Macro Cognitive Architectures

Robert L. West - Carleton University

Part 1

The Macro Architecture Hypothesis

Newell's Systems Levels

- ☐ Social Level

- ☐ Knowledge/rational Level

  - ☐ Unit Task

- ☐ Cognitive Level - ACT-R

- ☐ Neural Level

Micro and Macro

☐ **Micro Cognition**

☐ **Level - Cognitive**

☐ **Phenomena - memory, attention, low level perception, well defined problem solving, basic learning mechanisms**

☐ **Method - Experimental Psychology, Neuroscience, Cognitive Modeling**

☐ **Macro Cognition**

☐ **Level - Knowledge/Social**

☐ **Phenomena - planning, teamwork, real world problem solving, situation awareness, expert learning**

☐ **Method - Anthropology, Systems Engineering, Cognitive Modeling**

What does ACT-R tell us about macro cognition?

if we take Newell's levels seriously

- ☐ **Almost nothing**

- ☐ **Once the unit tasks are accurately modelled the architecture provides no further guidance or constraints**

- ☐ **Behaviour at the knowledge level and above is driven purely by learned combinations of unit tasks**

- ☐ **Social learning not neural**

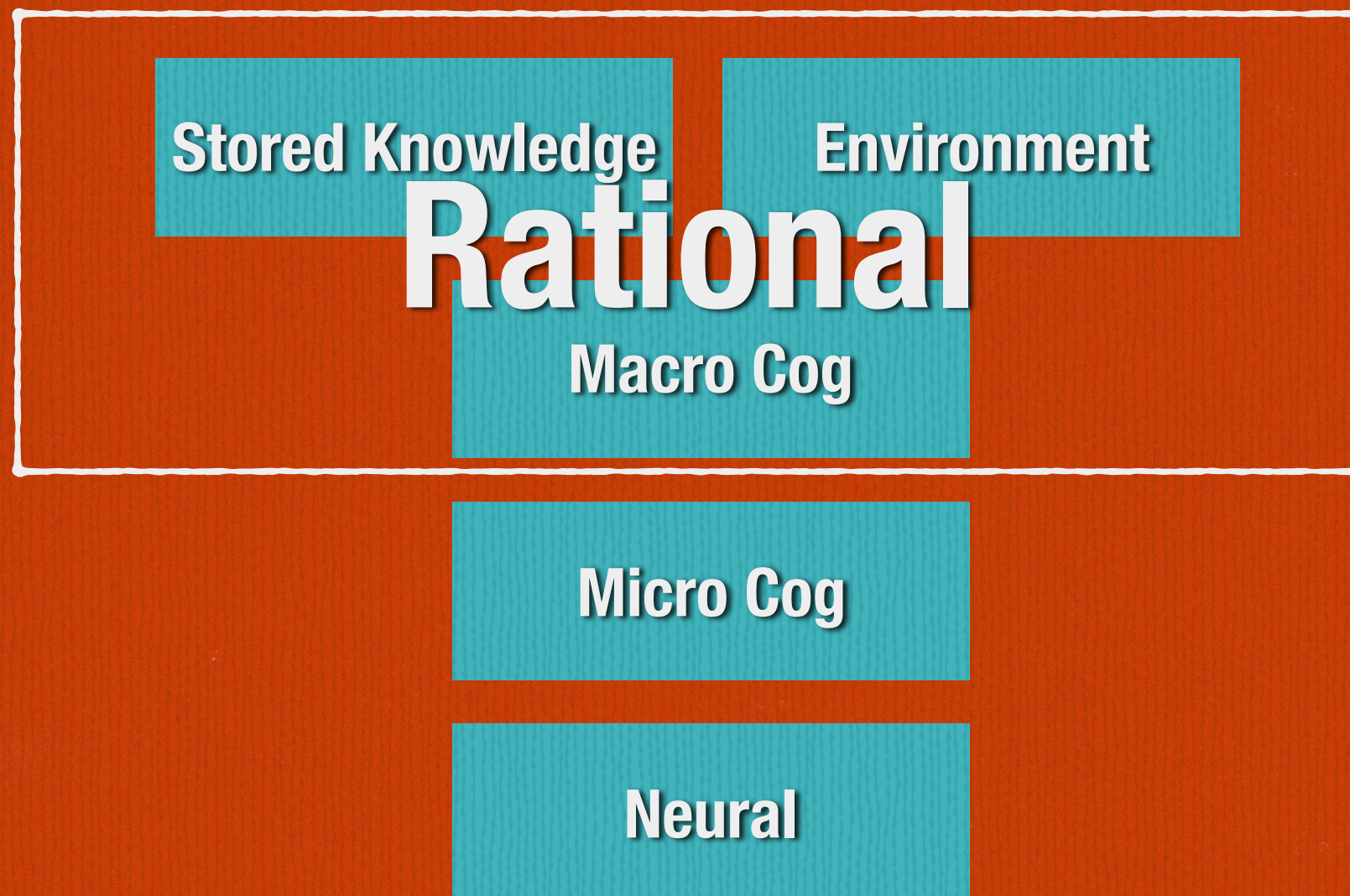# Macro Architecture Hypothesis

Stored Knowledge

Environment

Macro Cog

Micro Cog

Neural

Macro Architecture Hypothesis

Stored Knowledge

Environment

Rational

Macro Cog

Micro Cog

Neural

ACT-R and the macro architecture

- ☐ What does ACT-R do for the macro architecture

    - ☐ a lot!!!

- ☐ What does ACT-R do for the macro architecture

    - ☐ A lot!!!!

Macro Architecture(s)

1.8 Million years of experience

- ☐ **Expertise - SGOMS**

- ☐ **Adveserial**

- ☐ **Problem solving - SOAR**

- ☐ **Narrative**

- ☐ **<u>Emotion</u>**

- ☐ **Negotiation**

- ☐ **Planning and re-planning**

- ☐ **Navigation**

SGOMS: Planning Units

- ☐ Control structure for planning, coordination, and re-planning

- ☐ DM driven - creates interruptability, customizability, and fits with the production compilation story

