

Open Learning Session

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Project Malmo as a Cognitive Modeling Environment (and thinking about complexity...)

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Thinking about longer running complex models

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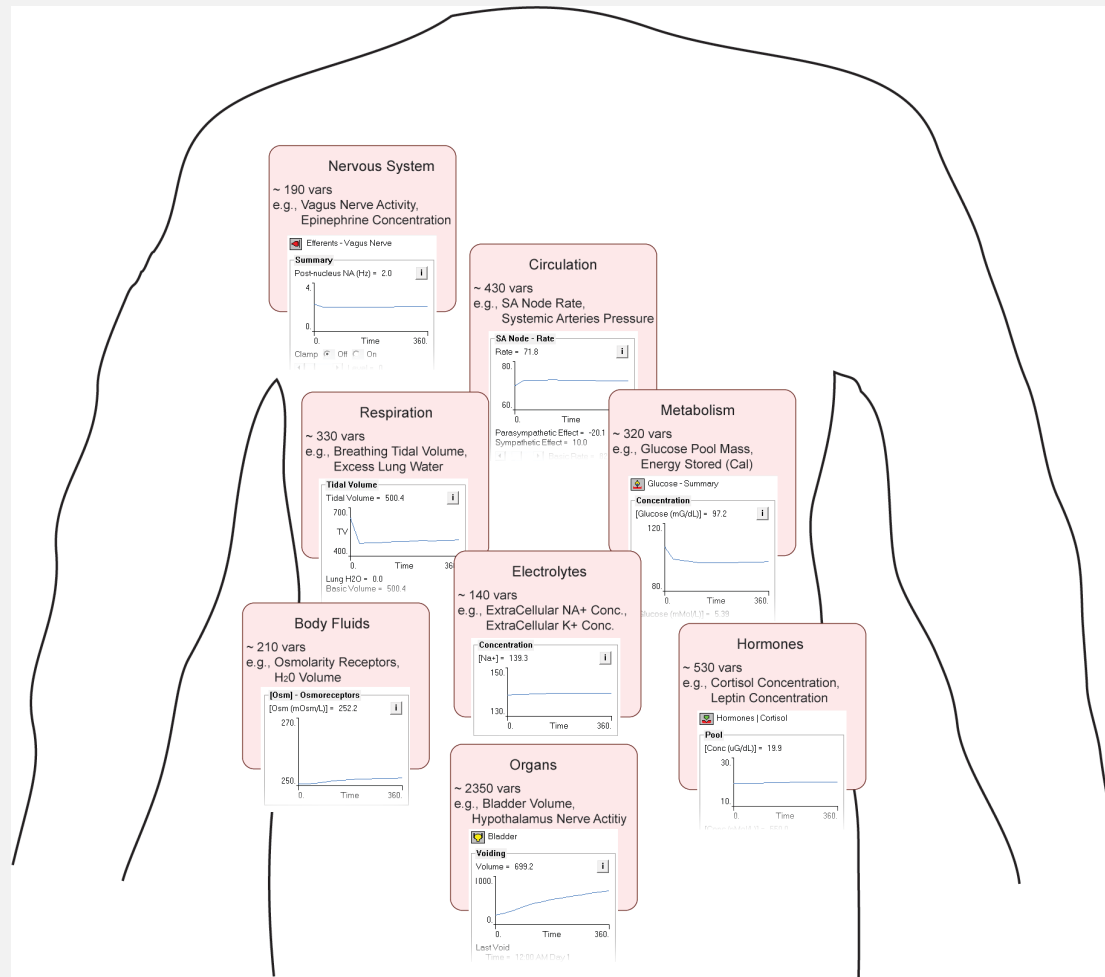
- State (description) complexity
 - ▣ Describing the world as “sensed”

- Process (Description) complexity
 - ▣ Describing the world as “acted upon”

- Hierarchy
 - ▣ May be important for describing environment (external & internal)

Thinking about longer running complex models

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Hester, R. L., Brown, A. J., Husband, L., Iliescu, R., Pruett, D., Summers, R., & Coleman, T. G. (2011). HumMod: A modeling environment for the simulation of integrative human physiology. *Frontiers in physiology*, 2(12).

Thinking about longer running complex models

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- What might we want in an environment?
 - ▣ Limited, but complex interaction between environment, behavioral processes, & physiological processes
 - ▣ Ability to span levels of abstraction when needed
 - ▣ Ability to span complexity (& in different ways)
 - ▣ It works (...)

What is Malmo?

