Visual Imagery

How many windows in your living room?

Answer: Use visual imagery

Created from non-sensory inputs

- Visual memories
- Other non-visual sources (e.g. language)
  - A triangles and the letter after “C”
- Combine images in new ways (“pigs flying”)

Visual Imagery and Perception

Differences:

- Perception much more detailed

Similarities:

- Same neural areas?
  - Damaged visual cortex = no images
  - Brain imaging studies

Visual Imagery: What's it good for?

Retrieve info from memory

Manipulate/combine objects without effort of real movement (test out new hypotheses)

Visual Images: What are they? Kosslyn and Schwartz Theory

Surface Representation

- Like a picture but with lower resolution
- Holistic
- Viewer centered

Deep Representations

- Long-term memory of components of image

Visual Images: What are they? Kosslyn and Schwartz Theory

Deep Representations: Long-term memory of image

Literal encodings

- How object is depicted in surface representation
- "How it looked"
- Right hemisphere

Propositional encodings

- Abstract, language like
- Object parts, locations and sizes
- left hemisphere

Visual Imagery: Components

Image generation

Image inspection

Image transformation

Image Generation

Image seems to be formed in parts

More complex images take longer to make

Imagers have some control over complexity of image

Image Inspection

Answer Question about image

Picture an elephant next to a rabbit
Does the rabbit have a tail?

Does Zooming exist?

Do you zoom in, or do you re-image the rabbit to answer this question?

Image Inspection

Do images preserve spatial extent?

Experiment with subjects imaging an island

Scanning between longer distance took longer

Image Transformation

Shift transformations

Incremental alterations in image

Blink transformations

Re-form a complete image

Image Transformation
A Shift Transformation?

Complex stimuli used in metal rotation studies
(Shepard & Metzler)

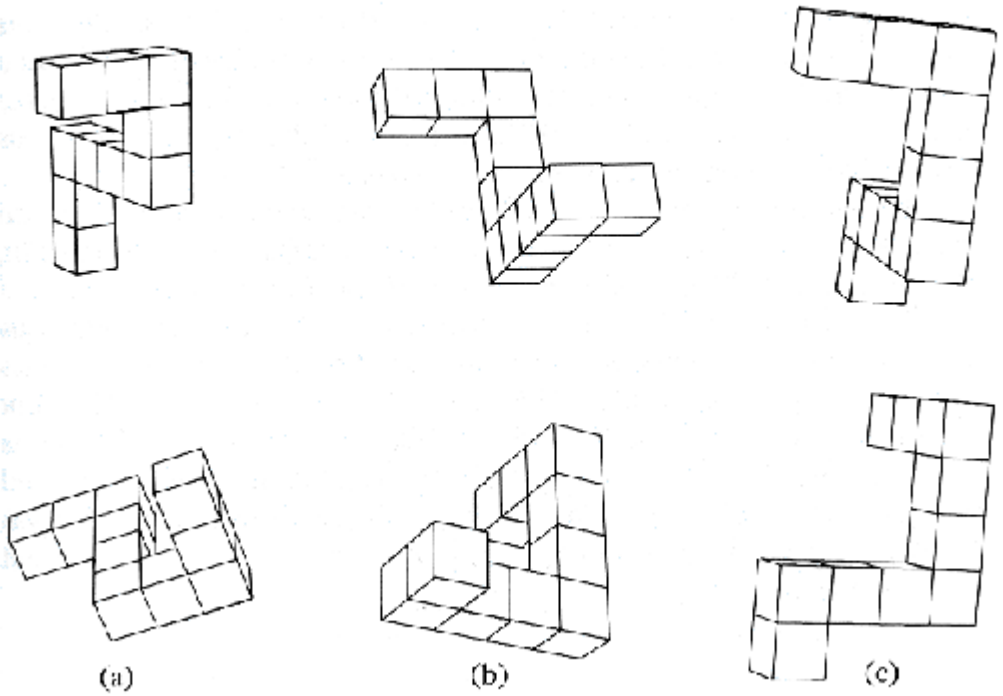


Image Transformation
A Shift Transformation?

