Animats, Evolution, IIT

PSY3280 - Week 10 Lecture (01 Oct 2018)

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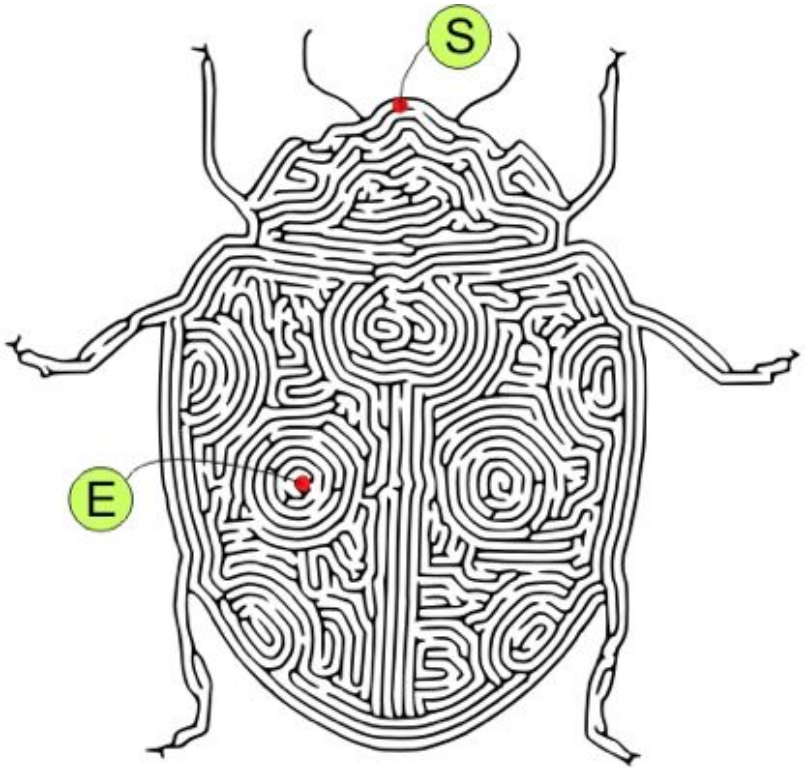
Learning Objective

- Animats & Environment
- Evolutionary Algorithm
- Integrated Information Theory in Animats



Ladybug Maze [Online image]. (n.d.). Retrieved Sep 19, 2018 from http://www.cse.cuhk.edu.hk/~ttwong/papers/maze/images/ladybug/Ladybug.htm

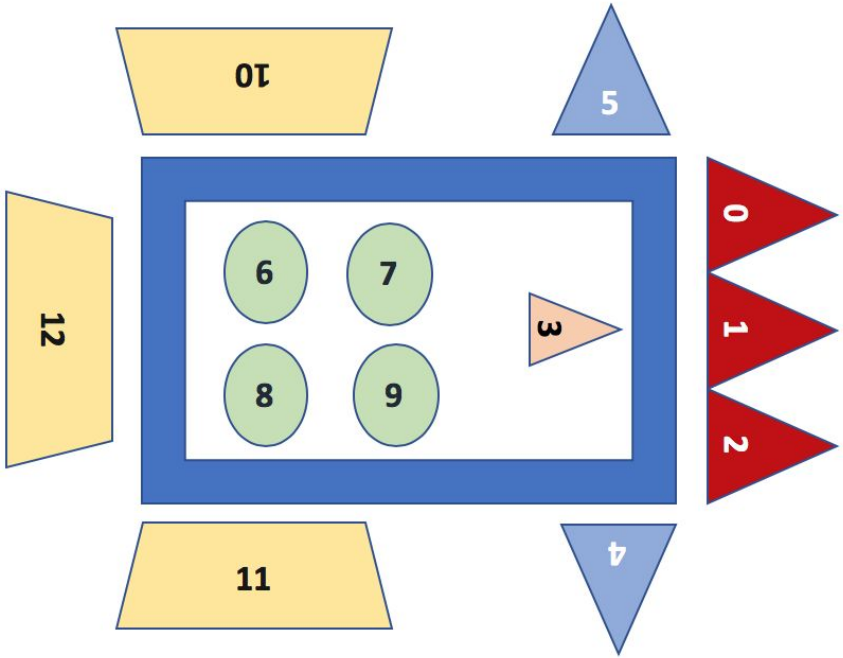
Animats

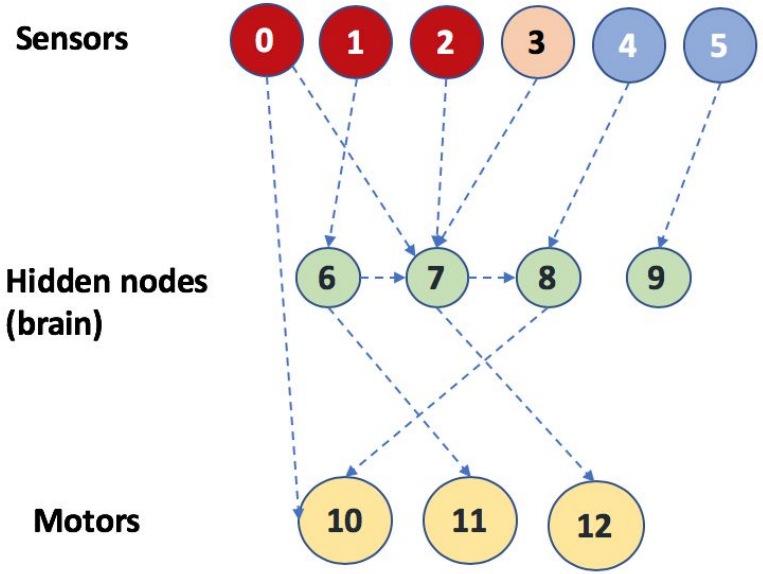
- Artificial animals - physical robots and virtual animal simulations (Dean, 1998).
- Useful in studying the changes of information and complexity during evolution (Albantakis et al., 2014)
- Animats live in a virtual environment

