Übung zur Vorlesung Mensch-Maschine-Interaktion

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(basierend auf den Folien von Paul Holleis, WS 06/07)

Übersicht

- GOMS (Goals, Operators, Methods, Selection rules)
- KLM (Keystroke-Level Model)
- Mobile Phone Extension

GOMS (Goals, Operators, Methods, Selection Rules)

- Reduce a user‘s interaction with a computer to elementary actions („operators“)

- GOMS elements:
  - **Goal:** what the user wants to accomplish
  - **Operator**: action perfomed to accomplish a goal
  - **Method**: sequence of operators to achieve a goal
  - **Selection Rule**: selection of method for solving a goal (if alternatives exist)
- Goals are achieved by solving subgoals in a divide-and-conquer fashion

- Motivation
  - Need of early design decisions
  - Building working prototypes is expensive
  - Need of clear metrics for judgments

GOMS Example

- Goal: Close the window that has the focus (Windows XP)

```
GOAL: CLOSE-WINDOW
.   [select GOAL: USE-MENU-METHOD
        .   MOVE-MOUSE-TO-FILE-MENU
        .   PULL-DOWN-FILE-MENU
        .   CLICK-OVER-CLOSE-OPTION
    GOAL: USE-KEY-SHORTCUT-METHOD
        .   HOLD-ALT-KEY
        .   PRESS-F4-KEY
    GOAL: USE-CLOSE-BUTTON-METHOD
        .   MOVE-MOUSE-BUTTON
        .   LEFT-CLICK-BUTTON]
```

Operators

Method

Method

Method

alternatives to achieving the goal

```
For a particular user:

   Rule 1: Select CLOSE-BUTTON-METHOD unless
           another rule applies
   Rule 2: Select USE-KEY-SHORTCUT-METHOD if
           no mouse is present
```

USE-MENU-METHOD:

USE-CLOSE-BUTTON-METHOD:

- Models are written in pseudo-code

GOMS Example II

ATM: Why you need to get your card before the money …

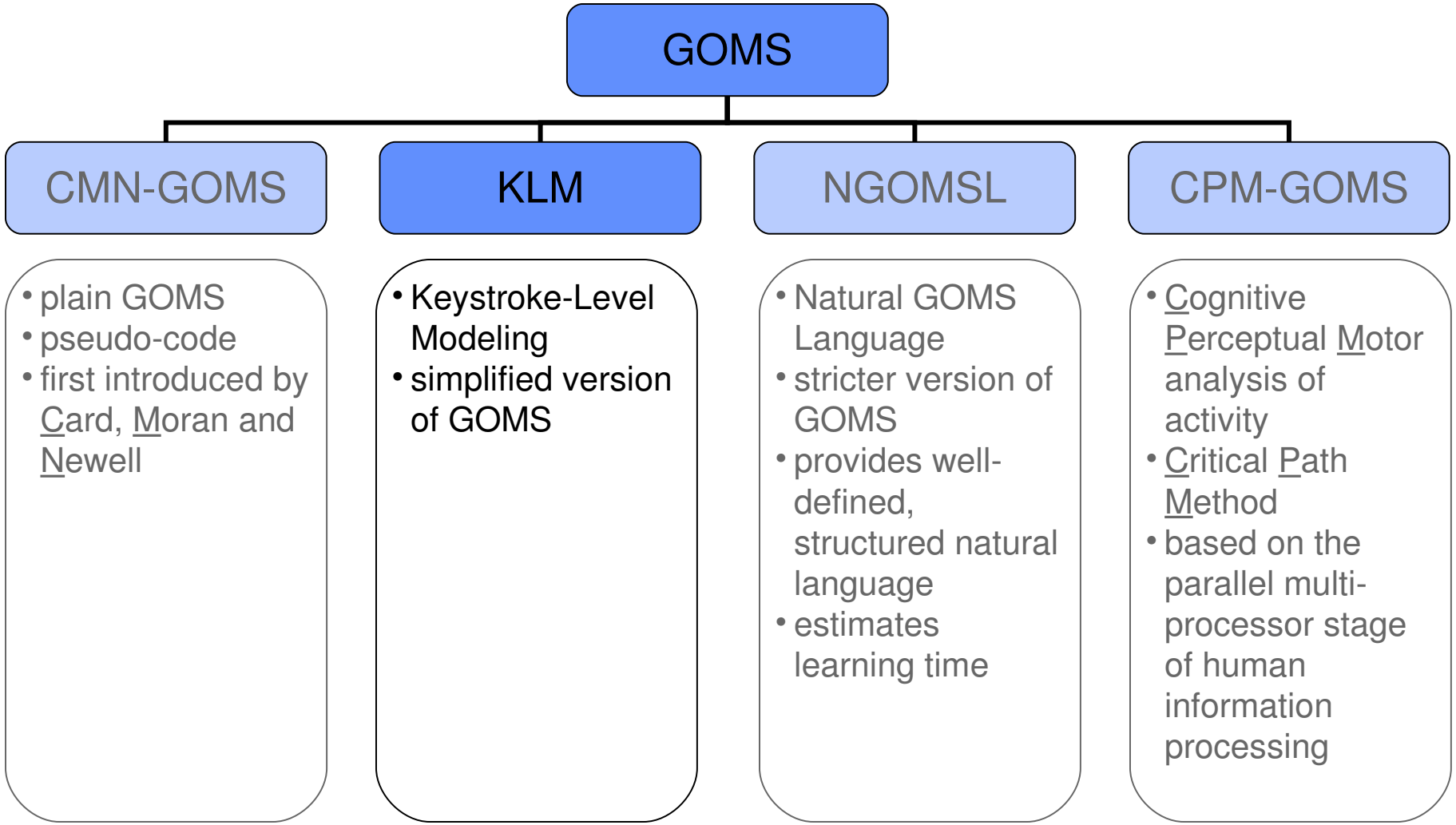
Design to lose your card:

```
GOAL: GET-MONEY
.  GOAL: USE-CASH-MACHINE
   .    INSERT-CARD
   .    ENTER-PIN
   .    SELECT-GET-CASH
   .    ENTER-AMOUNT
   .    COLLECT-MONEY
        (outer goal satisfied!)
   .    COLLECT-CARD
```

Design to keep your card:

```
GOAL: GET-MONEY
.  GOAL: USE-CASH-MACHINE
   .    INSERT-CARD
   .    ENTER-PIN
   .    SELECT-GET-CASH
   .    ENTER-AMOUNT
   .    COLLECT-CARD
   .    COLLECT-MONEY
        (outer goal satisfied!)
```

GOMS Variations



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Keystroke-Level Model

- Simplified version of GOMS
  - only operators on keystroke-level
  - no goals
  - no methods
  - no selection rules
- KLM predicts how much time it takes to execute a task
- Execution of a task is decomposed into primitive operators:
  - physical motor operators (pressing button, pointing, drawing line, …)
  - mental operator (preparing for a physical action)
  - system response operator (user waits for the system to do something)

KLM Operators

Each operator is assigned a duration (amount of time a user would take to perform it):

Operator		Execution Time
K	keystroke or button press	0.28 sec [0.12 sec – 1.2 sec]
P	pointing the mouse to a target	1.1 sec
H	homing: hand movement between mouse and keyboard	0.4 sec
M	mental thinking	1.2 sec [0.6 sec – 1.35 sec]
D	drawing	varies
R	system response	varies

Levels of Detail

The steps of a task performed by a user can be viewed at different levels of detail:

- Abstract: `correct wrong spelling`
- Concrete: `mark-word`
  `delete-word`
  `type-word`
- Keystroke-Level: `hold-shift`
  `n·cursor-right`
  `recall-word`
  `del-key`
  `n·letter-key`

Predicting the Task Execution Time

- Execution Time
  - OP: set of operators
  - n_{op}: number of occurrences of operator op

$$T_{execute} = \sum_{op \in OP} n_{op} \cdot op$$

- Example task on Keystroke-Level:

	Sequence:
1. `hold-shift`	K (Key)
2. `n·cursor-right`	n·K
3. `recall-word`	M (Mental Thinking)
4. `del-key`	K
5. `n·letter-key`	n·K

- Operator Time Values: K = 0.28 sec. and M = 1.35 sec
  2n·K + 2·K + M = 2n·0.28 + 1.91 sec
  → time it takes to replace a n=7 letter word: T = 5.83 sec

CMN-GOMS vs. KLM

CMN-GOMS

- pseudo-code (no formal syntax)
- very flexible
- goals and subgoals
- methods are informal programs
- selection rules
  ⇨ tree structure: use different branches for different scenarios
- time consuming to create

KLM

- simplified version of GOMS
- only operators on keystroke-level
  ⇨ focus on very low level tasks
- no goals
- no methods
- no selection rules
  ⇨ strictly sequential
- quick and easy

Problem with GOMS in general

- only for well defined routine cognitive tasks
- assumes statistical experts
- does not consider slips or errors, fatigue, social surroundings, …

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Mobile Phone Interaction

- What is special about mobile phones?
  - Different screen size
  - Different keyboard / keys
  - Different text input methods
  - Built-in microphone speaker
  - Different storage places
- Attention shifts to real world
- Distractions during tasks more probable
- Advanced interaction
  - Take pictures
  - Recognise visual markers
  - Touch tags
  - Gestures
- …

KLM for (Advanced) Mobile Phone Interaction

Adopted Operators		Execution Time
K	keystroke • Keypad • Hotkeys	 0.36 sec 0.16 sec
M	mental thinking	1.2 sec [0.6 – 1.35]
R	system response	varies
H	homing: movement from hand to ear	0.95 sec
P	pointing (slightly changed meaning)	1.0 sec

Added Operators		Execution Time
I	initial act (e.g. place mobile phone at your ear)	1.18 sec – 5.4 sec
E	execution (additional effort for pointing)	1.23 sec
G	gesture	0.80 sec
A	macro attention shift (A_{macro}) micro attention ahift (A_{micro})	0.36 sec 0.14 sec
D	slight distraction strong distraction	6% (multiply by 1.06) 21% (multiply by 1.21)

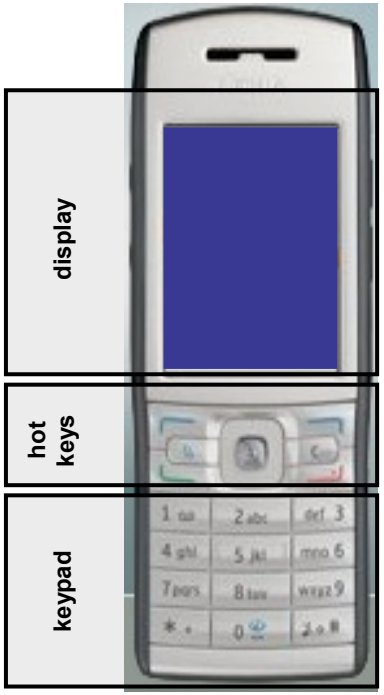
Pointing

- Pointing with a mobile phone means moving the phone to a target area

- Execution Operator
  - additional effort for pointing operations
  - e.g. focus on visual marker