Results: rotation of cuboid objects strongly related to Time to accomplish

Some propose that image is being mentally ‘rotated’

Criticism:

What does introspection have to say?

How do we know which way to rotate?

Kosslyn and Schwartz Theory Criticisms

The effect of demand characteristics

Experiment showed effect of experimenter expectancy on results.

Subjects told image distance would affect scanning time showed an effect of distance on scan times

Subjects told image distance would NOT affect scanning time showed NO effect of distance on scan times

Follow up study by another experimenter showed when subjects expected a “U” curve (and others), scanning time was always related to distance

Kosslyn and Schwartz Theory Criticisms

If perception and imagery share similar neural basis then people who have perceptual problems should have imagery problems

But …

> d.f. who has severe impairments in perception can nonetheless perform mental imagery just fine

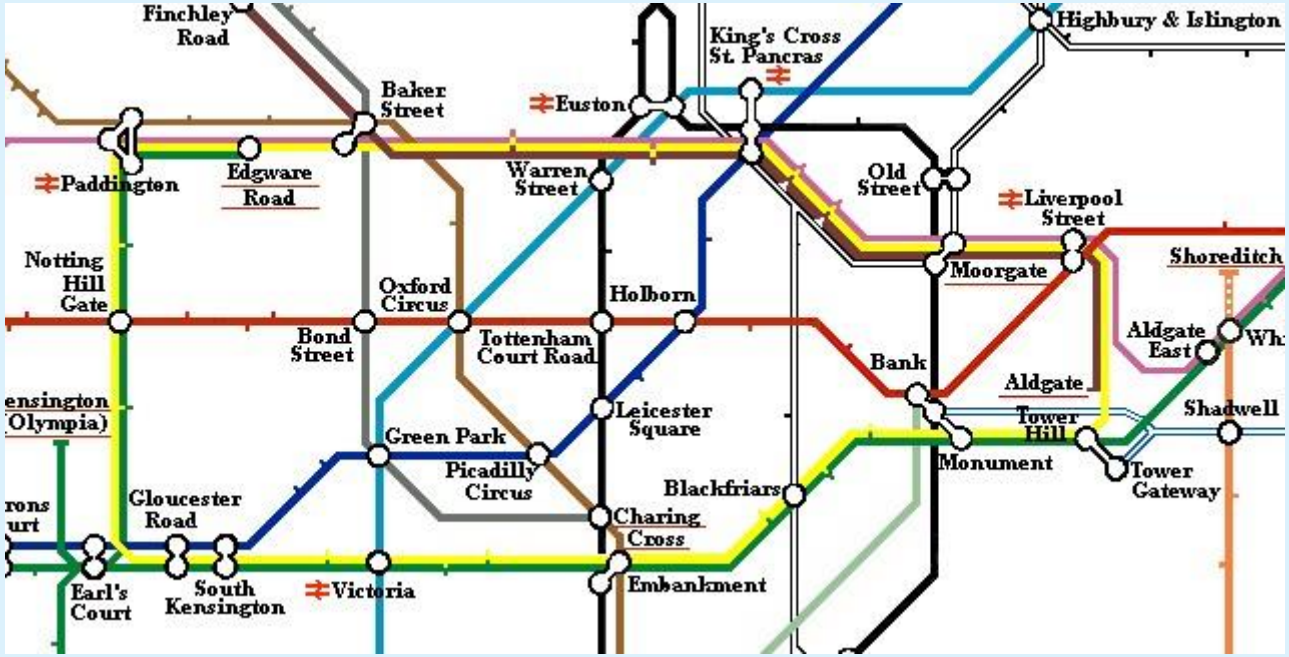
As usual– no definitive answer about how imagery works…

Problem Solving

Well-defined problems:

- A set of possible states that define a problem space
- A clearly defined initial state and goal state
- A set of operators that move you between states
- And any path constraints that tell you what kinds of solutions are acceptable