- ☐ Architecture - dedicated buffers, emotion/interuption, generic productions, generic chunk structures
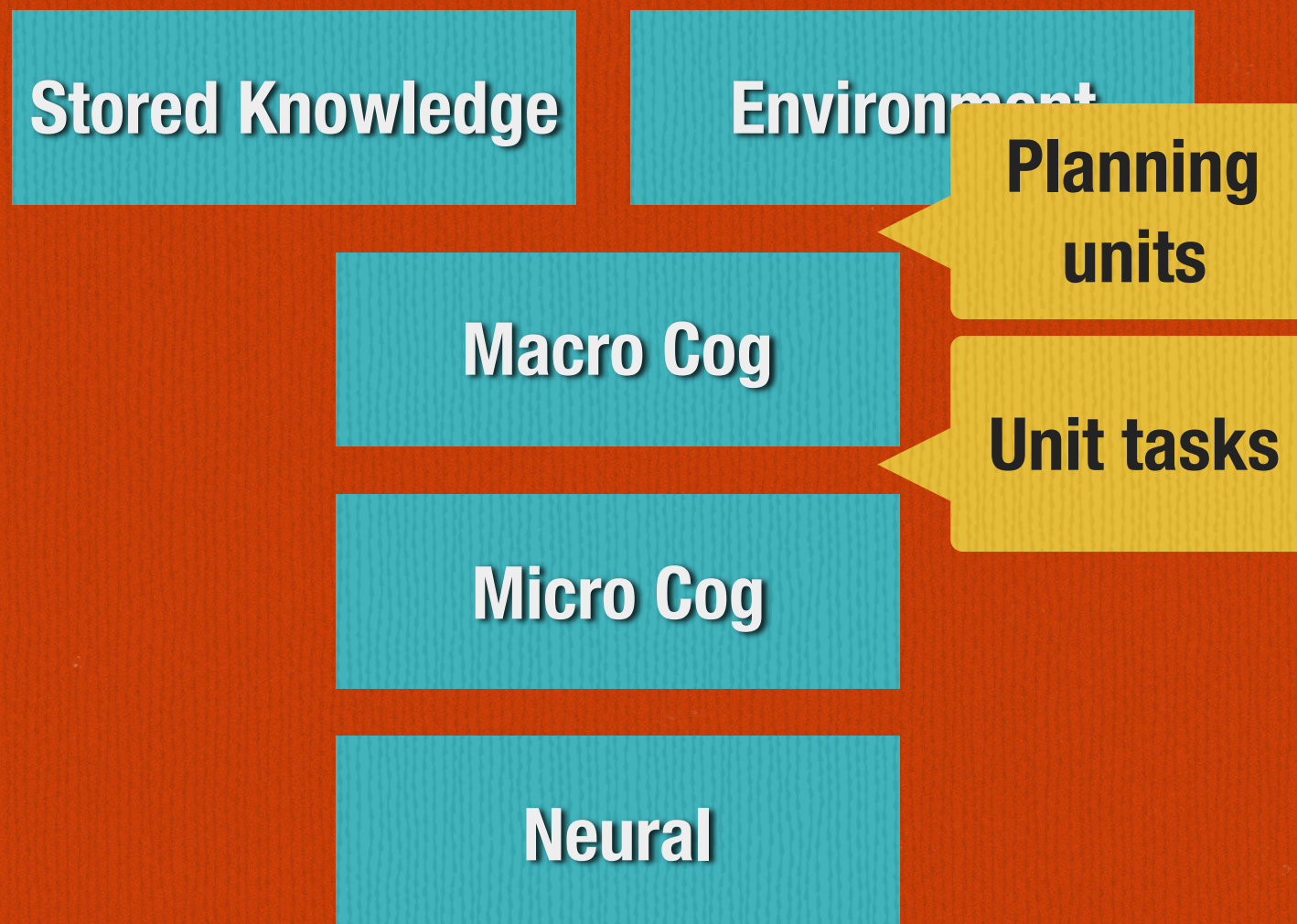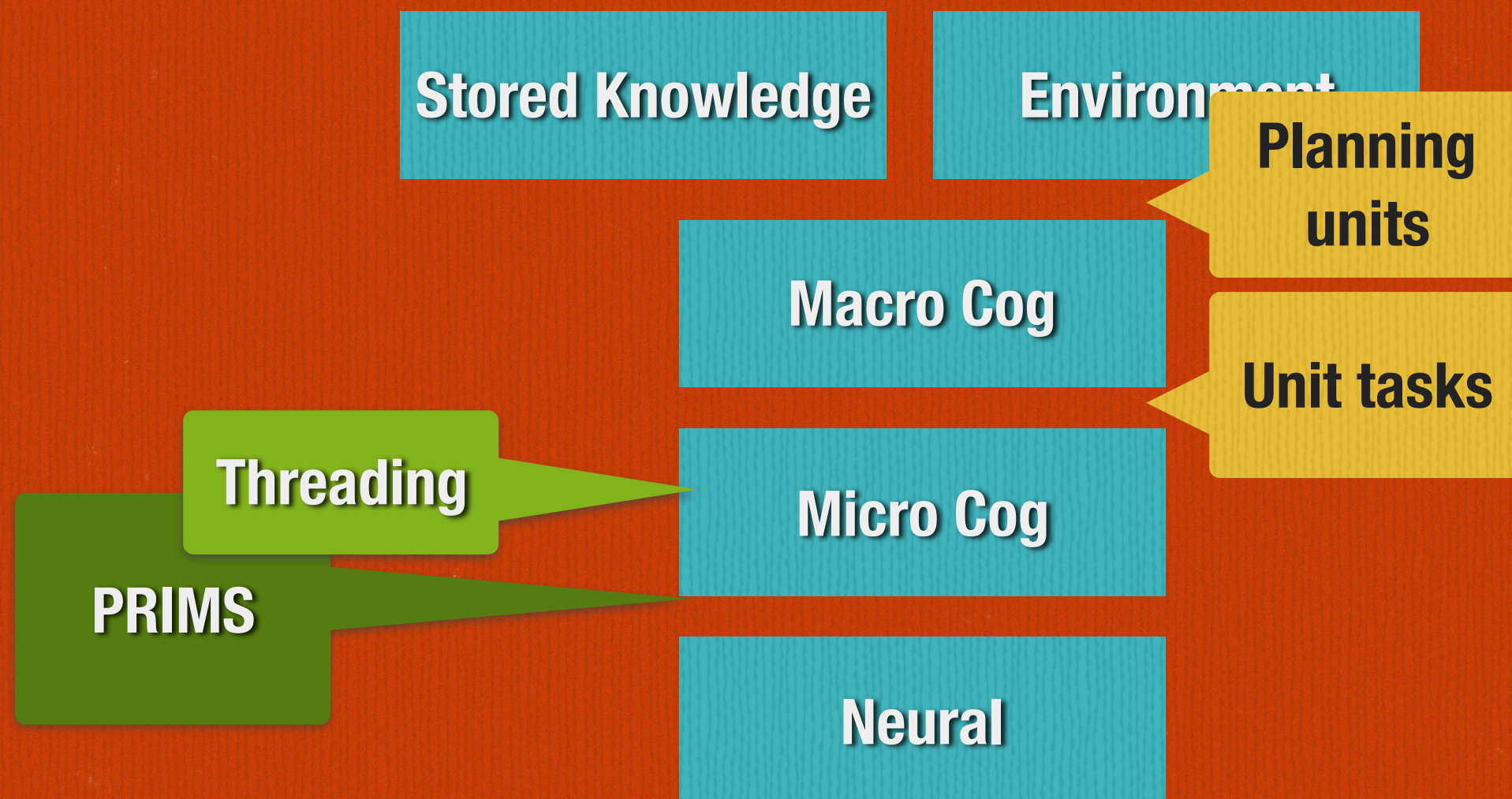
Macro Architecture Hypothesis