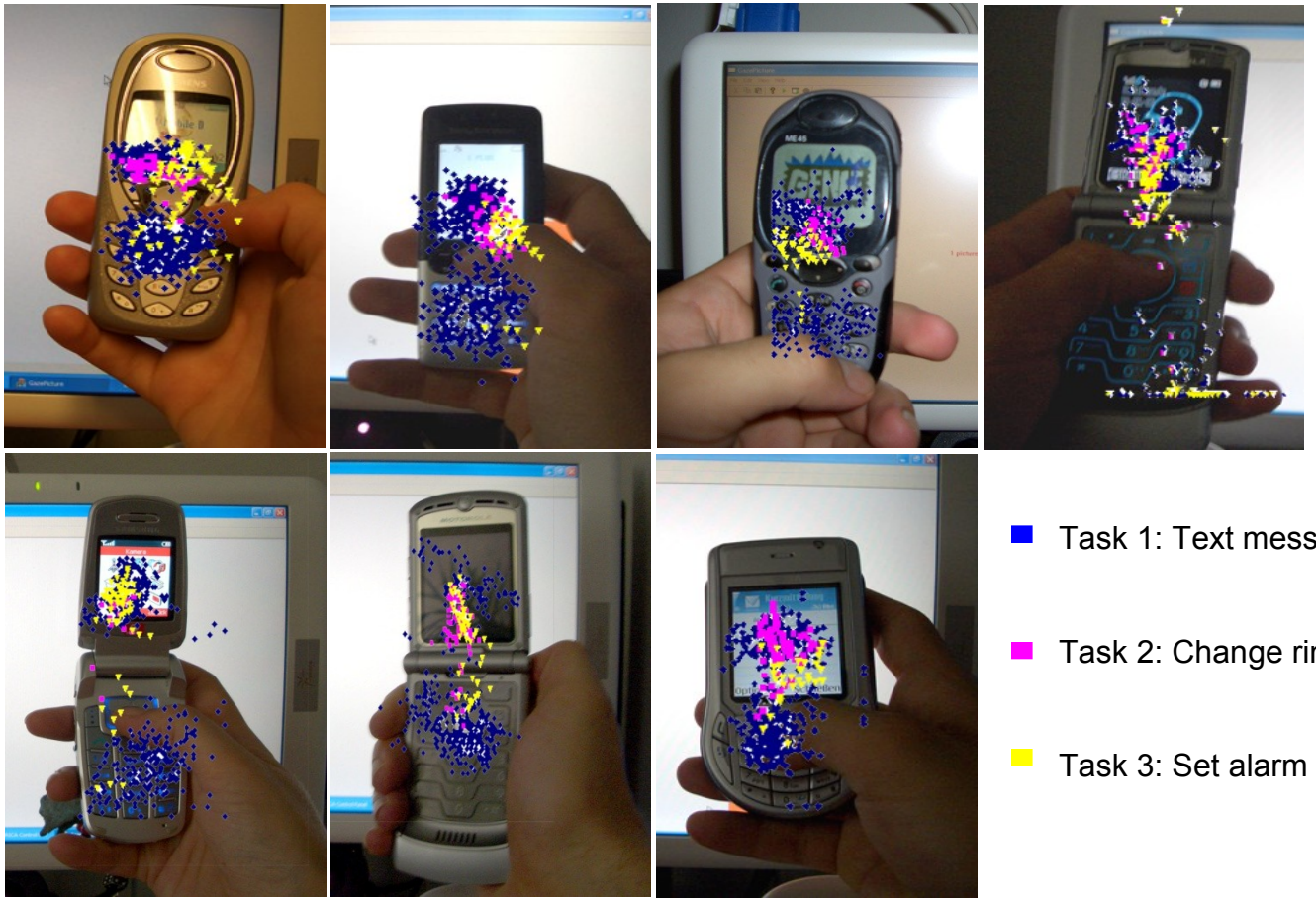
Attention Shifts

- Micro Attention Shift
  change concentration between different parts of the mobile phone