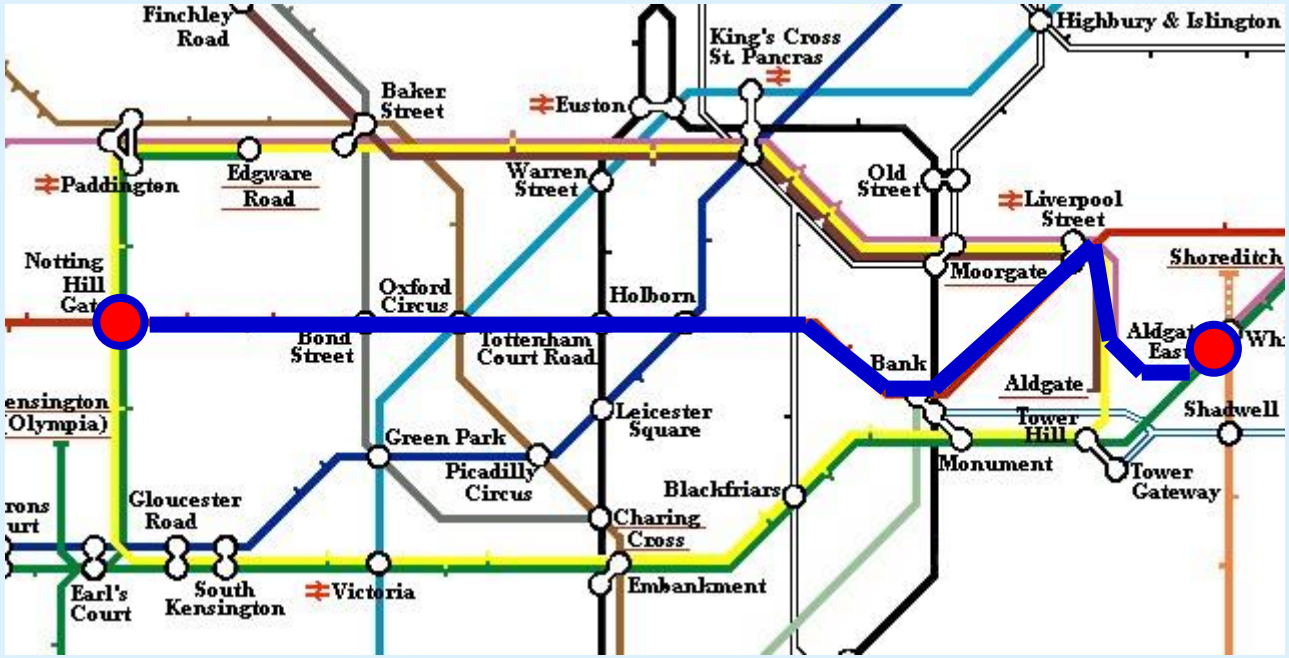
Problem Solving



- The **states** are the stops
- The **operators** are the trains
- The **path constraint** is you want to get there as quickly as possible

Solving the problem involves a search.

