Exploring the usability of adaptive menus with a simple object system

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Overview

- The ACT-R simulation tool space.
- Simple Object System - ACT-R/SOS.
- Modelling user interactions with adaptive menus.
  - Can we make design decisions based on ACT-R simulations?

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The ACT-R simulation tool space

- Interaction with external applications or environment
  - SegMan, sim-eye, sim-hand, SNIF-ACT-R, jACT-R, ACT-R robots, and Intelligent Human Computer Interfaces.
- High fidelity simulated task environments
  - ACT-R/PM.
- Low fidelity simulated task environments
  - ACT-R/SOS.

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Simple Object System - ACT-R/SOS

- What is it?
  - Work in progress
  - Tool to build low fidelity simulated environments to run against ACT-R cognitive models.
  - Focused on “What”, not “Where” are external objects.
  - Definition of plus-rhs buffer functions:
    - Perception module: modification of parameters (object selection method, and cost method).
    - Action module: support for calling motor actions defined in a model (action-cost, and object-response-time).
  - Definition of object classes, methods, and motor action methods:
    - Inheritance, class application and chunk slots.
    - Object methods for motor buffers.

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Simple Object System - ACT-R/SOS

- Why bother?
  - Cognitive modelling and simulation development through successive refinements.
  - Make explicit, in the model, the mechanisms of perception and motor action.
  - Make explicit, in the model, the external objects behaviour.
  - Tool to learn ACT-R.
  - Link to ACT-R/PM as a device plugin.

```
(yet-another-task23
      isa           to-do-list-item
      list          to-do-list45
      description   sos-as-an-ACT_R/PM-device-plugin)
```

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Simple Object System - ACT-R/SOS

- Who would be interested anyway?
  - People who want to learn ACT-R.
  - People who want to explore buffer computational properties.
  - People who want to generate some hypothesis based on simulation results.
  - People who want to use simulated users for usability testing.
  - People on the rush, they just want to get going.

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Model structure

- Class and method definitions
- Class instances
- Buffer definitions
- ACT-R model

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Classes and method definitions (WYSIWYG)

```
(define-sos-object-class target-list
  :inherit-from (interface-object)
  :application-slots (current-targets sos-menu)
  :chunk-slots (current-target-name))

(defmethod set-target ((target-list target-list))
  (let ((target (car (current-targets target-list))))
    (setf (current-targets target-list)
          (cdr (current-targets target-list)))
    target))

(define-sos-object-action-method get-target ((target-list target-list))
  :action-cost #'(lambda () 0.05)
  :sos-object-response-time #'(lambda () (system-busy-meter))
  (setf (current-target-name target-list)
        (set-target target-list)))
```

```
The Chunk type for sos-object-class TARGET-LIST is:
    (CHUNK-TYPE TARGET-LIST CURRENT-TARGET-NAME)
The Chunk type for sos-object-class MOTOR-ACTION is:
    (CHUNK-TYPE MOTOR-ACTION TARGET-OBJECT ACTION-METHOD)
```

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Class instances

```
(add-sos-objects
 (mt01 isa-sos-object target-list
       current-targets (t01 t02 t03 t01 t03 end)
       sos-menu        sos-menu01)
 (sos-menu01 isa-sos-object sos-menu))
```

Definition of plus-rhs buffer functions

```
(defparameter *perceptual* nil)
(defparameter *motor* nil)

(define-plus-rhs-perception-function find-sos-object
       :selection-function #'(lambda (indx-obs sos-obs)
              (if indx-obs
                 (nth (random (length indx-obs)) indx-obs)
                 (nth (random (length sos-obs)) sos-obs))))
     :cost-function #'(lambda (indx-obs sos-obs)
            (declare (ignore indx-obs sos-obs))
            *default-action-time*)))

(define-plus-rhs-motor-function sos-action)


(define-buffer perceptual *perceptual* :plus-rhs find-sos-object)
(define-buffer motor      *motor*     :plus-rhs sos-action)
```

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A production

```
(p get-target-menu
   =goal>
   isa goal
   step get-target-menu

   =perceptual>
   isa target-list

   ==>

   =goal>
   step look-at-target-menu

   +motor>
   isa motor-action
   target-object =perceptual
   action-method get-target

   +perceptual>
   isa target-list)
```

An example: Simulation of adaptive menus

- Motivation for the simulation
  - Are adaptive user interfaces usable?
  - Can ACT-R help us making design decisions?
- Adaptive menu options
  - Random: it says it all, never the same
  - Fixed: : it says it all, always the same
  - Stacked: last chosen goes on top, pushing down the rest
  - Frequency: Sorted based on frequency access
  - Activation: Sorted based on activation (frequency and time). *No model telepathy*

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Distribution of menu items

- A simulated subject sees 10 successive sets of 30 targets in the four adaptive menu conditions (menu of size 12)
  - Random targets 1-30: ("t08" "t08" "t08" "t08" "t11" "t11" "t11" "t02" "t02" "t05")
  - Early targets 1-15: ("t07" "t07" "t07" "t07" "t10" "t10" "t10" "t01" "t01" "t04")
  - Late targets 16-30: ("t09" "t09" "t09" "t09" "t12" "t12" "t12" "t03" "t03" "t06")
- The model is reset for each menu condition.
- Parameters
  - Randomness and Base level learning (0.5).
- Productions.
  - get-new-target, retrieve-target-position (with success or failure), scan-menu-for-target (upward or downward), test-target-success, add-target-to-menu.

