CREATIVE SOLUTIONS TO PROBLEMS

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Almost all of my papers are on the web page.

APPROACHES TO ARTIFICIAL INTELLIGENCE

biological—Humans are intelligent; imitate humans observe and imitate at either the psychological or neu physiological level

engineering—Achieve goals in the world—so study world

1. Write programs using non-logical representations.
2. represent facts about the world in logic and dec what to do by logical inference

We aim at human level AI, and the key phenomeno the common sense informatic situation.

THE COMMON SENSE INFORMATIC SITUATIO

- Contrasts with the situation in a formal scientific t ory and most AI theories. Science is embeddec common sense.

- No limitation on what information may be releva Theories must be elaboration tolerant.

- Needs non-monotonic reasoning.

- Needs approximate entities.

A LOGICAL ROAD TO HUMAN LEVEL AI

- Use *Drosophilas* that illustrate aspects of represen
tion and reasoning problems.

- Concepts, context, circumscription, counterfactu
consciousness, creativity, approximation

- narrative, projection, planning

- mental situation calculus

- domain dependent control of reasoning

IDENTIFYING CREATIVE SOLUTIONS TO PROBLEMS

- Making creative programs will be hard.

- Making a program that will recognize creativity is e
ier but still too hard for me now.

- Distinguish the idea of a solution from the solut
itself.

IDENTIFYING CREATIVE SOLUTIONS TO PROBLEMS

- I can identify, thinking by hand, creative solutions

- I can sometimes express the creative idea by a log formula.

- The *Drosophila* for this research is the mutilated ch board problem.

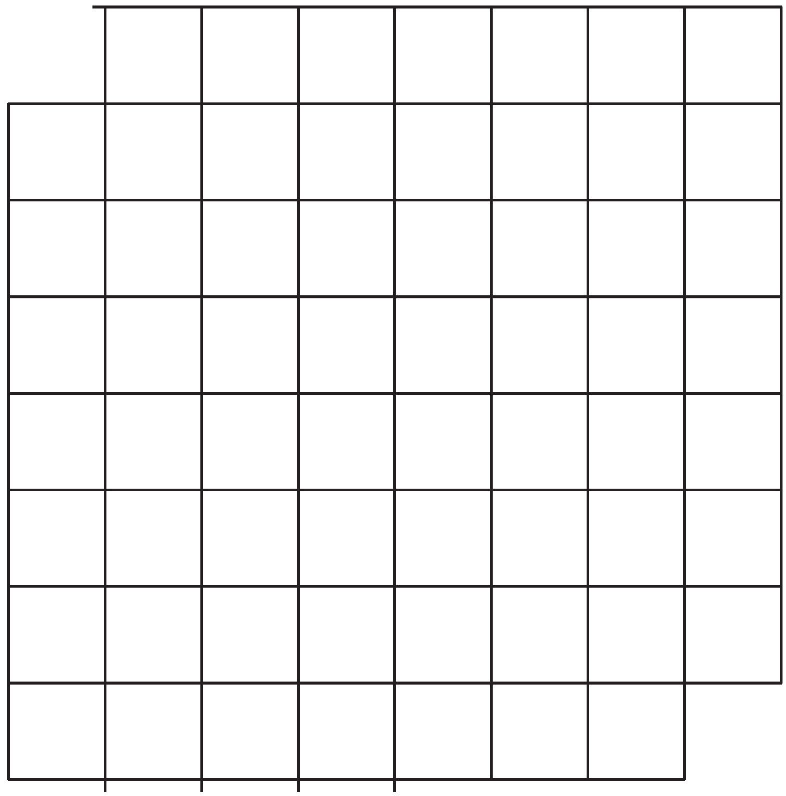
- As much as possible, an idea should be one thing, it should be promising in itself.

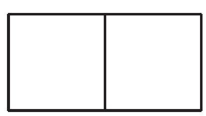
- I know four creative solutions to the mutilated chec board problem, the standard solution, Marvin M sky's solution, Shmuel Winograd's solution and D itri Stefanuk's 17 similar solutions.