Problem Solving



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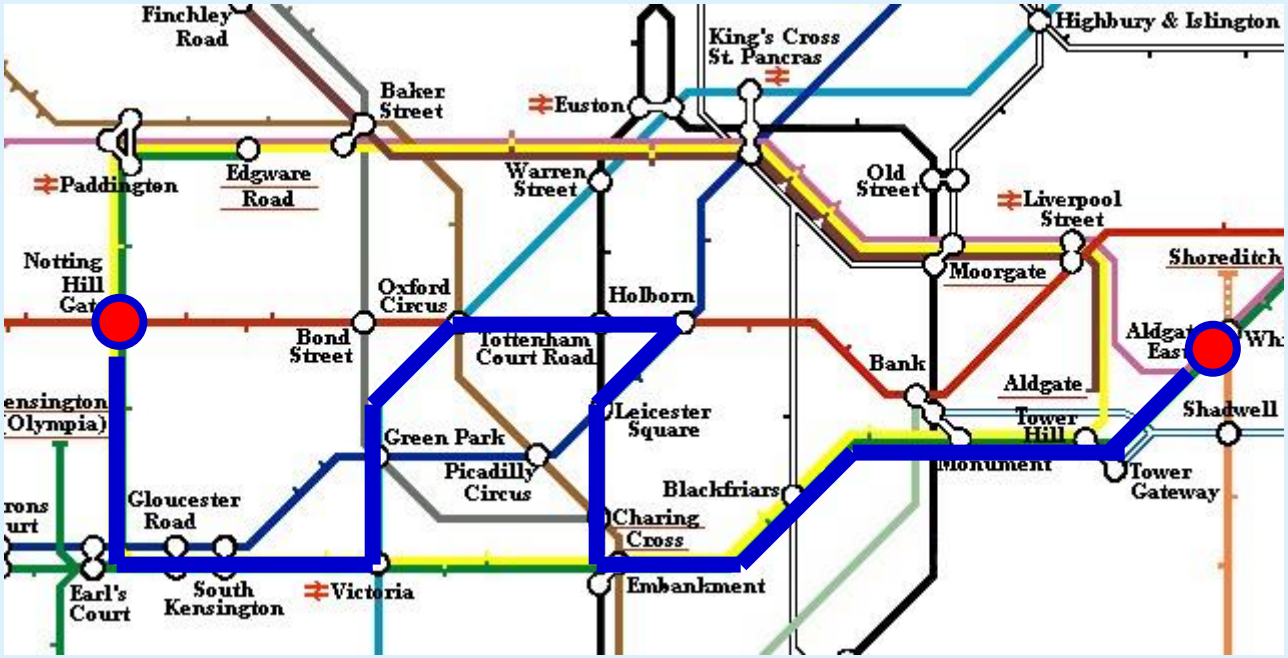

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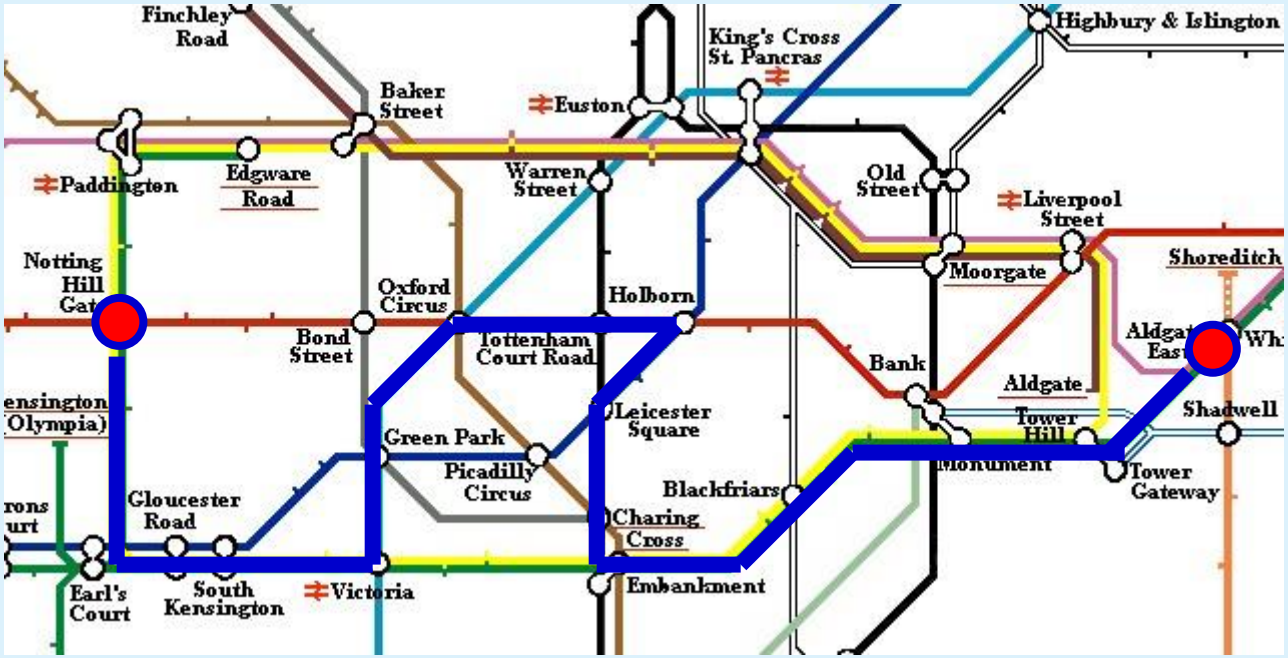


Problems can be then solved by searching for different paths from the initial state to the goal state.

