# Intelligence Without Representation

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Artificial Intelligence
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# Overview

1. What's wrong with AI

2. How AI should be

3. Proof by example

4. Conclusion

## AI, according to Brooks

**First goal:** Replicate human intelligence
Researchers quickly overwhelmed

**New goal:** Research specialized subproblems
NLP, representation, vision... *micro-worlds*

**Brooks sez:** "These people are fools."

- Incremental building with complete steps
- Test in the real world
- Real world == good
- Representation == bad

# Intelligence

**Proof of intelligence:** Humans
(But don't assume to much)

**Story Time**

- AF researchers travel through time
- See the innards of an aeroplane
- Inspired, travel back to their own time
- Try to rebuild aeroplane from small glimpse

**AI is similar**
to rebuild intelligence from small glimpse in humans

# Nobody is right

- AI has no successes
  - Hard problems $\rightarrow$ AI
  - Solved problems $\rightarrow$ Algorithms, not AI
- AI has no failures

# But...

Two parts to AI problems

- AI: gets solved
- Non-AI: gets skipped
- Anything not solved == not AI

# Representation

Problem with AI: abstraction is self delusion

- Chair: `(can (sit-on person chair))`,
  `(can (stand-on person chair))`

- Chair: flat, smooth, big, small,
  soft, covered, etc.

- No AI program can find any chair in arbitrary image

- Researchers must do representation abstraction

  - Leaves little for AI to do but search

Hard part done by researcher, easy by AI

# So what?

Abstraction == good science

Other researchers will solve the abstraction problem

Back to the story

- Chair people build beautiful, heavy chair
  - "Other people will make it fly"

- Aerodynamics: "Nobody in the future plane knew about it, must not be important"

Obviously, nothing will work if everybody thinks like that.

# Solution: Incremental Intelligence

Creatures - autonomous agents in the real world

- Dynamic environment
- Robust to environment
- Multiple goals
- Purpose in life

Two forms of decomposition

- By function
- By activity

# Decomposition by Function

**Central system**

**Inputs:** Percept modules

**Outputs:** Action modules

Input/central reasoning done by different groups

- Disjoint assumptions

Central system also broken up

- Knowledge representation, learning, planning, etc - all different assumptions too

# Decomposition by Activity

Divide agent into activity-producing subsystems

Each subsystem = layer

**Layers:**

- Run in parallel

- Are disconnected from other layers

**Example:** robot that avoids stuff

- Moving layer, stopping layer

- Add searching layer with no change to lower layers

# Where's the Representation?

Everywhere! Nowhere!

No complex representation
  $\rightarrow$ Fast low-level reactions

No specific representation
  $\rightarrow$ Change in world does not break system

Real world as model
  $\rightarrow$ Environment can affect goals more easily

No central representation

- Layers act on their own

- "Pattern out of chaos"

No variables, etc.

# Building Real Robots

Four built (as 1987)

Always tested in real world

Each built on layers

- Each layer: network of finite state machines

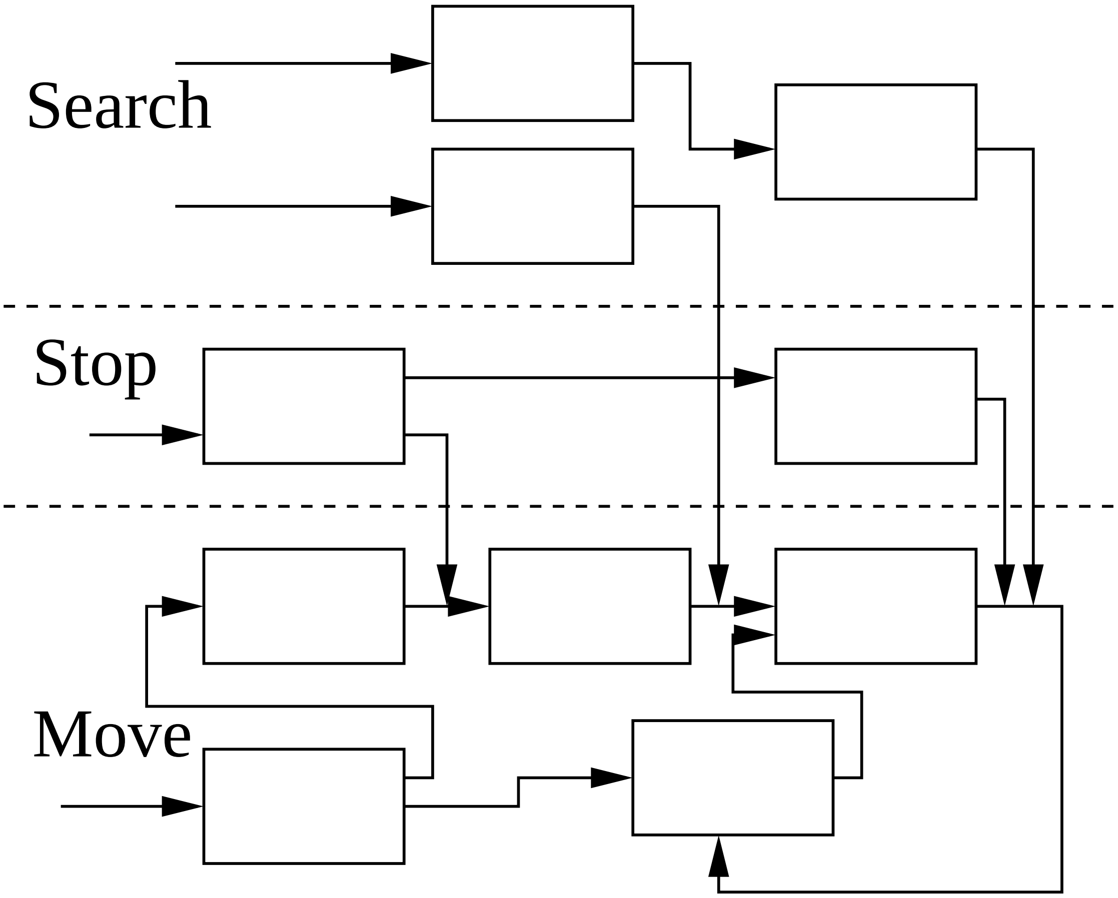
- Higher layers suppress lower layers

In-depth description in paper

- Description of 3 layers

- Fuzzy pictures

# Example Machine



# What this is not

**Connectionism**

$\longrightarrow$ Not uniform, no representation

**Neural Networks**

$\longrightarrow$ No biological claims

**Production Rules**

$\longrightarrow$ No real rules

**Blackboard System**

$\longrightarrow$ More explicit and permanent

**German Philosophy**

# Limits

- Claims “Simple insect intelligence”

- How many layers are possible?
  $\longrightarrow$ At least 3 to 6

- How complex can behavior be?
  $\longrightarrow$ Working on can-gatherer

- Is learning possible?
  $\longrightarrow$ Maybe “learning by instinct”

# Conclusion

Talk is cheap.