- “Tamagotchi in a virtual lab…”

Hatchi – Tamagotchi on your iPhone? [Online image]. (n.d.). Retrieved January 18, 2018 from http://applenapps.com/review/hatchi-tamagotchi-on-your-iphone#.WmA-JJP1VTY

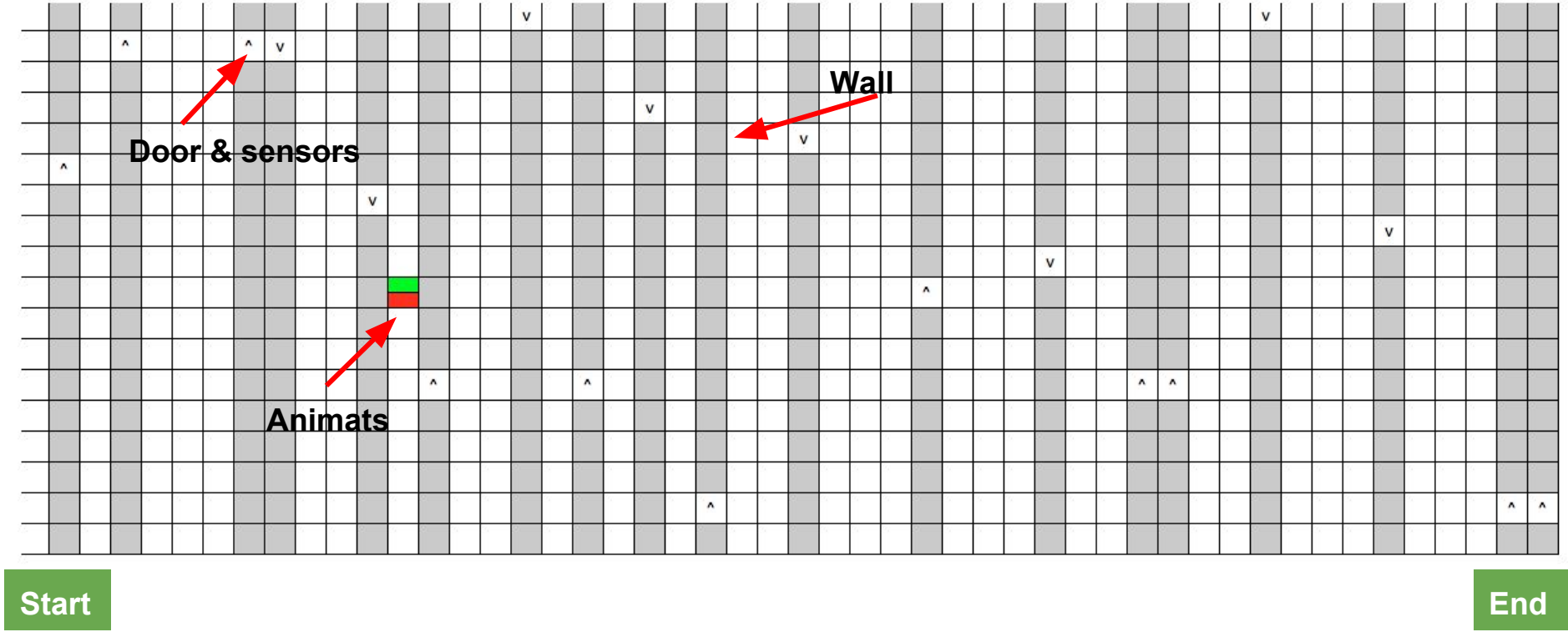
Animat's architecture (an example)





