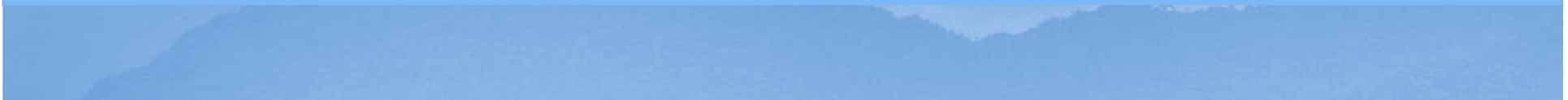


Millions of Rules, Billions of Decisions

John Laird, University of Michigan

29th Soar Workshop

June 2009



Soar for Long-Lived Agents?

- Someday Soar agents will exist for months.
- Is a pile of C (+ C++) code that has been patched and hacked on for 15 years up to it?
- Is Bob Doorenbos' thesis really true?
- Have we avoided screwing it up?
- Q1: Can Soar run for a long time without slowing down or crashing?
- Q2: Can Soar run with lots of rules without slowing down or crashing?

Doorebos' Thesis Results

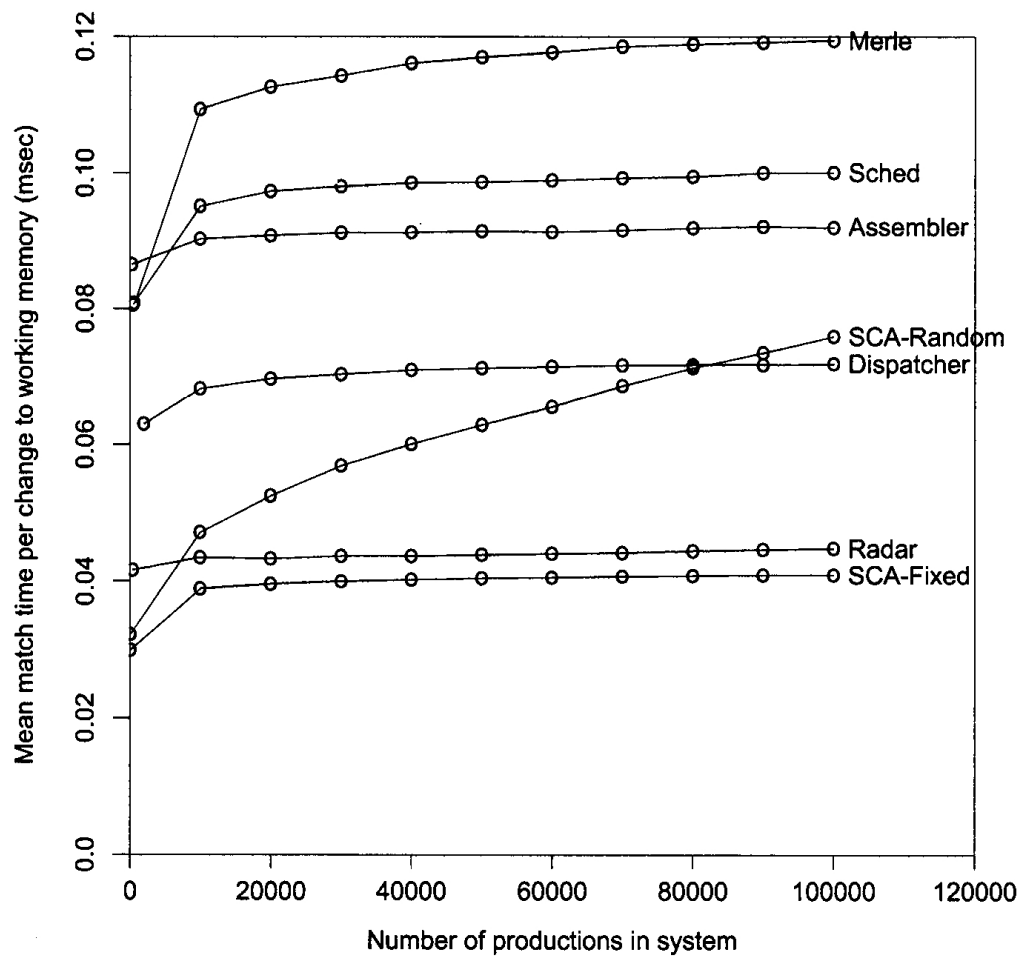


Figure 5.8: Match cost with Rete/UL.

