Towards Modeling Real-Time Game Player with Soar

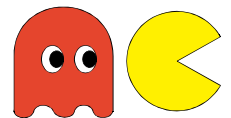## - Incorporation of Perceptual Operators in the Model-

Takehiko Ohno (NTT)
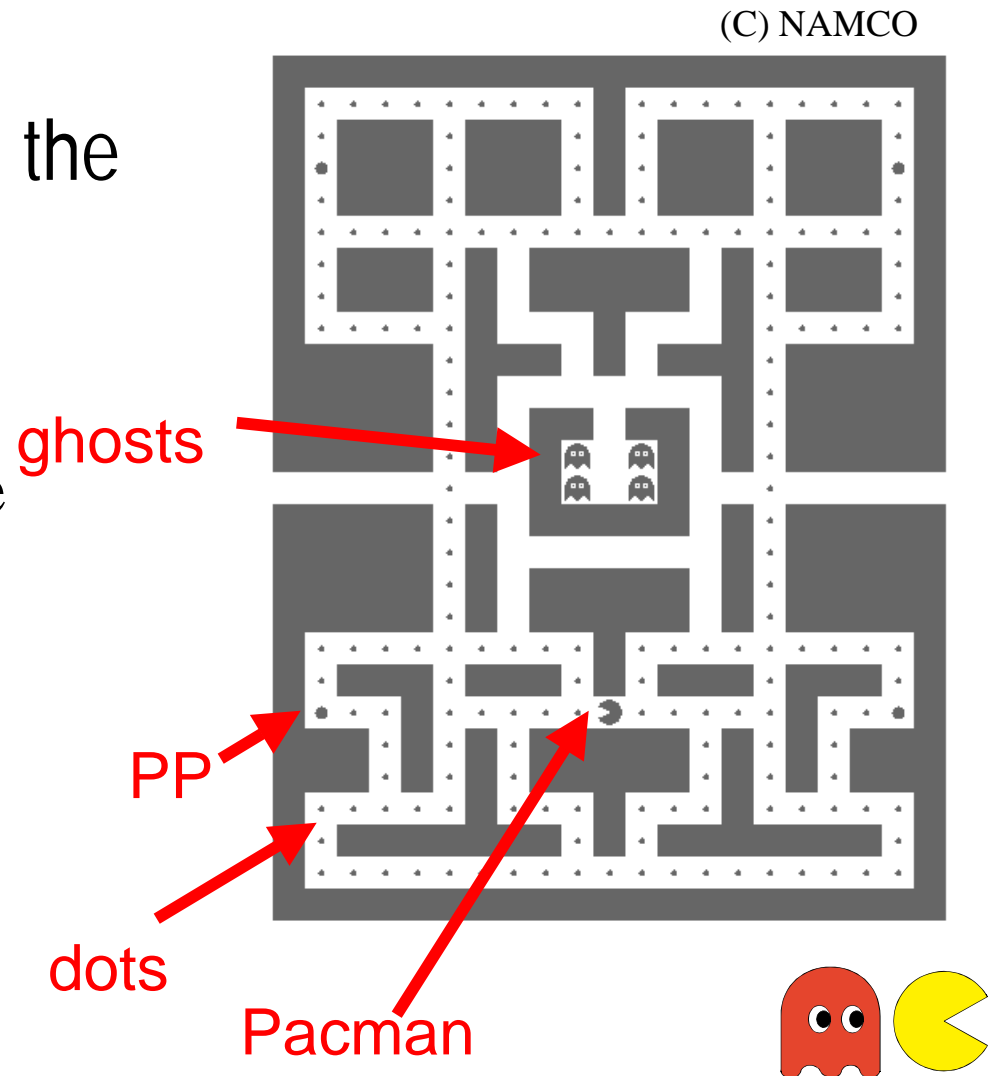
Hidemi Ogasawara (Chukyo Univ.)