- Macro Attention Shift
  look from phone to real world or back

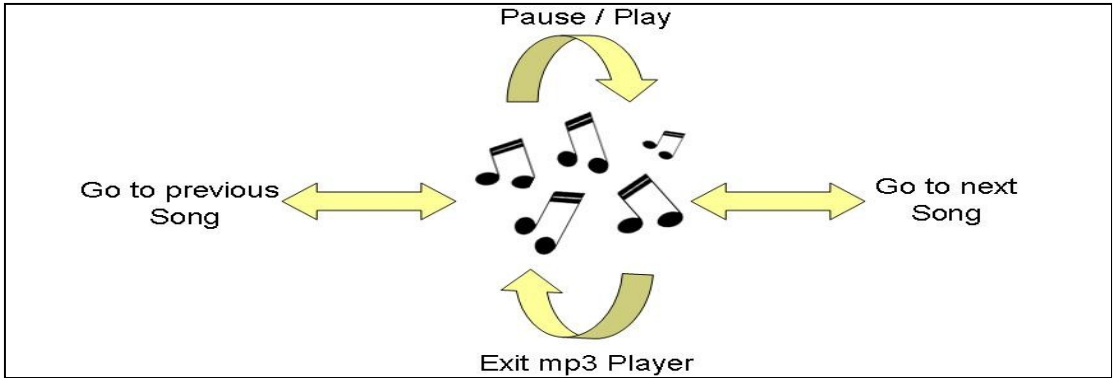
Micro Attention Shift



- Task 1: Text message
- Task 2: Change ring tone
- Task 3: Set alarm

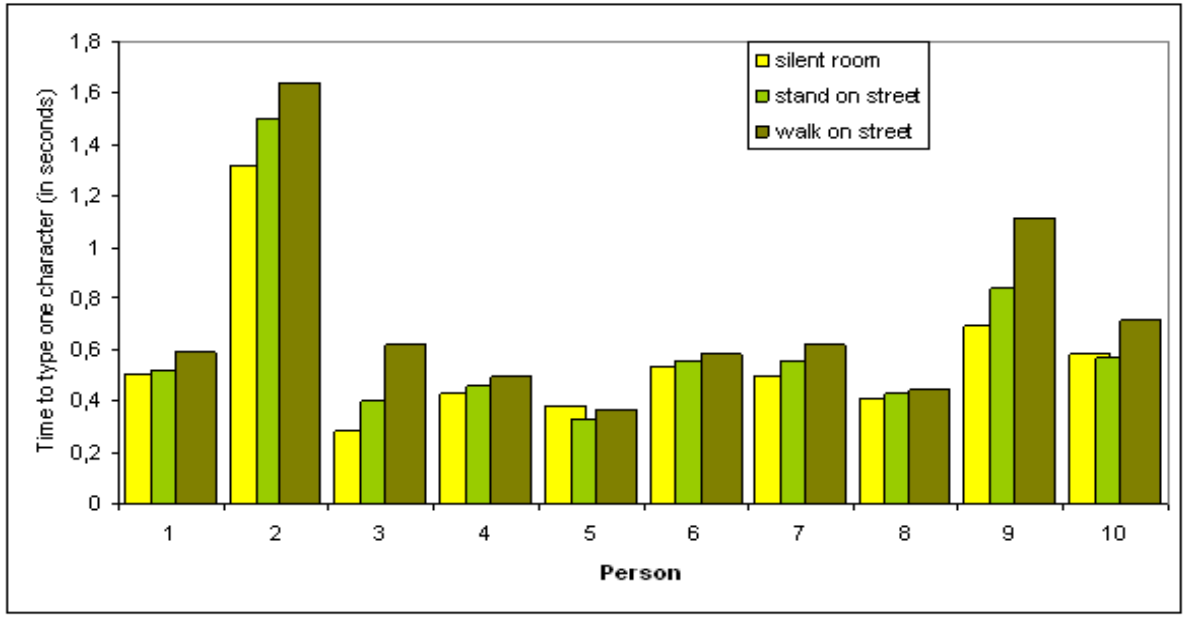
Gestures

Simple quick movements with the phone



Distraction

- Influence of real world distractions on execution time:



- modelled as a multiplicative factor:

$$T_{execute} = \sum_{op \in OP} \left(n_{op} + d_{op} \cdot X_{slight} + D_{op} \cdot X_{strong} \right) \cdot op$$

OP = {E P G H I K M R A_{micro} A_{macro}}
n_{op}: #op with no distraction
d_{op}: #op with slight distraction
D_{op}: #op with strong distraction
X_{slight}: 1.06 sec
X_{strong}: 1.21 sec

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