ESEGMAN: A substrate for ACT-R architecture and an Emacs Lisp application

Introduction

Cognitive models are developed and utilized to provide a fundamental understanding and prediction of human behaviors.

In particular, it is useful and necessary to develop a cognitive model to have more general access to a task environment to investigate realistic human performance.

For example, complex office tasks contain the important aspects of knowledge and skills (e.g., perceptual-motor or problem-solving tasks).

A cognitive model interacting with this task environment will give opportunities to study broader aspects of learning and forgetting behaviors of humans.

Problem Statement

Current restrictions on Cognitive Models:

- The model has limited access to external environments.
- The restrictions placed on the model reduce the ability to predict human performance in realistic contexts of industry and military tasks.
- The agent-based model is desirable to fully interact with the environments in order to better represent human behaviors.

Objectives

We propose the ESEGMAN system (Emacs SubstratE: Gates toward MAN-made world). ESEGMAN is designed to embody the cognitive model in order to fully interact with the task environment.

The ESEGMAN World

As shown in Figure 1, the ESEGMAN world consists of an ACT-R model, an Emacs substrate (ESEGMAN), and a spreadsheet task environment (Dismal). Dismal is a spreadsheet that runs under Emacs (Ritter & Wood, 2005).
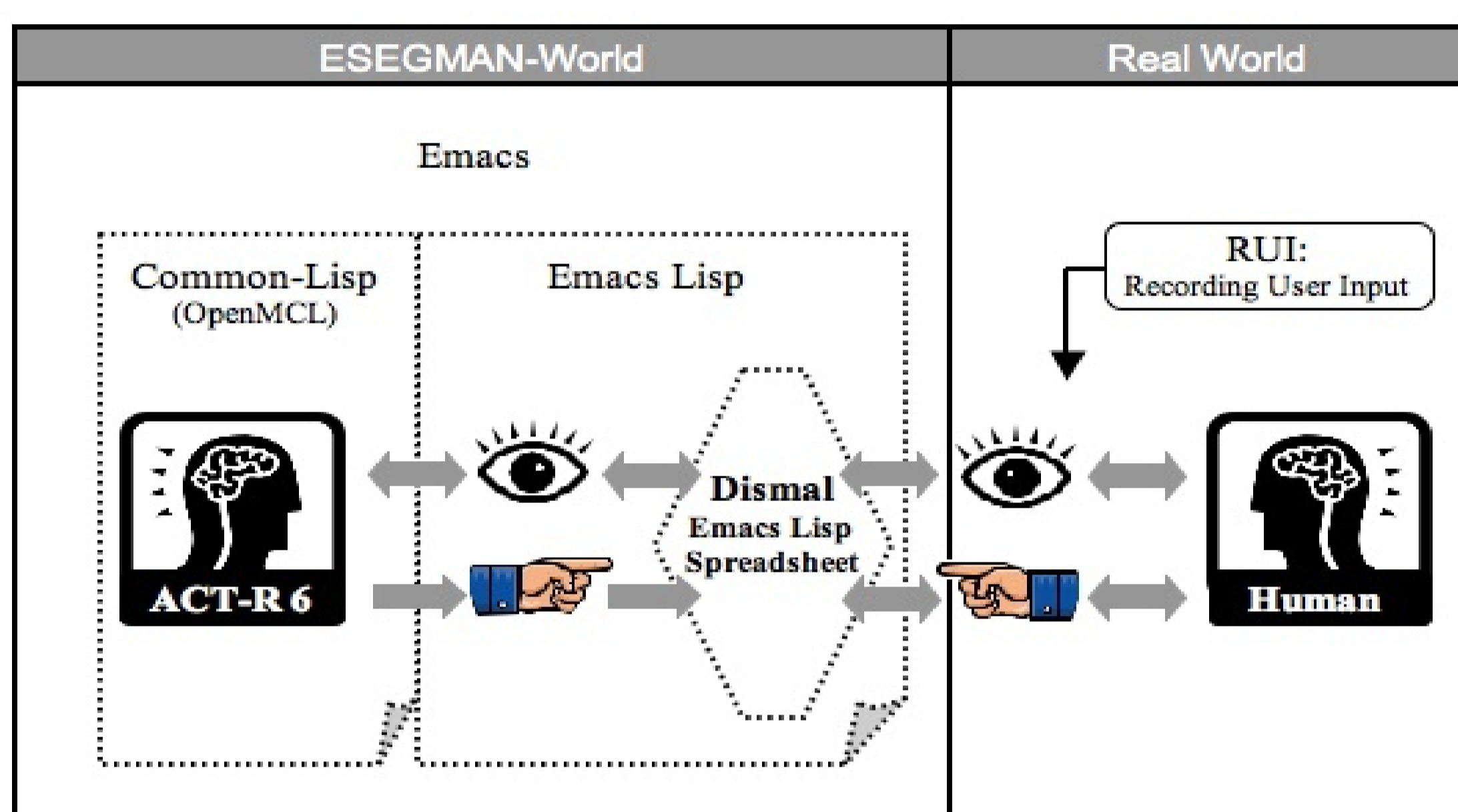