Goals

- Build a cognitive model of expertise
  - From novice to expert
  - Explain the skill difference

- Focus on highly interactive tasks
  - Super Mario Brothers 3 (John,1994)
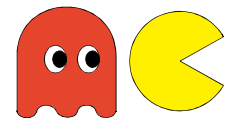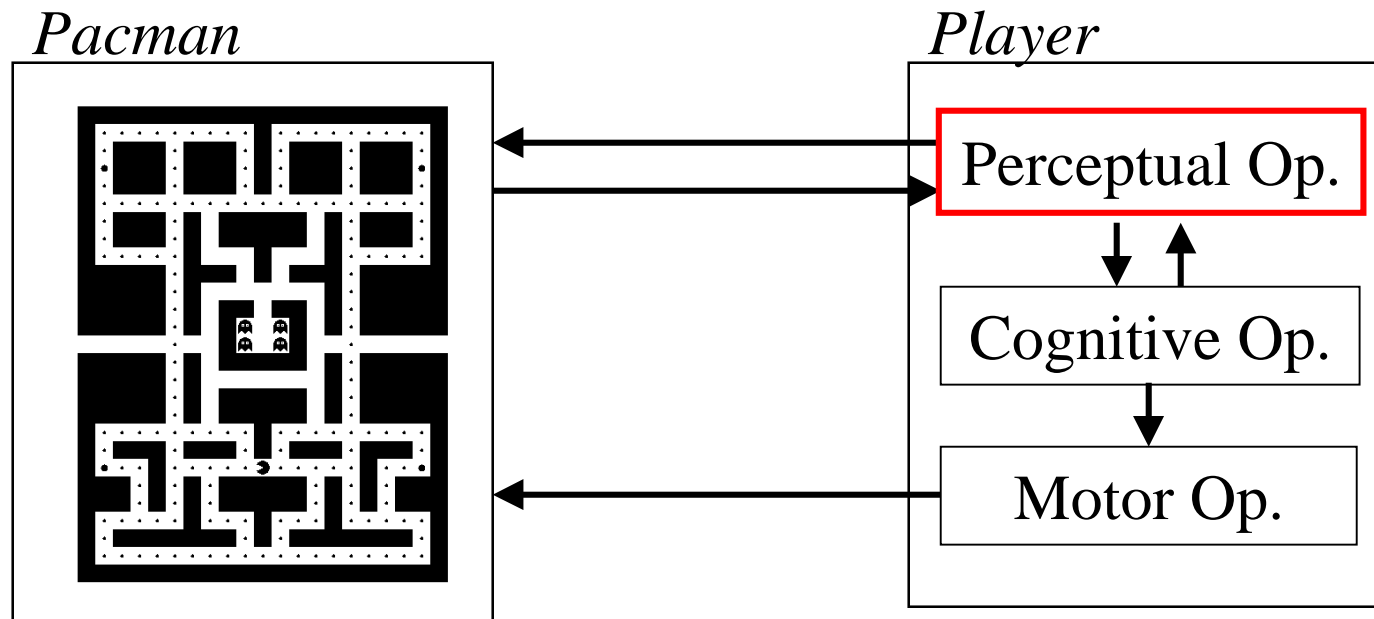
Pacman: An Example

(C) NAMCO

- Complete information on the screen

- Time constraints
  - Cannot encode all the information

ghosts
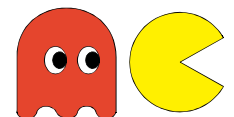
PP

dots

Pacman

What is Skill Difference ?

- Knowledge difference

  - Production-rule difference?

- Focus on Perceptual Operator.

Pacman

Player

Experiment: Play Pacman!