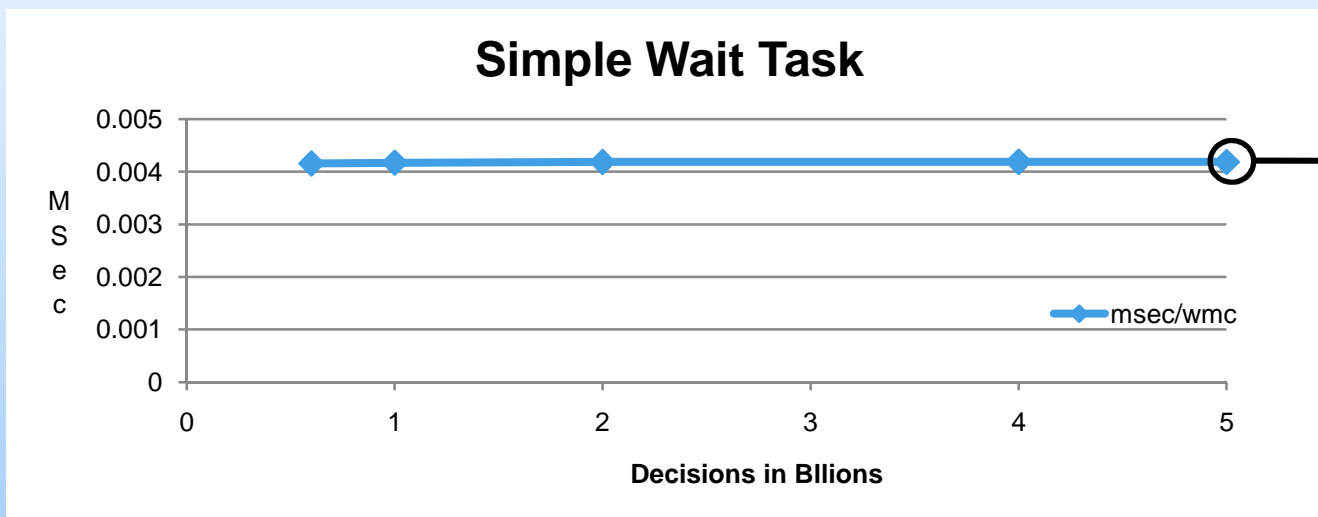
Why Now?

- Fast Machines (~1,000X cognitive real-time)
- Big Memories (8 Gigs on my laptop)
- 64-bit Soar
- gp command makes it easy to generate millions of rules

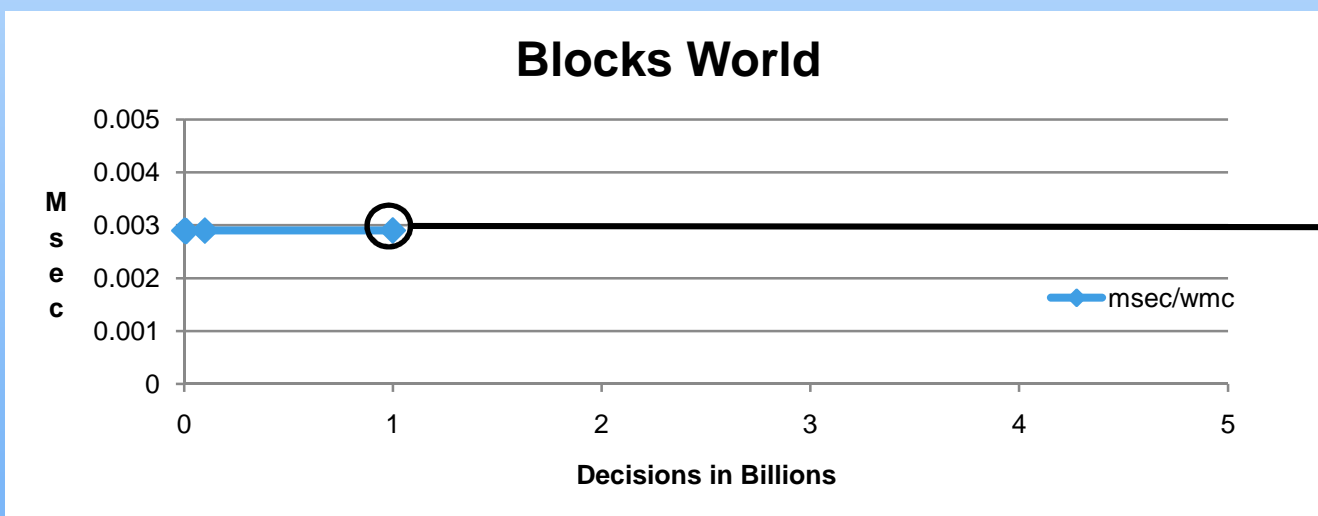
Q1: Can Soar Run For a Long Time?

