

ACT-R 7

An Introduction and Unit 1

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Introduction

ACT-R is Not Monolithic

- While ACT-R may be maintained from CMU it no longer resides at CMU. The community motto is “Let a thousand flowers grow”.
- While ACT-R is originated as LISP software for purposes of simulation, it is no longer tied to LISP. There are many theoretically motivated extensions and alternative practicality-motivated alternative implementations. There are full-functioning Python and Java versions.
- The ACT-R community shares a commitment to the “No Magic Principle” -- cognitive theory has to run and it has to predict data
- The theory includes assumptions that are more core, shared by most in the community, and others that are more peripheral and often the subject of active experimentation.

ACT-R: The Oldest Core Principles

- The Procedural-Declarative Distinction
 - The declarative component originated in Anderson & Bower (1973) HAM network representation of memory.
 - The procedural component originated in Newells (1973) production system theory of cognitive control.
 - Both the procedural and declarative components have evolved far from these origins.
- The Symbolic-Subsymbolic Distinction
 - In addition to the symbolic level that represented knowledge there is a subsymbolic level that controls access to that knowledge.
 - The subsymbolic level was initially designed to reflect the 1970s & 1980s ideas about neural processing.
 - Guided by rational analysis the subsymbolic level was updated in 1993 to reflected the likelihood that the information was useful. This was the birth of ACT-R

Evolution from ACT-R 2.0 (1993) to ACT-R 7.x (2018)

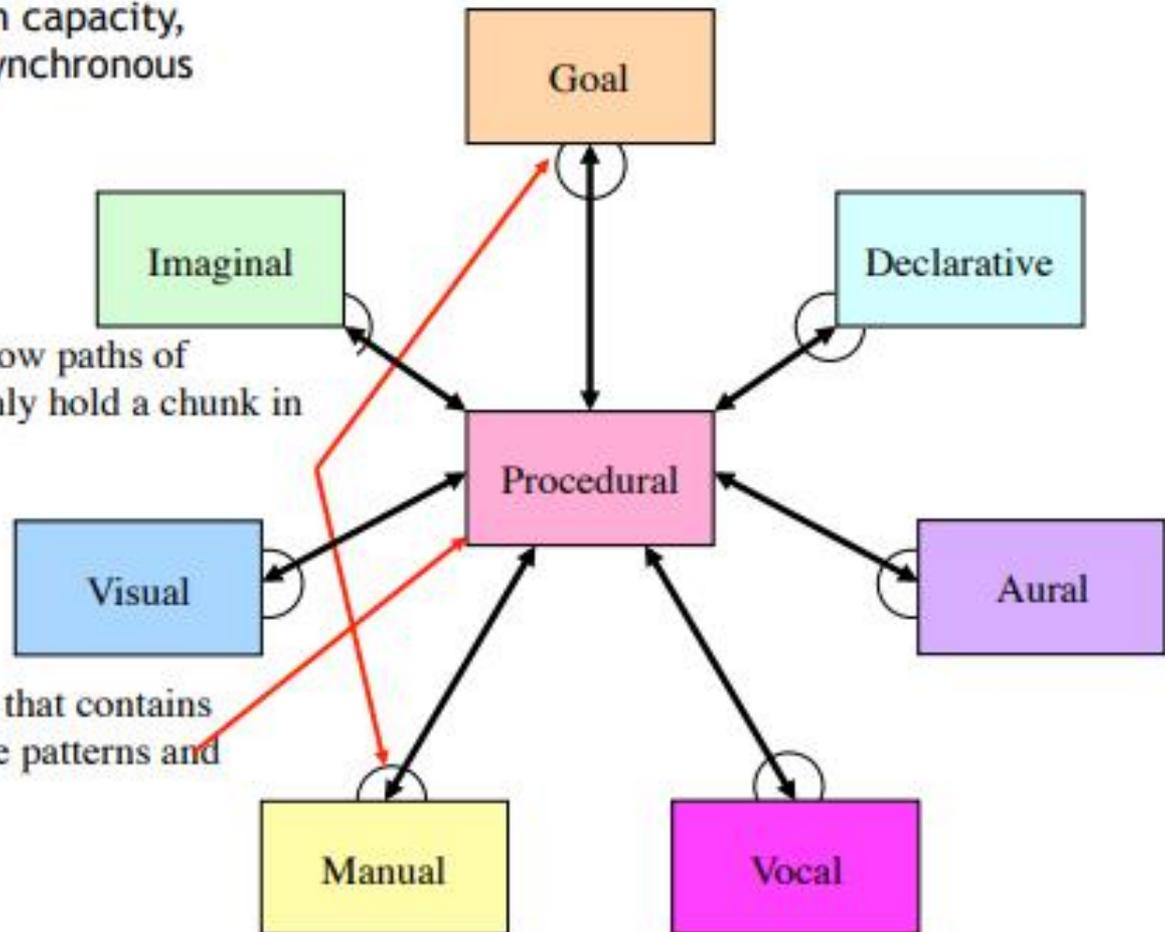
- There have been three driving forces:
 - The emergence of a user community around the publicly available ACT-R 2.0 (this is when Christian Lebiere's influence began).
 - The realization that the “No Magic” principle required that we be able to model the processing all the way from input to output.
 - The insistence on not making assumptions that could not be cashed out into neurally plausible computations.
- This converged in the modular architecture of ACT-R 6.0 (2005):
 - The allowed community members to try variations on existing ideas and extensions but keep what they wanted.
 - We borrowed the modular organization of EPIC for the perceptual-motor modules.
 - There was growing evidence that, while the brain was a complex parallel machine, different regions had their specializations.