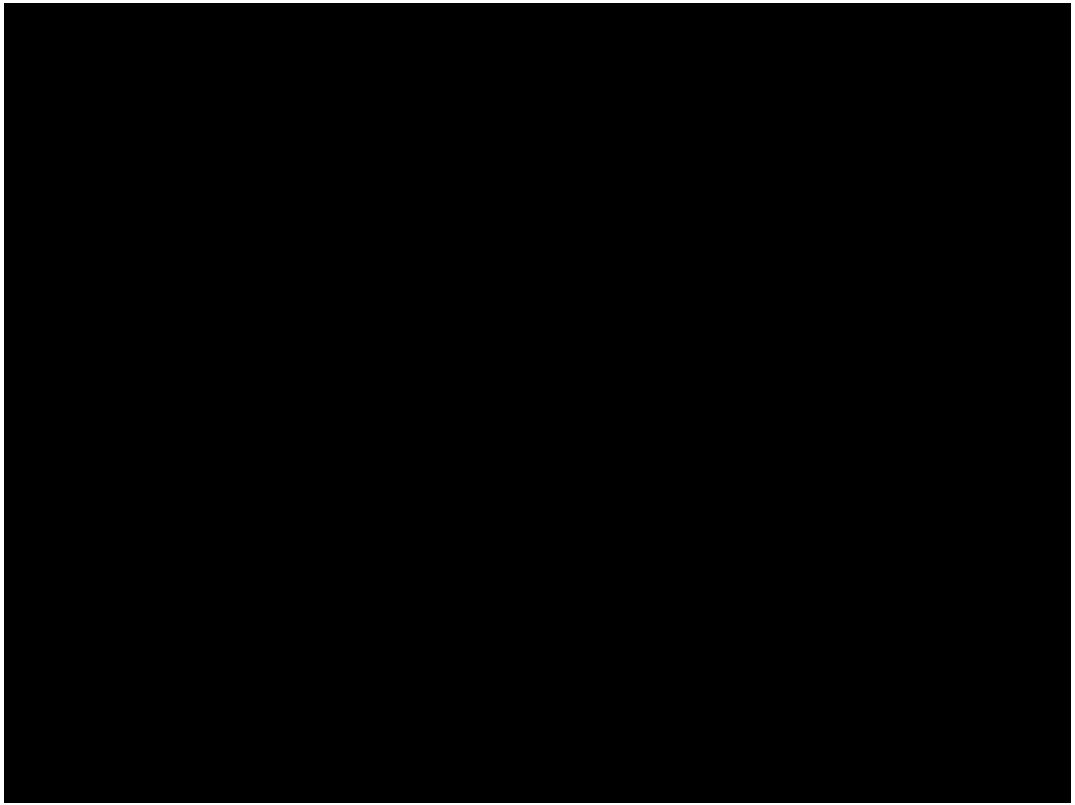
(adapted from Edlund et al., 2011)

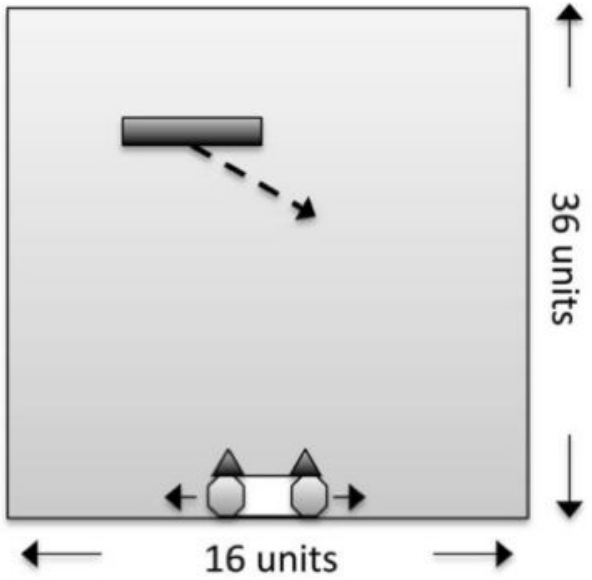
Environment (a virtual maze)



(adapted from Edlund et al., 2011)

Environment (Tetris)

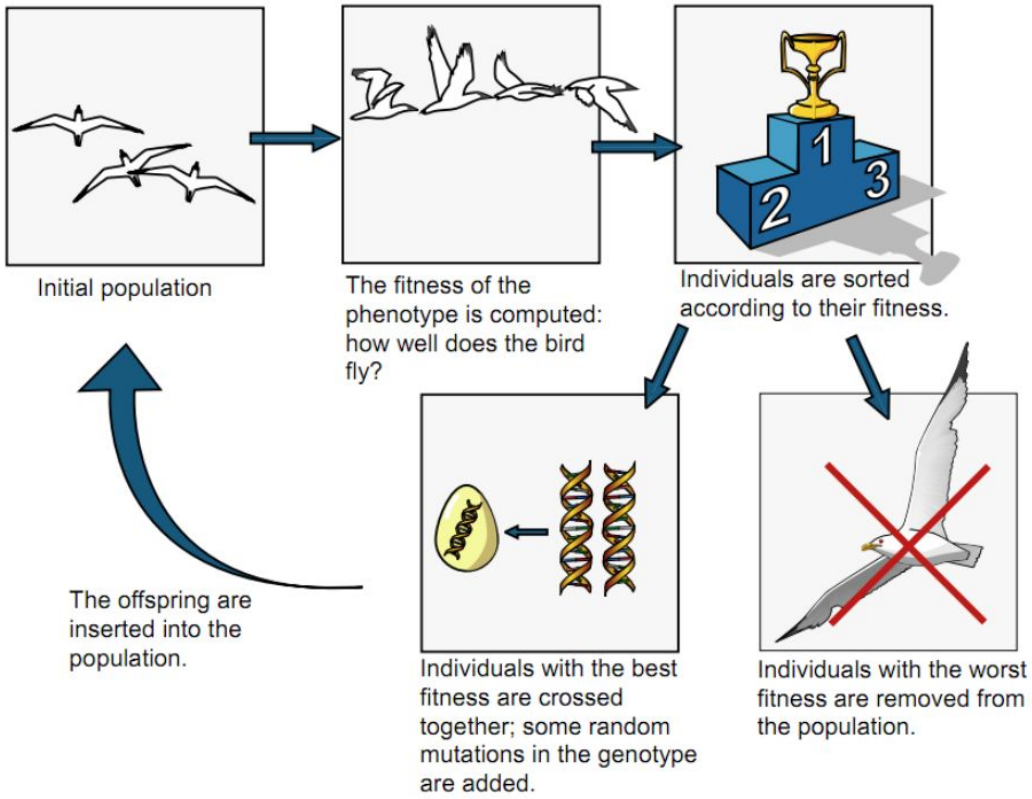




- **Trials 1–32:** size 3 blocks (catch)
- **Trials 33–64:** size 4 blocks (avoid)
- **Trials 65–96:** size 6 blocks (catch)
- **Trials 97–128:** size 5 blocks (avoid)