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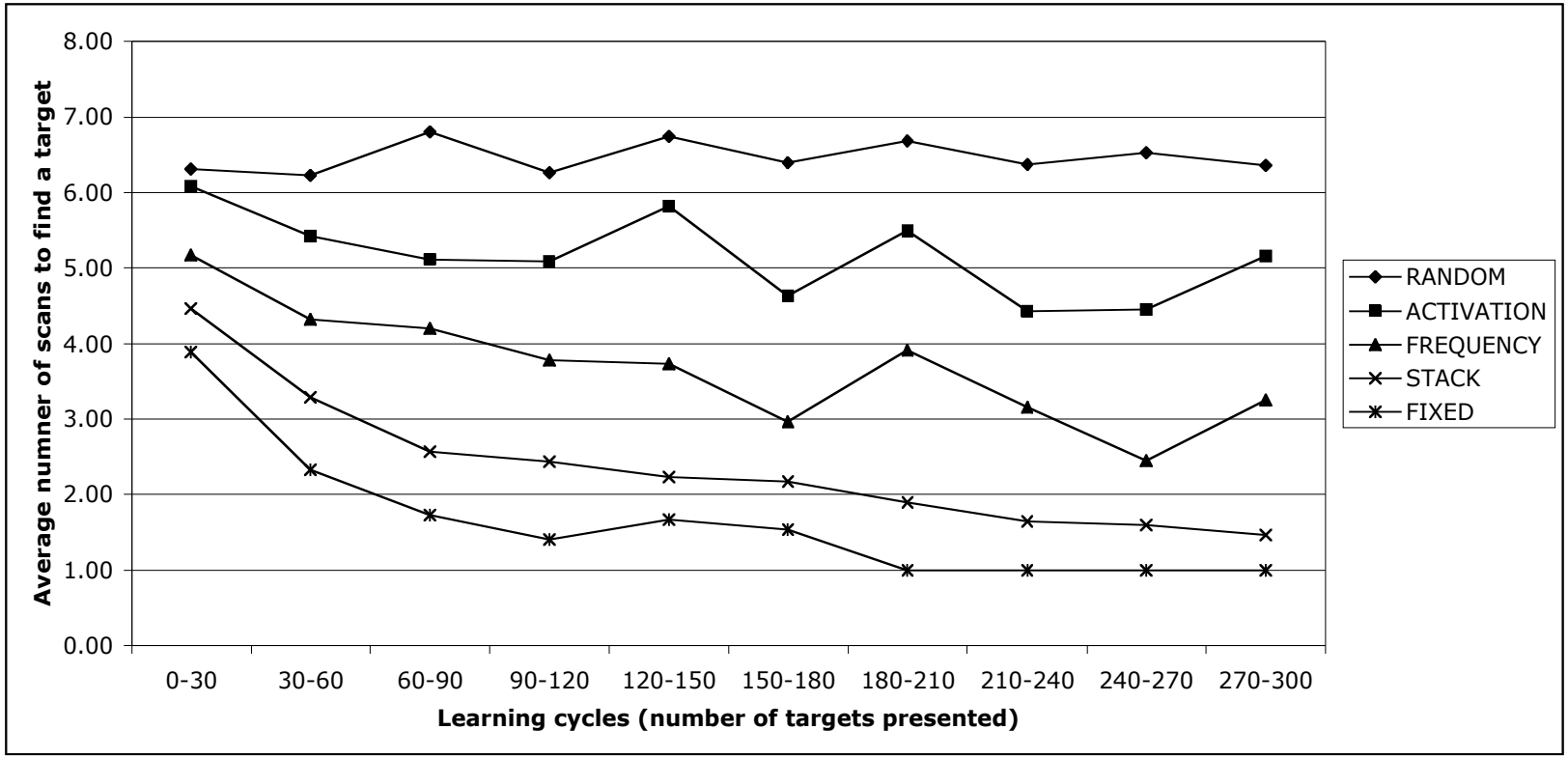
Simulation results



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Conclusion

- Data collection on adaptive menu task

- ACT-R simulations for user interface design decision

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Current and other work

- Usability testing with simulated users.
  - Robert West and COGNOS.
- Modelling media player usage in the context of music learning.
  - Reviewing music coaching session (ensemble).
  - MusicGrid: NRC, NAC, CRC, School boards.
- Modelling quality of experience judgments and person-person interaction.
  - Advanced collaborative environments: NRC, CRC, NewMic.

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Thank you :)

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