- 1 subject (novice Pacman player)
- 24 session, 120 trials (1.5 month)
- Sun SS10 + 19inch display
- Record the play data (20Hz)
  - Keystroke (cursor key)
  - Eye mark (EMR-NC)
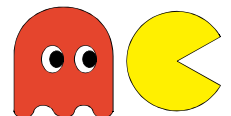 - Log of ghosts' movement
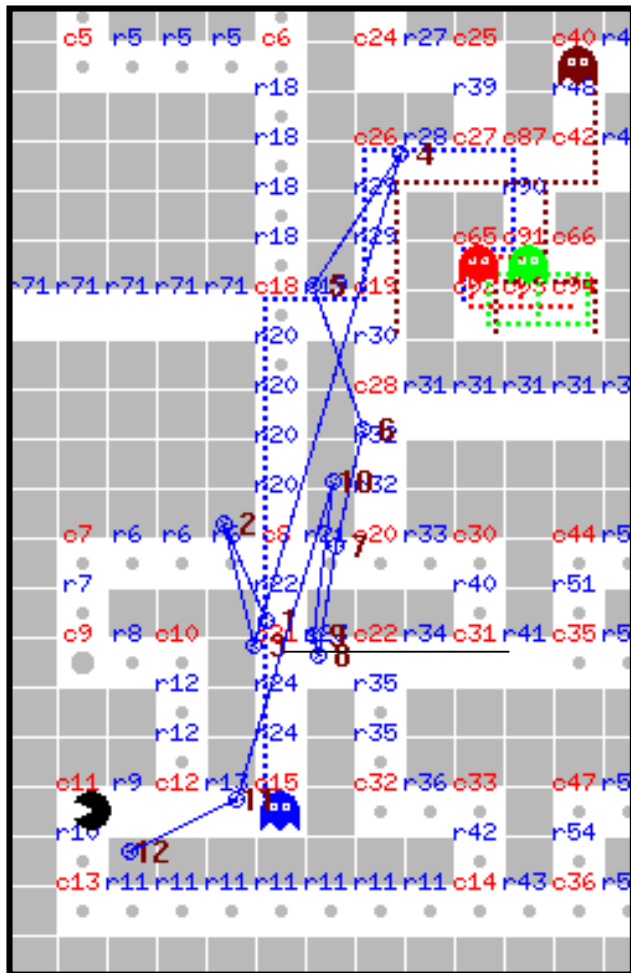
Cognitive Studies with EMR

- Analyze human behavior from many angles
  - Verbal protocol
  - Eye mark
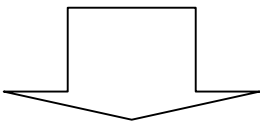 - Operation log
- Developed the new eye mark recorder, EMR-NC

- Head-free
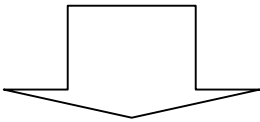- High accuracy: 0.28deg
- Sampling rate: 30Hz

Task Analysis

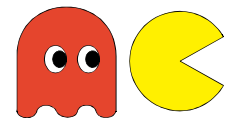Player's log data (keystroke, eye mark)

Time	Key	Eye Mark
0 24	$left_{c21}$	$course_{c21}$ $junction_{r6}$ $course_{c21}$
25 52	up_{r20}	$ghost_{r28}$ $junction_{r19}$
53 95	$down_{c15}$	$ghost_{r19}$ $junction_{r32}$ $junction_{r21}$
		$junction_{r23}$ $ghost_{r32}$ $course_{c15}$
96 115	$left_{c11}$	$course_{r13}$ $course_{r9}$

[Session 5, trial 2, 5.75sec]