- What is a long time?
 - $20 \text{ dec/sec} * 60 \text{ sec/min} * 60 \text{ min/hour} * 24 \text{ hr/day} =$
 - 1,728,000 dec/day
 - 2,000,000 dec ~ day of simulated time
 - 1,000,000,000 dec ~ 500 days of simulated time
 - 5,000,000,000 dec ~ 2,500 days ~ 7 years
- Tasks
 - Simple as possible – wait
 - 1 rule fire/decision, 4 wmc/decision, 44 rules, Soar 9.0.0
 - Simple 3 block world –
 - 8.6 rules/decision, 25 wmc/decision, 6092 rules, Soar 9.0.1
- What to measure?
 - Basic agent level activity = working memory changes/second
- Hardware:
 - Core2 6600@2.4GHz, 3GB RAM, Windows XP

Results Q1: Run a long time?



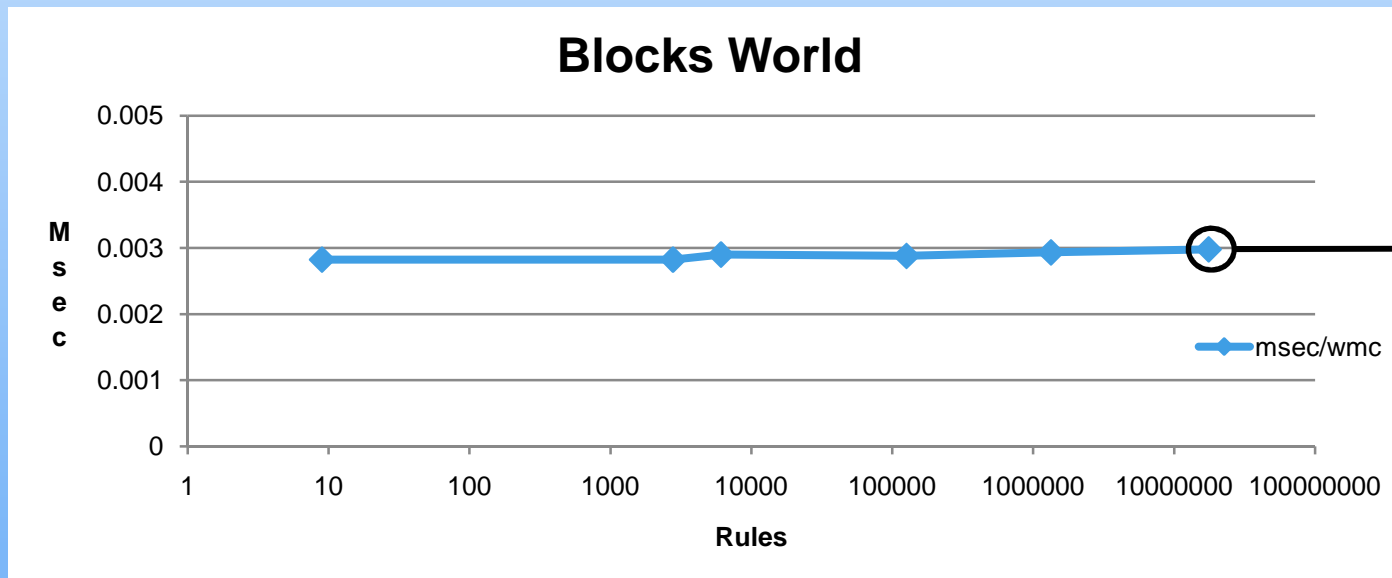
44 rules
5B decisions
20B WM changes
83,688 sec. total CPU
= ~23.25 hours



6092 rules
1B decisions
25.3B WM changes
73,574 sec. total CPU
121Mbytes image size

Results Q2: Large numbers of rules?