(Albantakis et al., 2014 & http://integratedinformationtheory.org/animats.html)

Evolutionary Algorithm



Population

Generation

Fitness

Mutation (+/-)

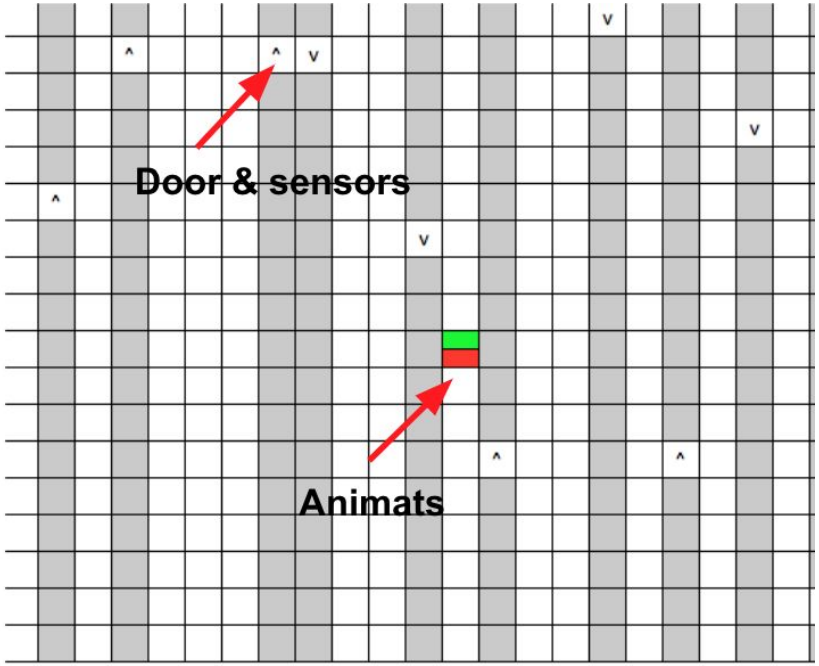
Crossover

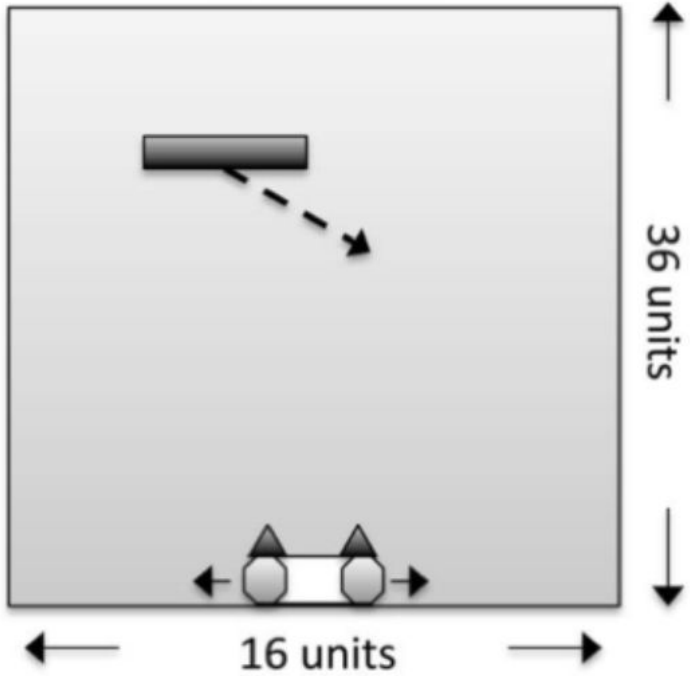
Offspring

(Doncieux et al., 2004)