…but we don't have time for all that silliness!

Searching Problem Spaces

Short-cuts in searching through problem space:

Heuristic Search: Don't search *all* pathways, just ones *likely* to be the shortest.

Satisficing: Don't look for the *shortest*, just look for one that is short *enough*.

Means-Ends Analysis: Divide the problem up into sub-goals, that direct your search toward the goal.

Means-End Analysis

1) Compare the current state to the goal state (If they are the same, you're done)

2) Find some operator that will make the difference between them smaller

3) If you can apply the operator, apply it! Otherwise, set up a sub-goal to make it so you *can* apply it

4) Go back to 1)

Improving the Search

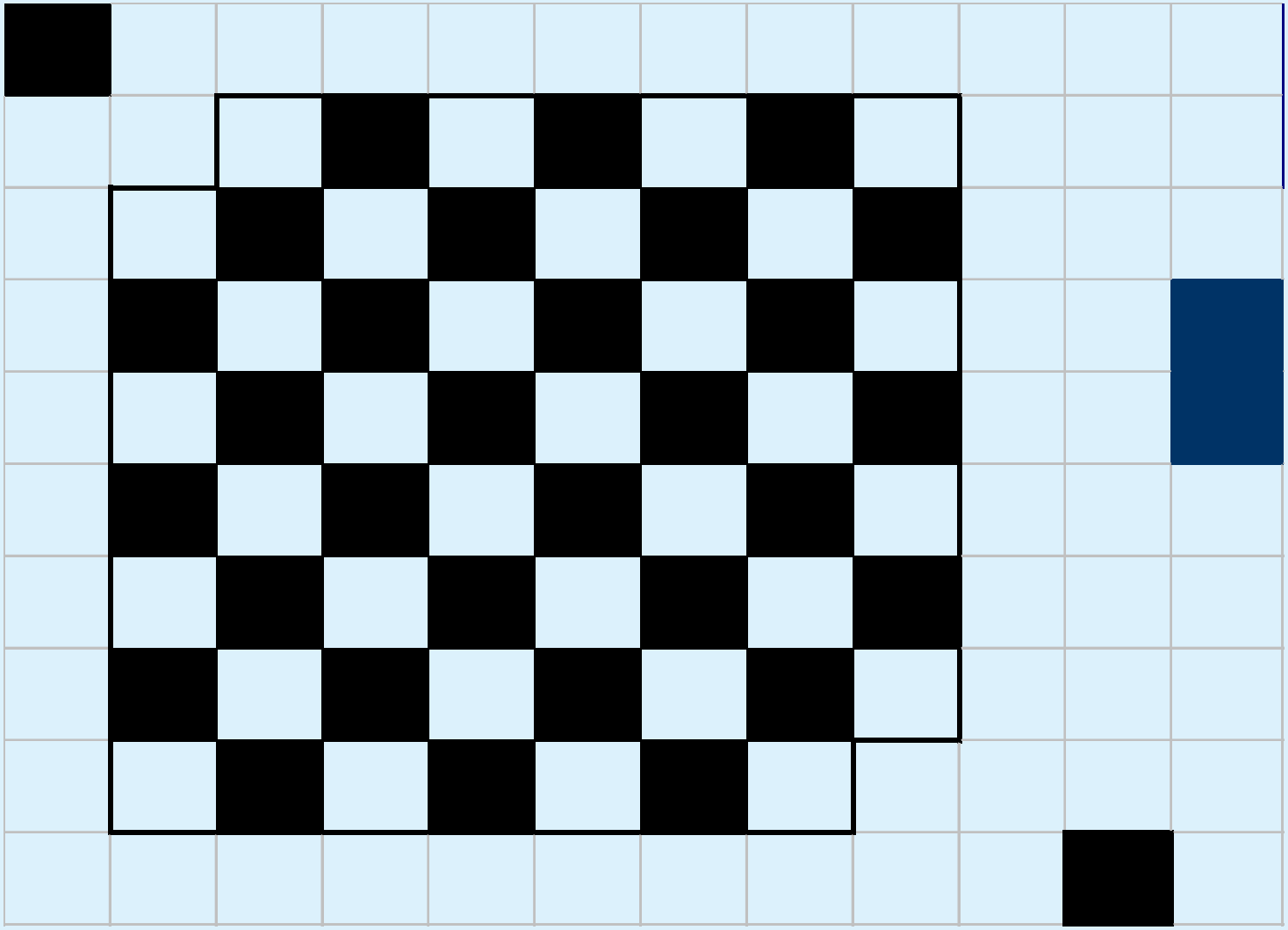
What gets better with expertise:

Chunking: States are represented in terms of meaningful arrangements, rather than individual pieces.

Composition: Several separate steps in a process can be consolidated into a single step.

Schemas: Experience with similar situations in the past can be used to guide new searches.

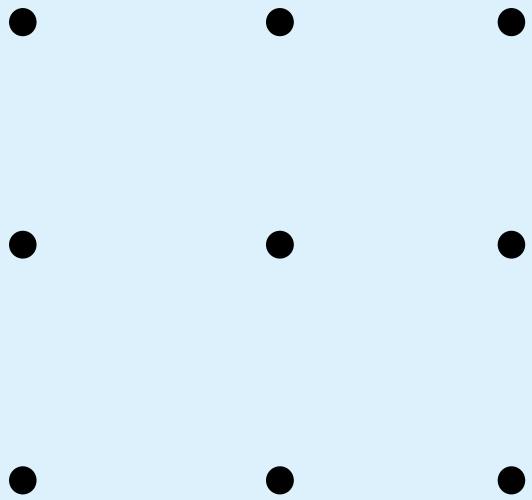
Problem Representation



Problem Representation

Can you solve the 5x5 problem?

Insight Problems



Insight Problems

One morning, exactly at sunrise, a Buddhist monk began to climb a tall mountain. The narrow path, no more than a foot or two across, spiraled around the mountain to a glittering temple at the summit. The monk ascended the path at varying rates of speed, stopping many times along the way to rest and to eat dried fruit he carried with him. He reached the temple shortly before sunset. After several days of fasting, he began his journey back along the same path, again beginning exactly at sunrise, walking at variable speeds and resting along the way.

Show that there is a time when the monk was at exactly the same spot at exactly the same time of day on each journey.

Insight Problems

"Insight Problems" involve a sudden change in the mental representation of the problem space, rather than a search of paths *within* one problem space.

How do we discover a new representation?

Creativity: How do we find a totally new way of looking at something?

Scientific Creativity often seems to make sure of abstract similarities between otherwise unrelated domains.

Analogy

“Atoms are like the Solar System.”

Nucleus:
- **positive charge**
- **too small to be seen**
- **between 1 and 100 AMU**
- **[…]**

Electrons:
- **negative charge**
- **too small to be seen**
- **have wavelike properties**
- **[…]**

Sun:
- **hot**
- **yellow**
- **millions of tons**
- **[…]**

Planets:
- **cold**
- **solid, with atmosphere**
- **sometimes have moons**
- **[…]**

Analogy

"Atoms are like the Solar System."

(Nucleus, Electrons):
- **B revolves around A**
- **A is bigger than B**
- **A is more massive than B**
- **[…]**

(Sun, Planets):
- **B revolves around A**
- **A is bigger than B**
- **A is more massive than B**
- **[…]**

The mapping aligns nucleus with sun, electrons with planets
(even though individually these items are not similar)