Module Structure of Current ACT-R

Modules are high capacity, parallel, and asynchronous

Buffers provide narrow paths of communication -- only hold a chunk in ACT-R terms.

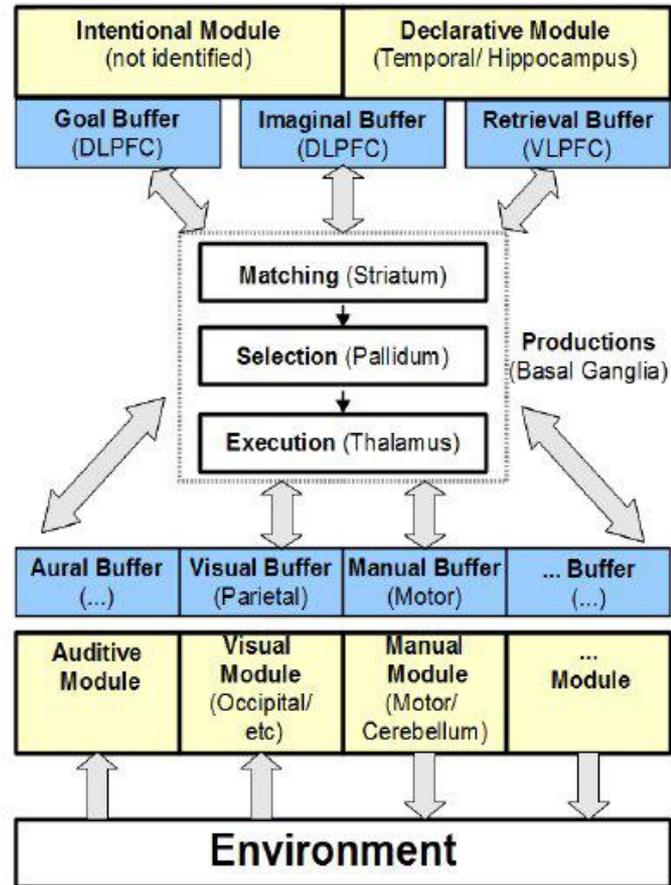
Production system that contains rules that recognize patterns and react



Four Key Features of How ACT-R Models Performance and Learning

- The model needs to represent realistic performance limitations including perceptual-motor skills and not assume super human response times.
 - ACT-R architecture captures these human limitations.
- The system needs to deploy task knowledge – without this it would take many more trials to master what participants master in few trials.
 - ACT-R instruction following can capture this.
- Participants start out deploying that knowledge slowly but speed up.
 - ACT-R production compilation can capture this.
- Successful performance requires learning the parameters that define successful actions.
 - In a fast-paced game, there is not enough time for ACT-R to perform the task and monitor these parameters within its cognitive cycle.
 - This can be done by developing a new Tracking Module that can be informed by the cognitive cycle but monitors performance off-cycle.

ACT-R Architecture



Unit 1: in the tutorial pdfs.

Resources

- Twenty-Fifth Annual ACT-R Workshop Program 2018, Slides by John R. Anderson
- Salvucci, D. D., Boer, E. R., & Liu, A. (2001). Toward an integrated model of driver behavior in cognitive architecture. *Transportation Research Record, 1779*(1), 9-16.

Installing ACT-R

- Download Standalone Application from <http://act-r.psy.cmu.edu/software/> for your OS and extract the zip file.
- Run run-act-r file.