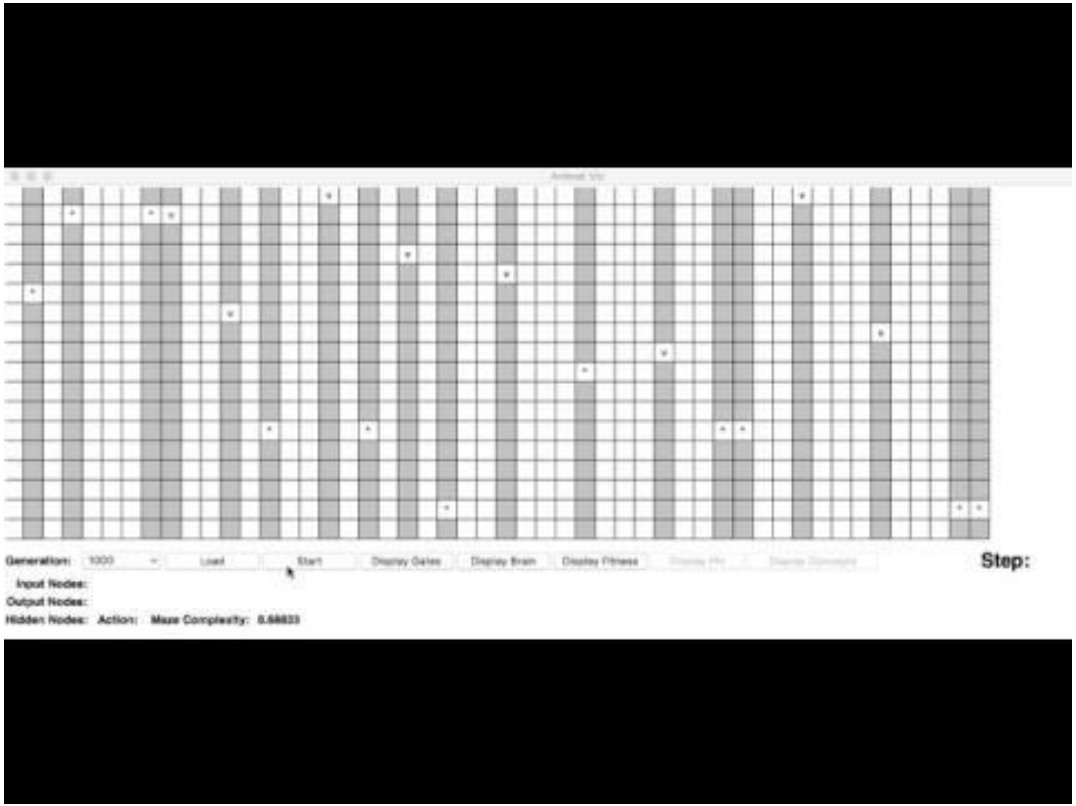
Fitness

- How to measure the fitness of animats in each environment?



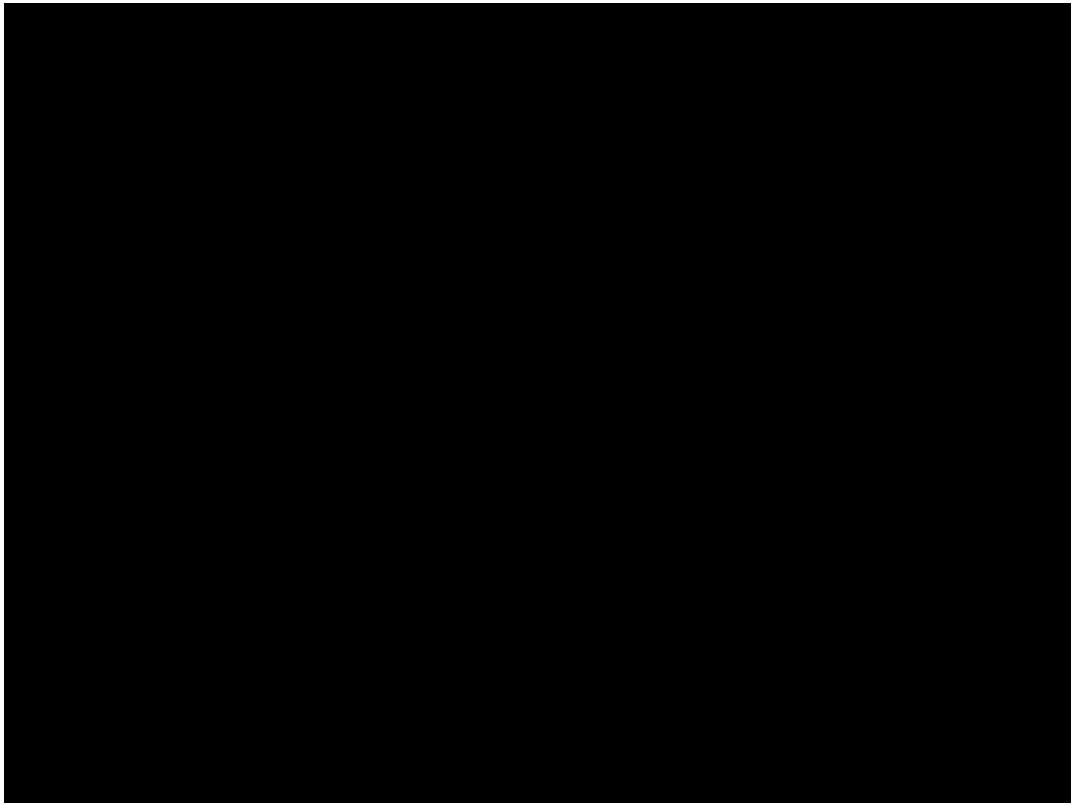


Environment (Maze) - Generation 1000



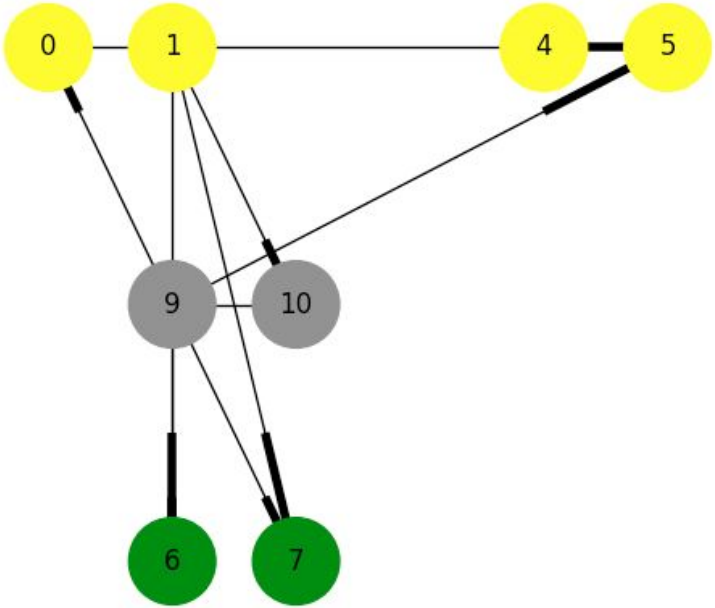
(adapted from Edlund et al., 2011)