Operator Sequence

Operators

- Goal: get-a-high-score

Move the eye

Visual Information

P-Op

P-1: look-front
P-2: look-front-corner
P-3: look-nearest-ghost

C-Op

O-1: avoid-danger
O-2: eat-dots
O-3: eat-PP
O-4: kill-ghosts
O-5: gather-ghosts

Key

M-Op

M-1: press-UP
M-2: press-DOWN
M-3: press-LEFT
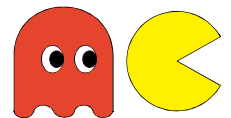M-4: press-RIGHT
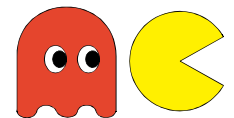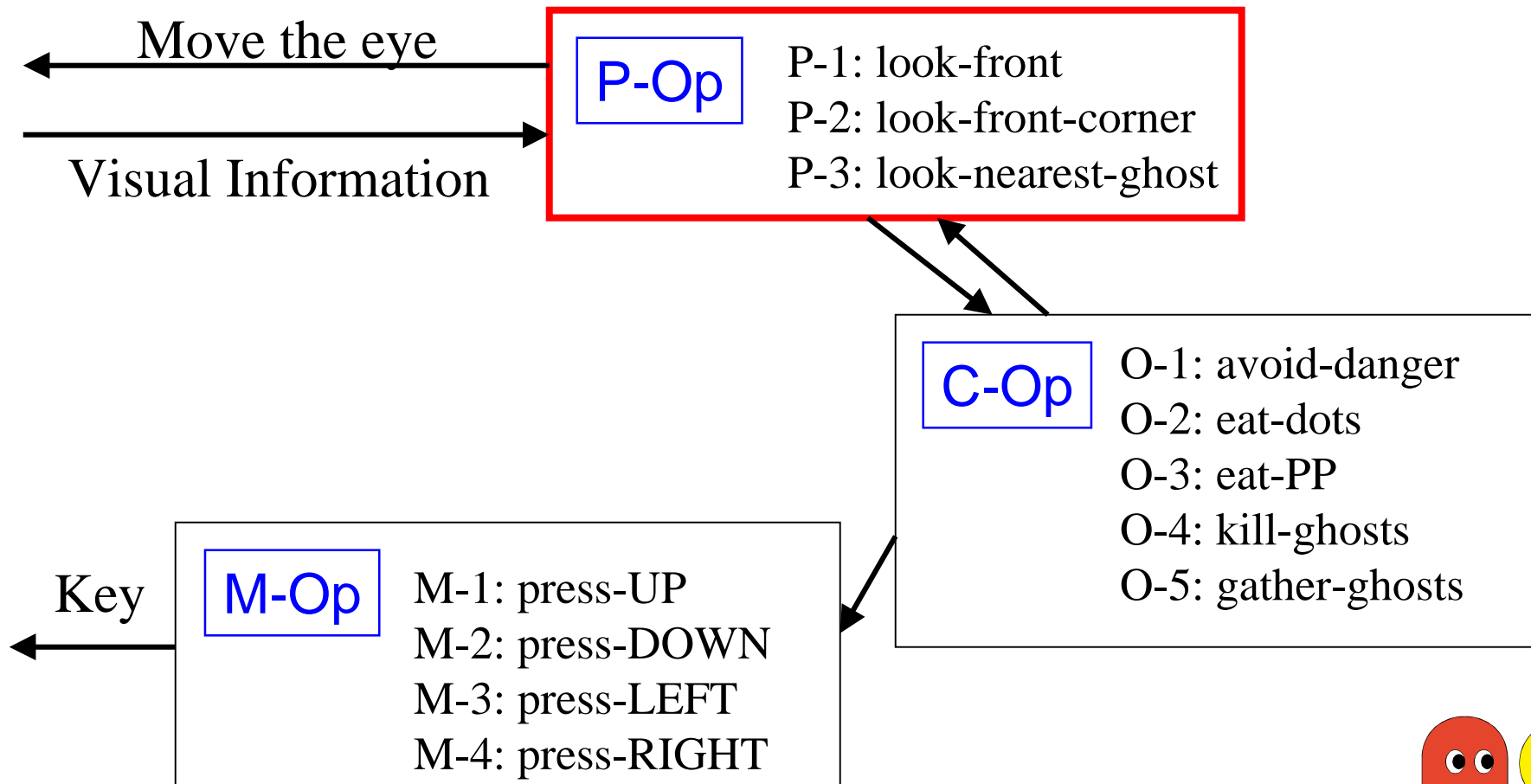
Time Constraints