- Blocks world task – 10,000,000 decisions
 - 9 rules = core task
 - 2785 rules = + all non-RL rules on my computer
 - 6092 rules = + HRL blocks world
 - ... rules = + extra RL rules for blocks world
 - [possible matching to 4-20 tokens]



17,560,093 rules
10M decisions
51M WM Changes
151 sec. total CPU*
~7-8 Gbytes Memory

*scaled time from 64b Laptop

Conclusion

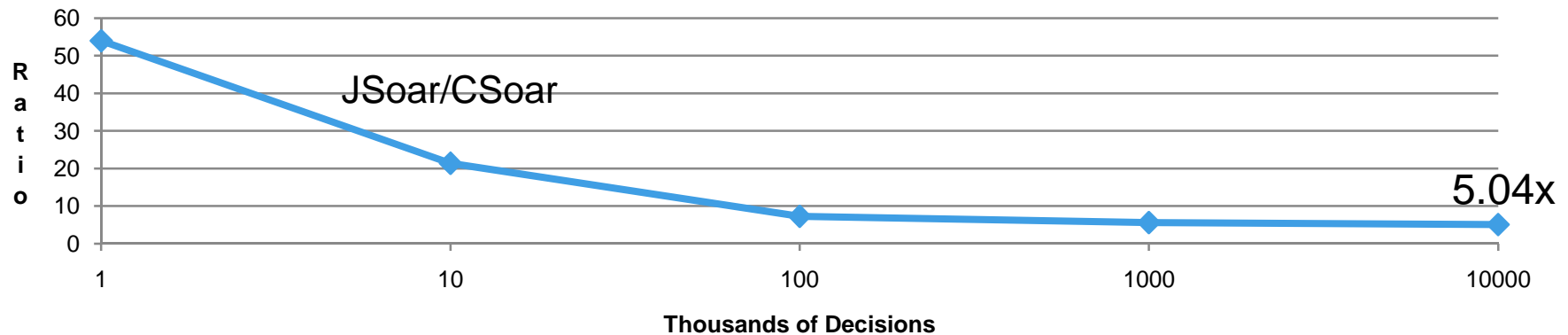
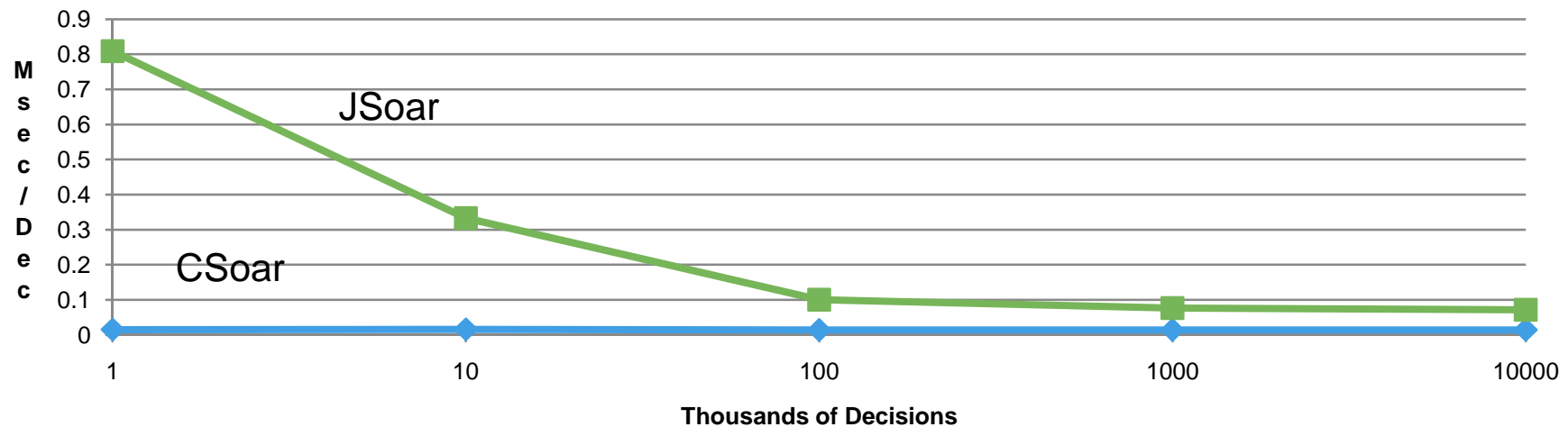
- Nuggets:
 - Soar can run for a long (simulated) time...
 - About 24 hours
 - Soar scales to large number of rules
- Coal:
 - Soar still slows down with expensive rules
 - Other memories don't scale as well (EpMem)
 - Still need full conversion to 64bit