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- “AI experimentation” platform
- Built on top of Minecraft
- Designed to support fundamental research in artificial intelligence.



Why Malmö?

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- Diverse and self-designed environment
- Virtual platform to develop models and agents
- Good looking
 - ▣ (may make human experimentation interesting)



Previous work on AI with Minecraft

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- Smart Dog For Minecraft
- Combine reinforcement learning to adapt to the environment
- The agent in this project is a dog in Minecraft and it learns to keep itself at a good level of health in the environment.



Our Projects with Malmo & ACT-R

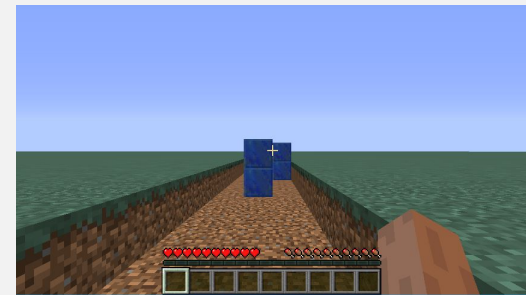
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□ Minecraft Maze

- ▣ Agent moving in maze and avoiding dropping into the lava.

□ Minecraft Run

- ▣ Agent running in lanes, jumping over lava and avoiding blocks.



Some Knowledge of Features

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- XML
- Movement
- Observation
- Rewards



XML

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```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<Mission xmlns="http://ProjectMalmö.microsoft.com" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="http://ProjectMalmö.microsoft.com Mission.xsd">
  <About>
    <Summary/>
  </About>
  <ServerSection>
    <ServerHandlers>
      <FlatWorldGenerator generatorString="3;7,220*1,5*3,2;3;;biome_1"/>
      <ServerQuitFromTimeUp description="" timeLimitMs="10000"/>
      <ServerQuitWhenAnyAgentFinishes description=""/>
    </ServerHandlers>
  </ServerSection>
  <AgentSection mode="Survival">
    <Name>Cristina</Name>
    <AgentStart/>
    <AgentHandlers>
      <ObservationFromFullStats/>
      <ContinuousMovementCommands turnSpeedDeps="180"/>
    </AgentHandlers>
  </AgentSection>
</Mission>
```

Movement

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- Continuous Movement
 - ▣ More realistic
 - ▣ Jump and move simultaneously
 - ▣ Turn degree and move distance decided by time
- Discrete Movement
 - ▣ Move block by block
 - ▣ Assign move direction



Observation

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- ObservationFromGrid
 - ▣ Return a list of blocks
 - ▣ Can't observe entities
- ObservationFromNearbyEntities
 - ▣ Return detail info of entities inside range
- ObservationFromRay
 - ▣ The most realistic one



Rewards

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- ❑ RewardForCollectingItem
- ❑ RewardForDiscardingItem
- ❑ RewardForMissionEnd

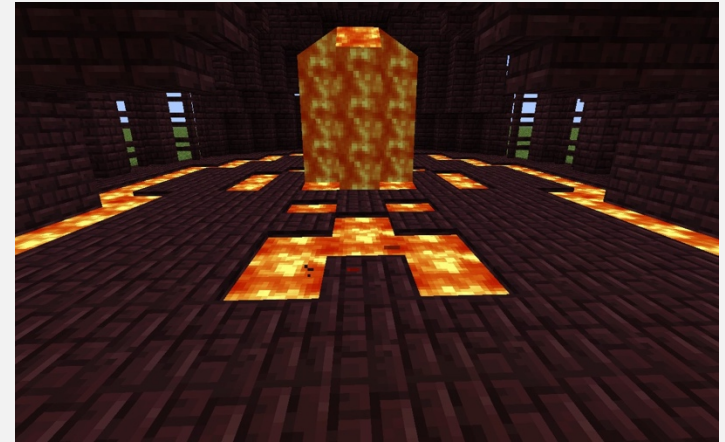


Some Problems...

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- Discrete Movement
 - ▣ Can't perform two simultaneous actions (e.g., jump & move forward)

- Continuous Movement
 - ▣ Less straightforward
 - ▣ Can run into sync/timing issues (perception/motor modules have to work correctly in concert given the time)



Psychological Experiments?

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Education? (CogSci/AI)

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Whereto next?

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- Is this a reasonable environment?
- What are the things we might need for more general ACT-R models?
- What are the (existing) similar environments?

Thanks

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- Thanks to my research assistants
 - ▣ Haipu Sun (Summer 2017)
 - ▣ Son Pham (Summer 2016)