- Perceptual Operator
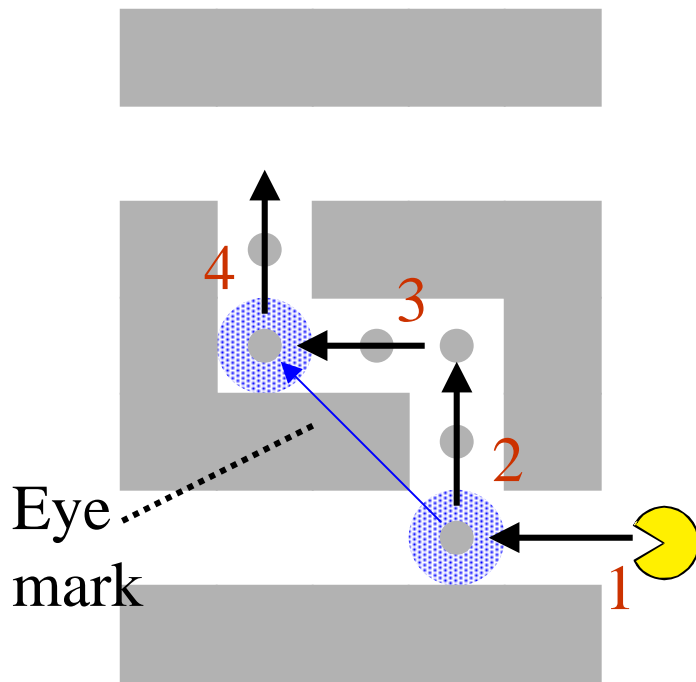
  - 2.34 times/sec

- Motor Operator

  - 1.02 times/sec

Choose next operator from **two** or **three** pieces of visual information.

P/M=2.3

Operators (cont.)

Eye
mark

[session1, trial 2, 256-301 frame]

1. Move-forward
    P: look-front-corner
        - no ghosts
        - front: no-food, right: food

2: Turn-right
    M: press-UP
    P: look-front-side
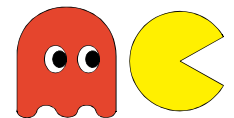   - no ghosts
        - right: food

3. Turn-left
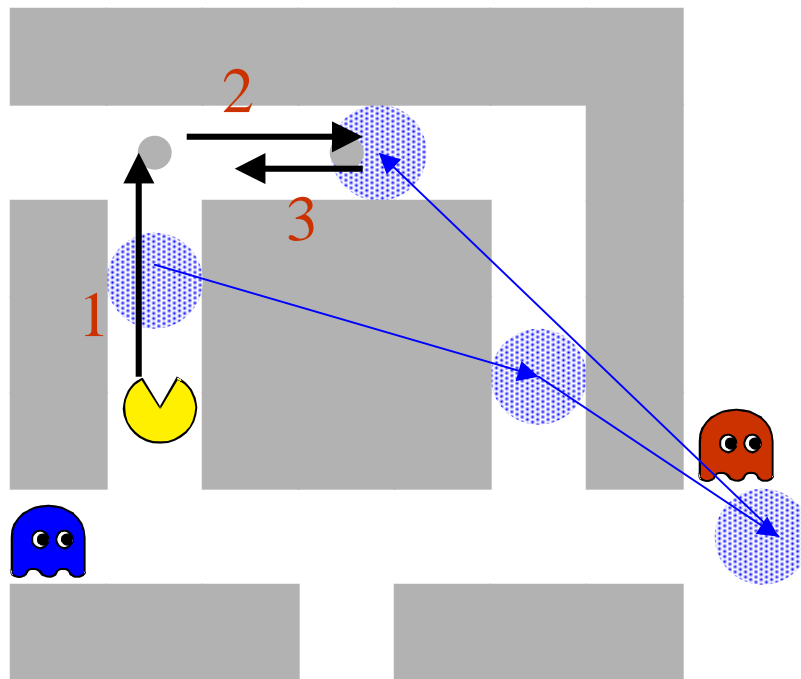   M: press-LEFT
    P: look-front-corner
        - right: food

4. Turn-right
    M: press-UP

Operators (cont.)

