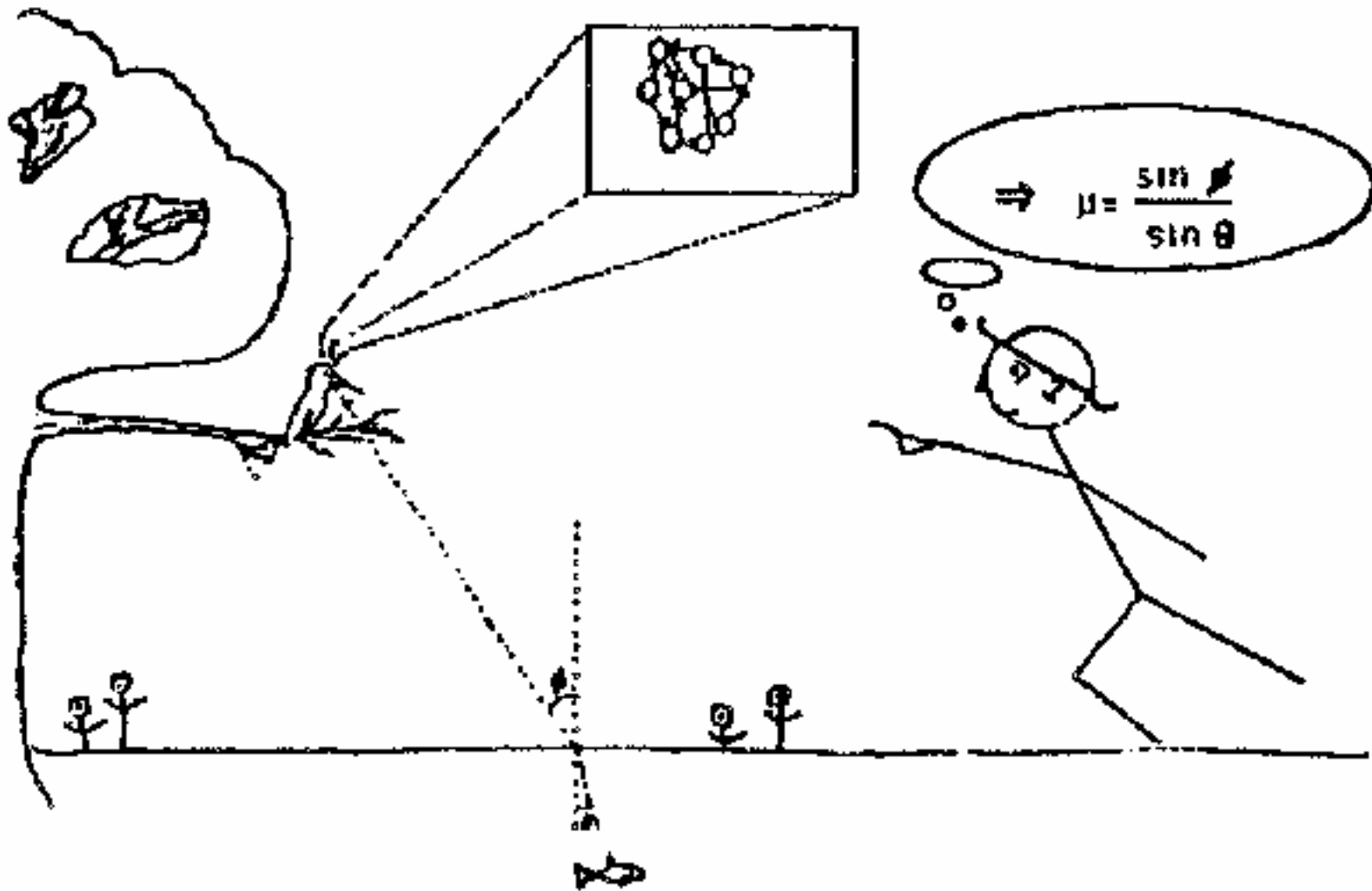# Knowledge

Representation and Symbols

- What is being represented by a representation?
  - Depends on the paradigm: cognitivist systems or emergent systems

- Cognitivist
  - One-to-one mapping between some internal state (represented symbolically) and some absolute counterpart in the world.
  - The representation is a model of the real world
  - Since the world is absolute and unique (and not contingent on the observer), the models in all cognitive agents are consistent and compatible
  - Consequence: the designer of a cognitive system can implant representations in the agent
  - Knowledge can be shared directly

Representation and Symbols

- What is being represented by a representation?
  - Depends on the paradigm: cognitivist systems or emergent systems

- Emergent
  - No right to assert that your perceptions are identical with other agents
  - Perceptions are shaped by action and the possibility of action
  - Representation is agent-specific
  - Can't implant representations directly into the agent
  - Knowledge must be agreed (and meaning negotiated)

$$\mu = \frac{\sin\phi}{\sin\phi}$$

$$\Rightarrow \quad \mu = \frac{\sin \phi}{\sin \theta}$$

Knowledge

- Two Key Questions:
    - Where does knowledge come from?
    - What relationship does it imply between cognitive agent and the world?

- Cognitivist Answer
    - Provided in symbolic form by humans
    - Refined by learning
    - Brittle representations (designer assumptions)

Knowledge

- Two Key Questions:
  - Where does knowledge come from?
  - What relationship does it imply between cognitive agent and the world?

- Hybrid Answer
  - Generic representational schemes (e.g. ISA, ICA, PCA)
  - Populated by incremental unsupervised learning
  - But behaviour is designed in (links between actions and perceptions)
  - Combination of agent-specific and agent-acquired knowledge and pre-programmed perception-reasoning-action strategies

Knowledge

- ## Two Key Questions:
  - Where does knowledge come from?
  - What relationship does it imply between cognitive agent and the world?

- ## Emergent Answer
  - Connectionist / dynamical approaches
  - No symbolic representations
  - Knowledge is encapsulated by system states
  - Acquired by exploration and social interaction

Memory

- Knowledge is (relatively) persistent

- Types of memory

  - Procedural memory / implicit memory

  - Declarative / working memory / explicit memory

    - Episodic memory

    - Semantic memory

  - Modal memory (visual/acoustic)

  - Short-term memory

  - Long-term memory

Memory

- ## Memory recall

  - ### Associative

    - Auto-associative
    - Hetero-associative

  - ### Symbolic index

- ## Memory degradation

  - Graceful degradation
  - Avoid catastrophic forgetting
  - Loss of important memories when something new is learned

Symbol Grounding

- How do representations acquire meaning?
- How do symbolic representations acquire semantics?
  - Symbol grounding problem

- Steven Harnad:
  - Symbolic representations grounded bottom-up in non-symbolic representations

    - Iconic representations (derived directly from sensory data)

    - Categorical representations (based on the output of learned and innate processes for detecting invariances / invariant features in the sensed data)

The Frame Problem

- "How can we build a program capable of inferring the effects of an action without reasoning explicitly about all its obvious non-effects?"[Shanahan Baars 2005]

- "How.does the machine's program determine which beliefs the robot ought to re-evaluate given that it has embarked upon some or other course of action?" [Fodor 1983]

- The issue is how to ignore non-effects of actions on the agent's knowledge