Environment (Maze) - Generation 50000

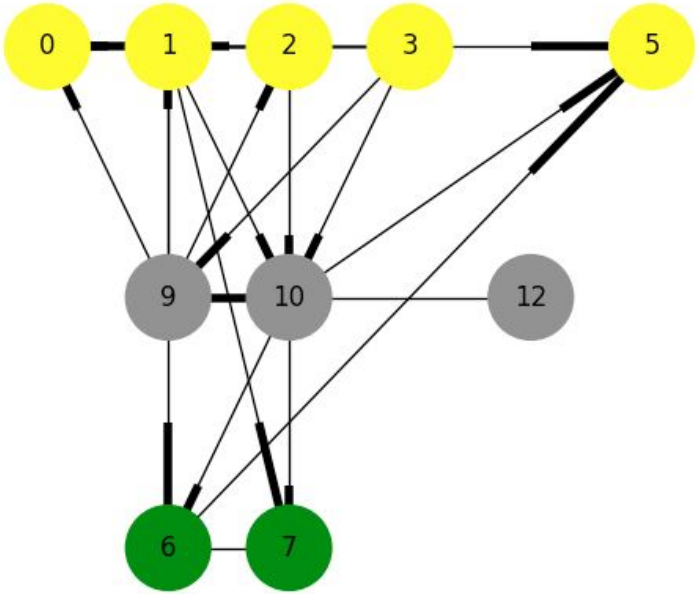


(adapted from Edlund et al., 2011)

Animat’s Brain (Maze)