Wrong operation

[session10, trial 2, 666-693 frame]

1. Move-forward
   P: look-front
       - no ghosts
       - right: course
2: Turn-right
   M: press-RIGHT
   P: look-course
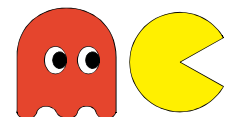   - ghost! → O-1: avoid-danger
3. Turn-back
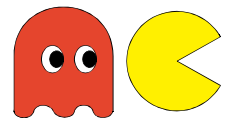   M: press-LEFT
   P: look-front-corner
       - right: food

Killed

Skill Difference

- Adequate Information
  - A beginner does not use correct perceptual operator.

- Strategies
  - Additional cognitive operators
    - Gather ghosts
    - Escape from ghosts
  - Maze dependent cognitive operators
    - Change the operator in the specific position

Implementation

- Pac-Soar (Ogasawara,1996)
  - Soar 6 version (Soar + C)
- Currently Implementing
  - Soar 8.2 version (Soar + Tcl/Tk)

Perceptual Operator

Pacman

Tcl/Tk

400msec

Player

Soar

Motor Operator

50msec/cycle
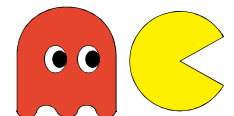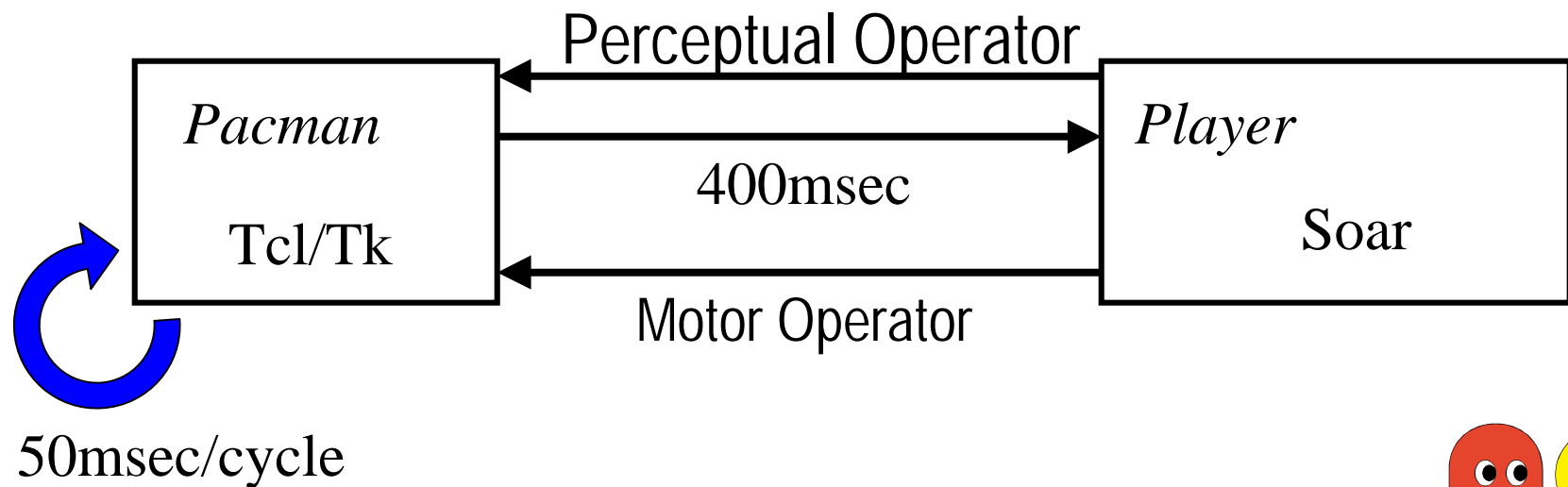
Summary

- Focus on Perceptual Operator.

- Use of eye mark data into the model

- Challenge:
  - Generalize the task