 - Might be some overhead in decision procedure

JSoar vs. CSoar – Simple & Long

Simple wait task – 1 rule fire/decision, 44 total rules

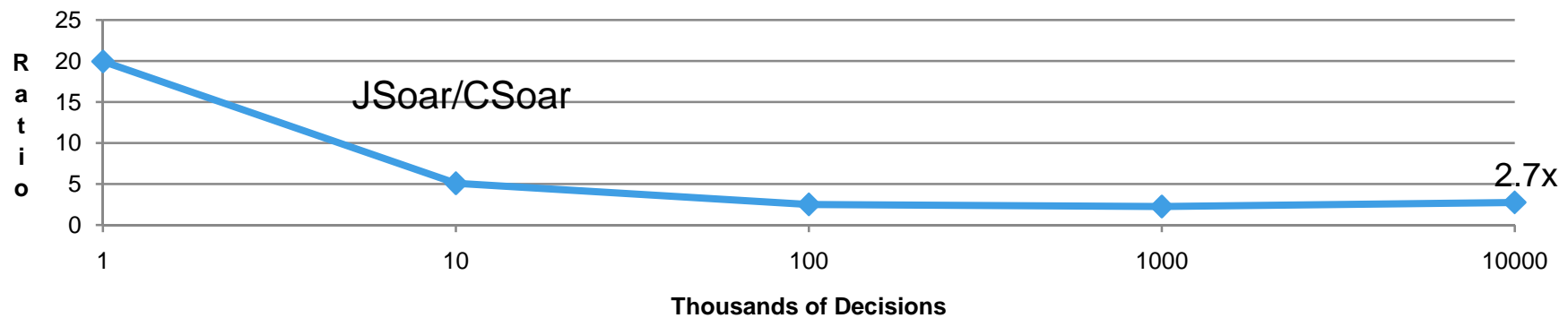
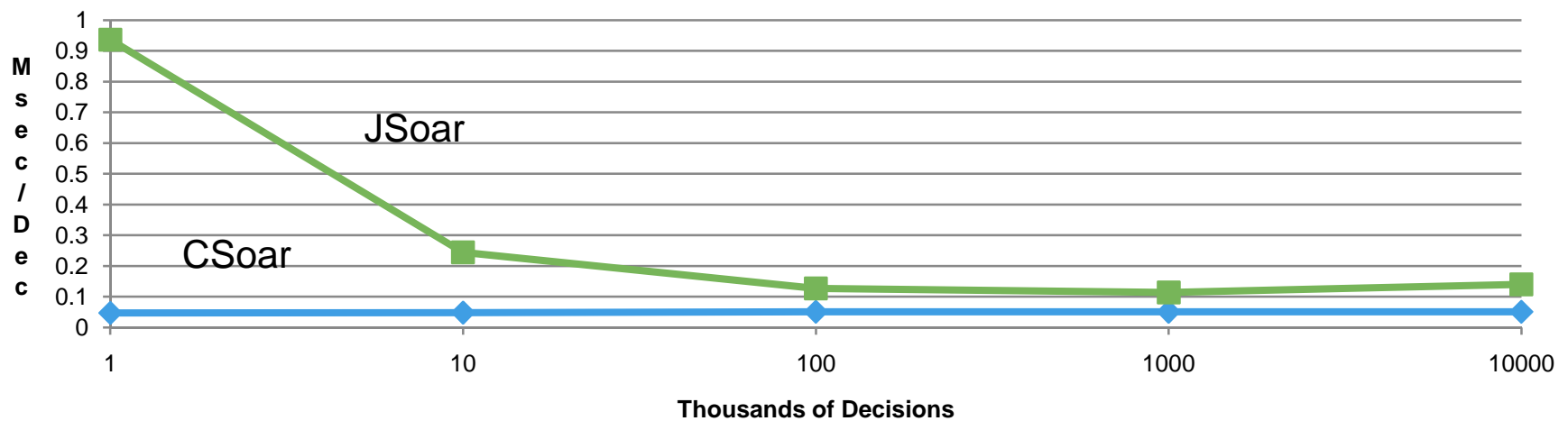
2.93 GHz T9800 Core2 Duo, 64-bit, Vista, 8 GB – jSoar.0.7.1



JSoar vs. Csoar – Lots of Rules

Blocks World with 2700 rules

2.93 GHz T9800 Core2 Duo, 64-bit, Vista, 8 GB



JSoar vs. Csoar – Lots of Activity

Count-Test [20,000] 44 rules, exercises substates, results, wm changes, ...
2.93 GHz T9800Core2 Duo, 64-bit, Vista, 8 GB