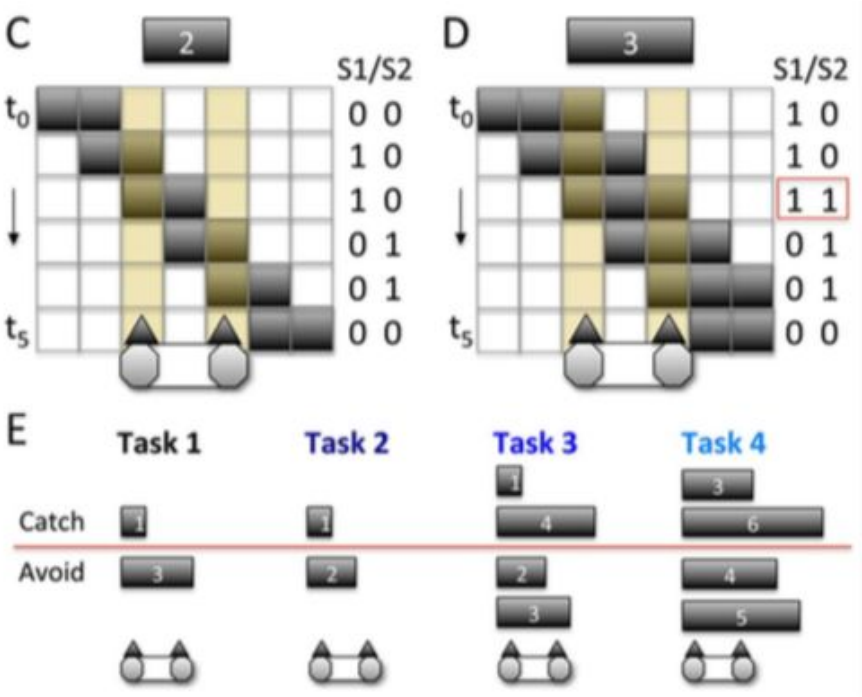
Generation 1000



Generation 50000

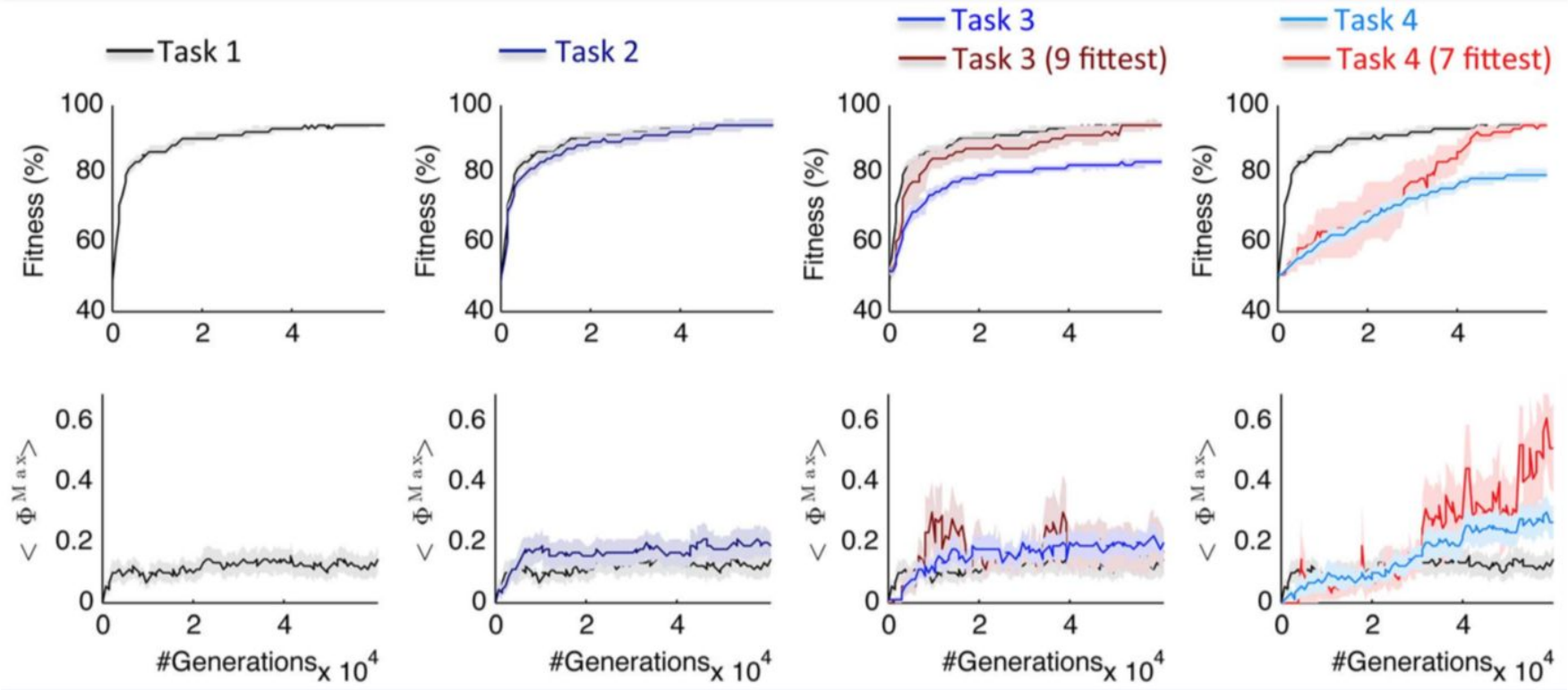
Integrated Information Theory (IIT) in Animats

- **Study**: Tetris environment (Albantakis et al., 2014)
- **Hypothesis**: Measures of integrated information should increase with the **complexity** of the environment
- Animats' increasing fitness (adaptation to an environment) is associated with an increase in the capacity to integrate information.



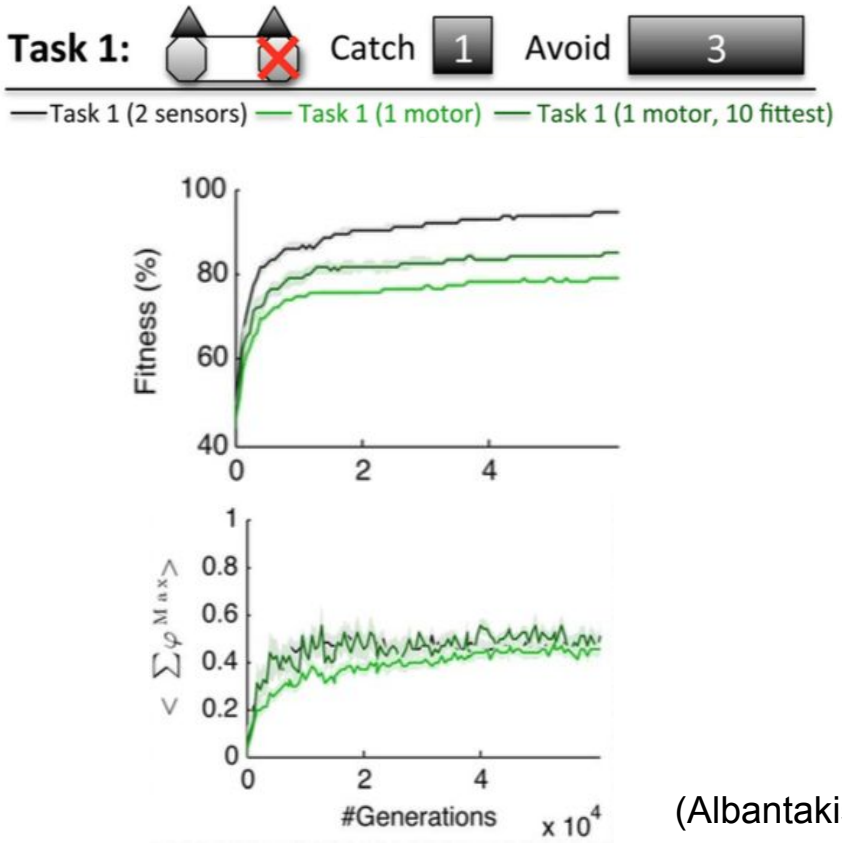
(Albantakis et al., 2014)