Part 2

Lessons Learned

Lesson 1: ACT-R is perfect

- ☐ Productions, associative memory, chunks, buffers, and modules

- ☐ But multi-realizable and not complete

- ☐ Macro architecture can be built on ACT-R

- ☐ Difference between building on ACT-R and building modules for ACT-R, and altering ACT-R

Lesson 2: You can't play 20 questions with nature and win

- [ ] Currently we build different ad hoc macro architectures in act-r to fit different macro cognitive phenomena

- [ ] This is just a scaled up version of building many different ad hoc micro cognitive models - i.e. - no architecture

- [ ] Macro Architecture = Newell's Test (Anderson & Lebiere)

Lesson 3: The architecture is the method

- ☐ **Anthropology ontology**

- ☐ **Architecture ontology**

- ☐ **Architecture driven task analysis**

- ☐ **Model tracing**

Lesson 4: Evolution and Rational Analysis

☐ **ACT-R evolved in human brains during a long hunter gatherer period to solve common macro cognitive problems - 1.8 million years approx**

　☐ **Team work, navigation, negotiation, planning, competition, reacting to unexpected events, re-planning, etc.**

☐ **Rational analysis assuming ACT-R - there is a best way to use ACT-R and most people will find it**

Lesson 5: Make it simple sir

- ☐ Macro architecture is a method for data collection

- ☐ Macro architecture is a higher level language that compiles to ACT-R - OR NOT, still ACT-R inspired

- ☐ Can also be done by template

- ☐ Re-use of code

Done (almost)

☐ **Makes it much easier to build complex, real world ACT-R models - including how to do the task analysis**

☐ **Promotes re use**

☐ **Makes a clear story about why ACT-R is useful for macro cognition and AI**

☐ **Makes it clear when the micro model is needed or relevant**

☐ **Built on ACT-R not in ACT-R**