Figure 1. A schematic of the ESEGMAN system.

In the ESEGMAN World

The model can interact with the spreadsheet task environment via ESEGMAN.

In the Real World

Humans access the same task environments of the Dismal spreadsheet as the model does.

Human behaviors can be recorded via RUI (Kukreja et al., in press), which records the timing characteristics of user behaviors (e.g., key strokes and mouse movements).

How does ESEGMAN work?

ESEGMAN is layered on the operation of Emacs. It is basically built on the Common Lisp and Emacs Lisp languages.

A shell is started in Emacs to invoke OpenMCL. ACT-R (Anderson et al., 2004) is loaded into OpenMCL. The ESEGMAN system is loaded on the shell. Then an ACT-R model can be loaded. Figure 2 shows this process under Gnu Emacs. In particular, the message buffer shows that ESEGMAN catches a key press of "e" performed by the model.

An ACT-R model can send commands to ESEGMAN, such as to move the mouse, to type a letter, or to get the visual contents of a Dismal task window.
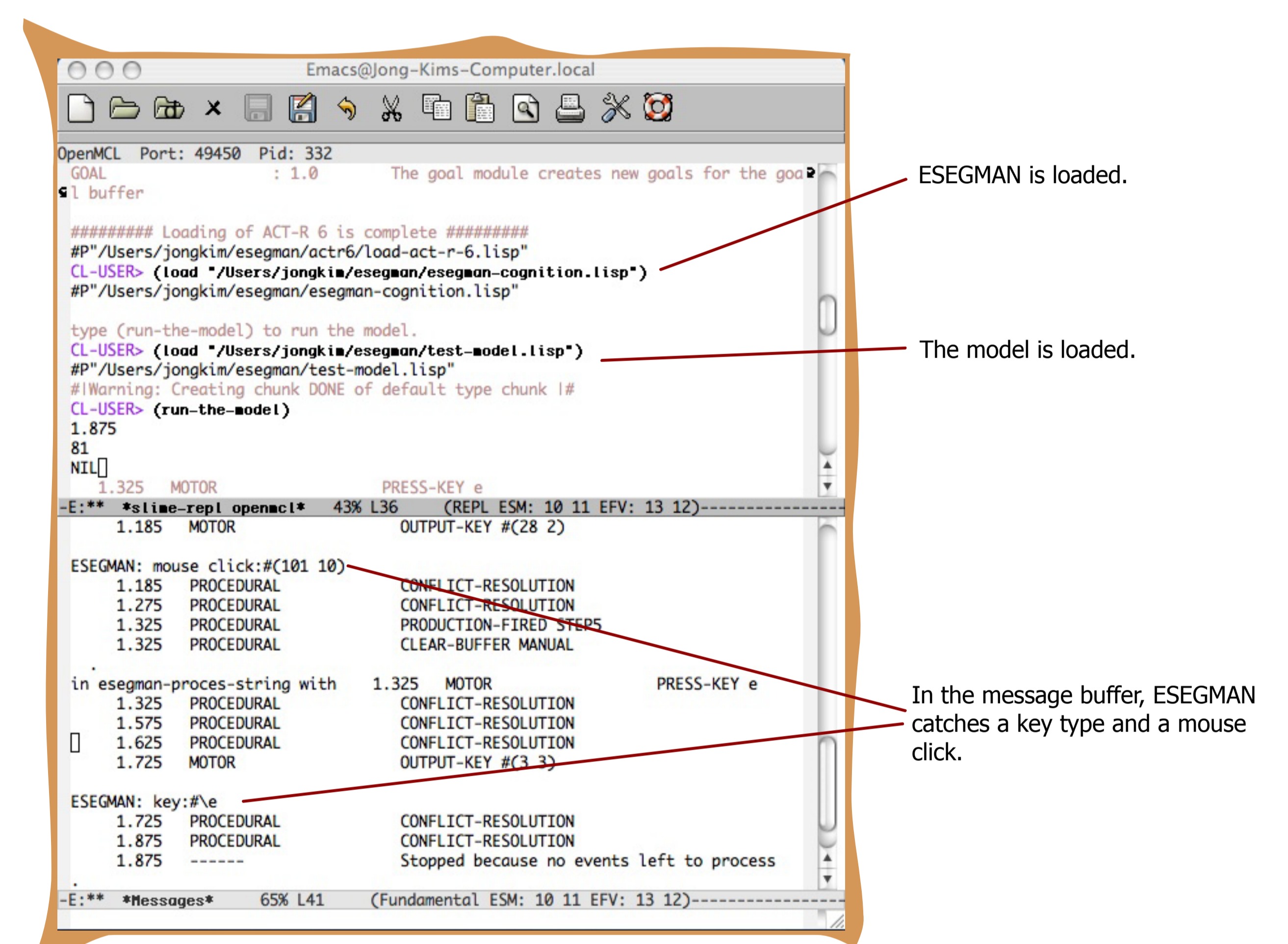