- I tried to express each idea as concisely as was co patible with leading a person to the solution.

THE MUTILATED CHECKERBOARD

MUTILATED CHECKERBOARD





DOMINO

THE STANDARD SOLUTION

What's the idea of the solution that a creative person
program may come up with? This is distinct from giv
the detailed argument. English first—then a formula.

Color the board as in a checkerboard.

A domino covers two squares of the opposite color.

Some people also need that the removed squares are
the same color.

THE COMMON FACTS IN SET THEORY

$$Board = Z8 \times Z8,$$

$$mutilated\text{-}board = Board - \{(0,0),(7,7)\},$$

$$domino\text{-}on\text{-}board(x) \equiv (x \subset Board) \wedge card(x) = 2$$
$$\wedge (\forall x1\ x2)(x1 \neq x2 \wedge x1 \in x \wedge x2 \in x$$
$$\rightarrow adjacent(x1, x2))$$

$$
\begin{aligned}
&adjacent(x1, x2) \equiv \\
&|c(x1,1) - c(x2,1)| = 1 \wedge c(x1,2) = c(x2,2) \\
&\vee \\
&|c(x1,2) - c(x2,2)| = 1 \wedge c(x1,1) = c(x2,1).
\end{aligned}
$$

$$adjacent(x1, x2) \equiv$$
$$|c(x1,1) - c(x2,1)| + |c(x1,2) - c(x2,2)| = 1,$$

$$partial\text{-}covering(z)$$
$$\equiv (\forall x)(x \in z \rightarrow domino\text{-}on\text{-}board(x))$$
$$\wedge (\forall x\ y)(x \in z \wedge y \in z \rightarrow x = y \vee x \cap y = \{\})$$

Theorem:

$$\neg(\exists z)(partial\text{-}covering(z) \wedge \bigcup z = mutilated\text{-}board)$$

Makers of automatic or interactive theorem provers often don't like set theory because of the comprehension principle. They had better get used to it.

THE UNMATHEMATICAL REQUIRE MANY HINT

- Take into account the colors.

- What are the colors of the diagonally opposite cor squares?

- How many of each color does a domino cover?

- How many of each do n dominoes cover? huh?

- What about 7 dominoes?

- How many of each do n dominoes cover? Equal.

- Two blacks left over, but maybe a more clever per . . . .

MARVIN MINSKY'S IDEA

Starting with the two square diagonal next to an excluded square, successively compute how many dominoes must project from each diagonal to the next diagonal.

- Good enough hint for a horse doctor.

- Not a sentence, but a program fragment—without termination condition.

SHMUEL WINOGRAD'S IDEA

• Note that an odd number of dominoes project from
top row to the second and continue.

• A movie showed a math teacher rejecting this idea
Socratically leading the student to the standard solut

• Winograd showed the student was on the right tra
but most people need something like

• Starting with the top row, compute the parity of
number of dominoes projecting down out of each r
Consider the parity of the sum. Repeat going horiz
tally. Compute the parity of the total number of do
noes compared to the sum of the two parities.

DIMITRI STEFANUK'S IDEA

The idea seems to involve two program fragments.

Label an arbitrary square 1, label its rectilinear neigbors 2, their neighbors 3, etc.

Starting with $n = 1$, successively compute how many dominoes must project from the set of squares labelled n to the squares labelled $n + 1$.

FORMULAS FOR MINSKY SOLUTION

$$diag(n) = \{x \in Board | c(x,1) + c(x,2) = n\}$$

$$covering(u) \equiv partial\text{-}covering(u) \wedge \bigcup u = Board$$

$$covering(u) \wedge 2 \leq n \leq 13$$
$$\rightarrow$$
$$dominoes\text{-}into(n,u) = \{x \in u |$$
$$x \cap diag(n-1) \neq \{\} \wedge x \cap diag(n) \neq \{\}\}$$

$$card(dominoes\text{-}into(n,u)) + card(dominoes\text{-}into(n+1,$$
$$= card(diag(n))$$

$$covering(u) \rightarrow card(dominoes\text{-}into(2, u)) = 2$$

REALITY BEHIND APPEARANCE