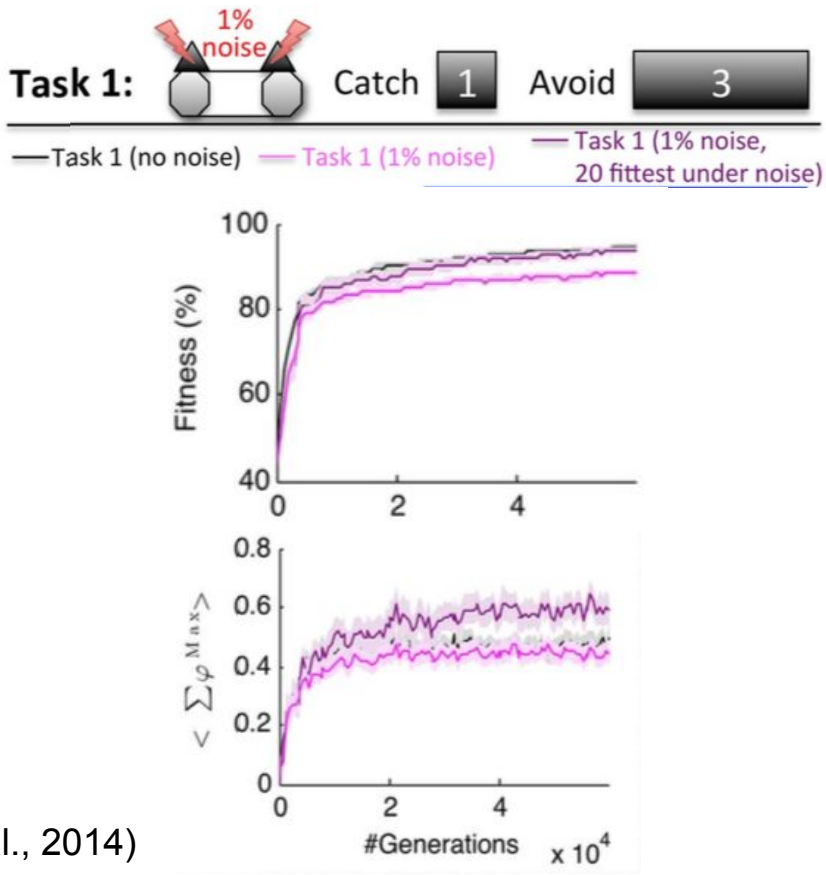
Integrated Information Theory (IIT) in Animats



(Albantakis et al., 2014)

Integrated Information Theory (IIT) in Animats





(Albantakis et al., 2014)

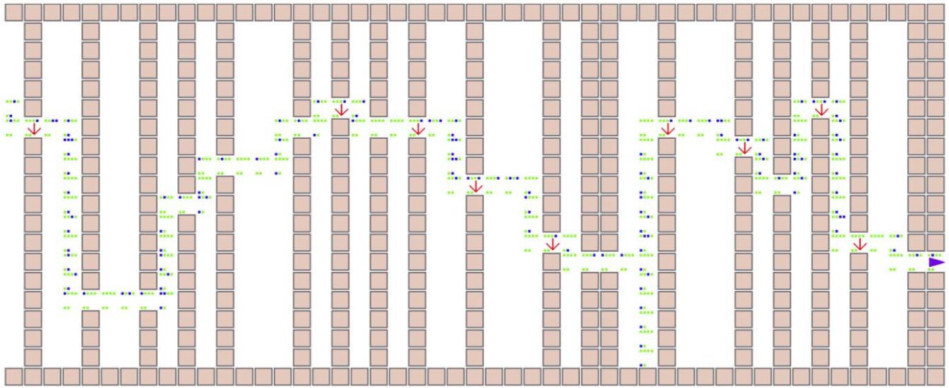
Integrated Information Theory (IIT) in Animats

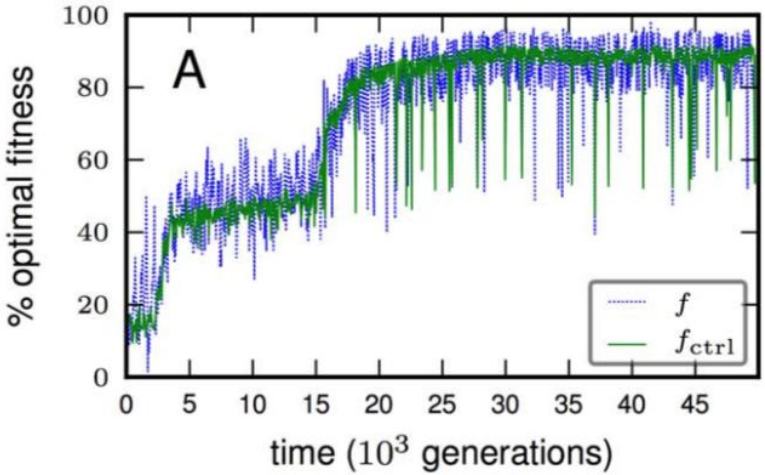
- Integrated systems can have a selective advantage if the environment is **complex**, compared to modular systems.
- Integrated brains can implement more functions/concepts for the same number of elements - higher-order concepts (irreducible combinations of elements).
- Integrated brains - degeneracy (redundancy) - adaptation
- IIT - integrated conceptual structures underlie consciousness, the finding that such structures offer selected advantage in complex environments -> why and how consciousness evolved.

(Albantakis et al., 2014)

Integrated Information Theory (IIT) in Animats

- Study: Maze environment (Edlund et al., 2011)
- Integration of memory and other streams (sensors & motors)





(Edlund et al., 2011)

References

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- Doncieux, S., Mouret, J., Muratet, L., and Meyer, J. (2004). The robur project: towards an autonomous flapping-wing animat. *Proceedings of the Journ´ees MicroDrones*.
- Edlund, J. A., Chaumont, N., Hintze, A., Koch, C., Tononi, G., & Adami, C. (2011). Integrated Information Increases with Fitness in the Evolution of Animats. *PLOS Computational Biology*, *7*(10), e1002236–13. http://doi.org/10.1371/journal.pcbi.1002236