Figure 2. A screenshot of ESEGMAN under Gnu Emacs.

Code for ESEGMAN

ESEGMAN mainly consists of three files. One is built on Common Lisp (esegman-cognition.lisp). The other two files are built on Emacs Lisp (esegman-world.el and esegman-string-to-poass.el). Figure 3 shows the procedures of ESEGMAN.
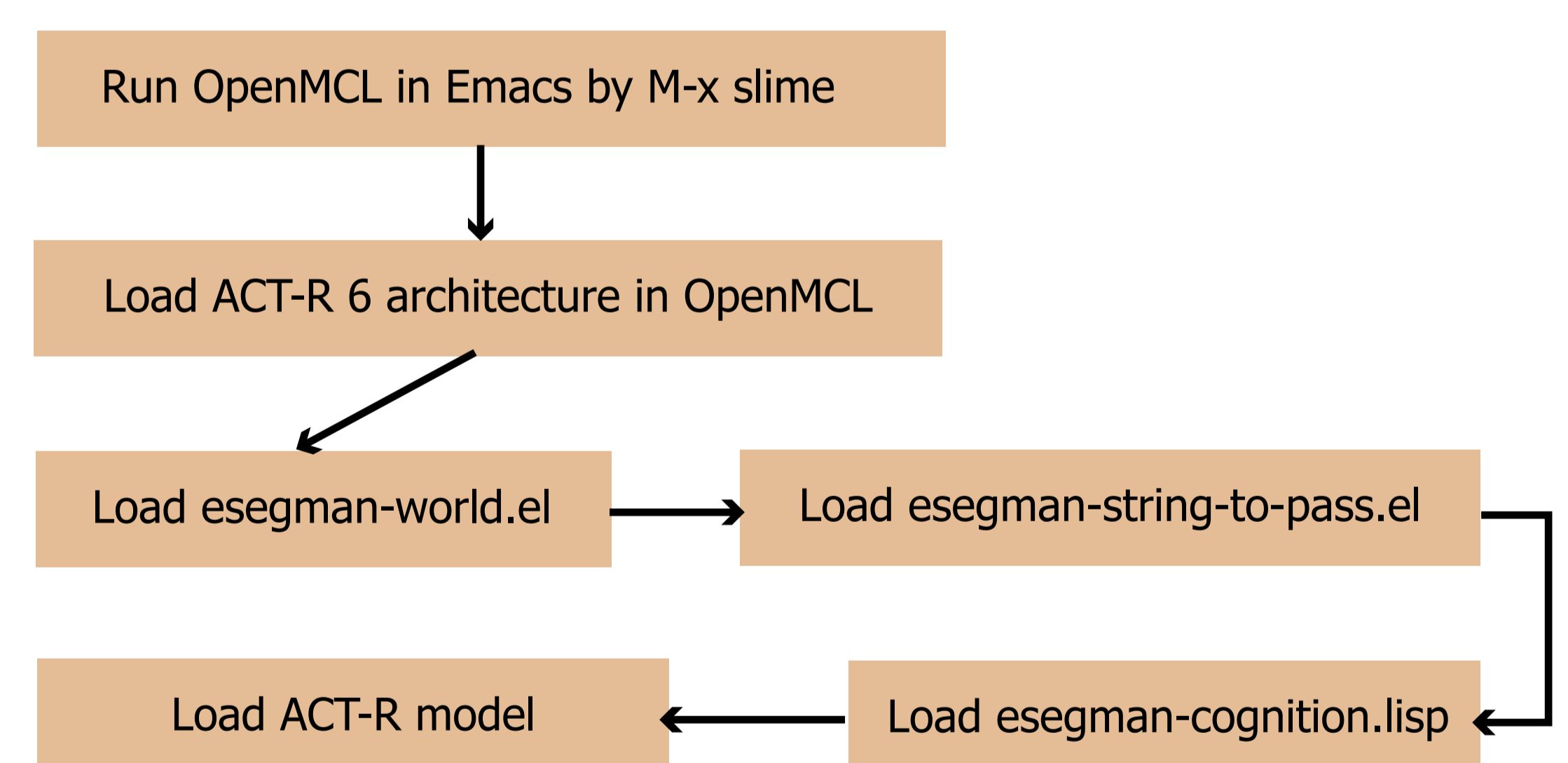

Figure 3. Flowchart to set up the ESEGMAN system.

Benefits and Future Directions

Benefits

1. ESEGMAN embodies a cognitive model to better simulate human behaviors in a more realistic way by accessing the same spreadsheet task environments that human subjects interact with.
2. The ESEGMAN world provides continuum of real spreadsheet tasks between the human and model subjects in a laboratory setting.
3. Dismal tasks are complex and novel enough to measure learning and forgetting behaviors of humans.
4. The tasks provide the important range of knowledge and skills (e.g., motor skills by using a mouse or a cognition-demanding problem solving skills).

Future Directions

1. A learning and forgetting model will be developed under the ACT-R 6 architecture.
2. Skill acquisition and degradation performance of the model will be investigated with Dismal spreadsheet tasks.
3. The model performance will be validated with the performance of subjects under the same Dismal environments.
4. The forgetting model will provide principles of knowledge and skills training for use in industry and military domains.

References

Anderson, J. R., Bothell, D., Byrne, M. D., Douglass, S., Lebiere, C., & Qin, Y. (2004). An integrated theory of mind. Psychological Review, 111(4), 1036-1060.

Kukreja, U., Stevenson, W. E., & Ritter, F. E. (in press). RUI: Recording user input from interfaces under Window and Mac OS X. Behavior Research Methods, Instruments, & Computers.

Ritter, F. E., & Wood, A. B. (2005). Dismal: A spreadsheet for sequential data analysis and HCI experimentation. Behavior Research Methods, Instruments, & Computers, 37(1), 71-81.

The 7th International Conference on Cognitive Modeling, Trieste, Italy, 5 - 8 April 2006

Jong W. Kim (jongkim@psu.edu),
Department of Industrial Engineering
The Pennsylvania State University

Frank E. Ritter (frank.ritter@psu.edu)
College of Information Sciences & Technology
The Pennsylvania State University

Richard J. Koubek (rkoubek@psu.edu)
Department of Industrial Engineering
The Pennsylvania State University