

Kaiser Lab

www.dynamic-connectome.org



Simulation of Brain Development on Hybrid Cloud Computers

Roman Bauer
School of Computing Science
Newcastle University

11.11.14





video from Dr. Yujiang Wang

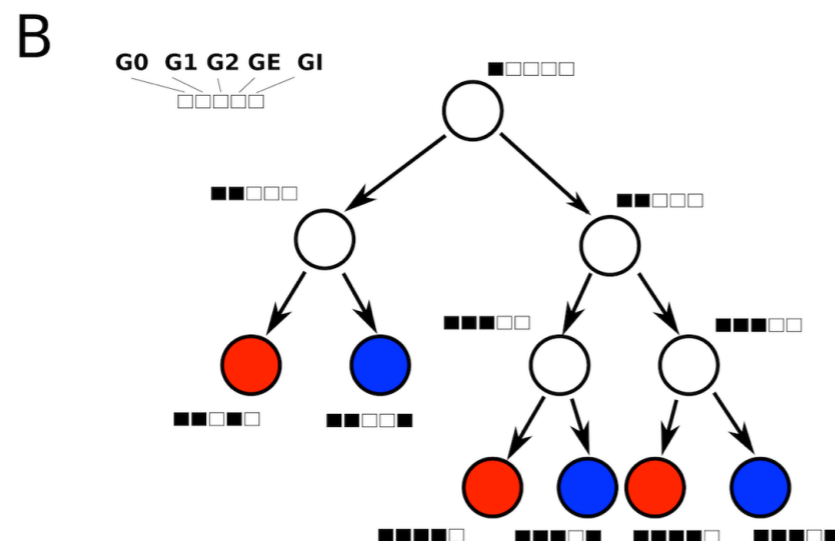
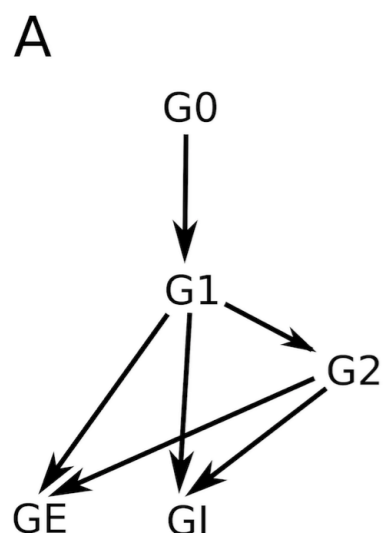


Human Brain:

~ 100 Billion Neurons
~ 10^{15} Synapses



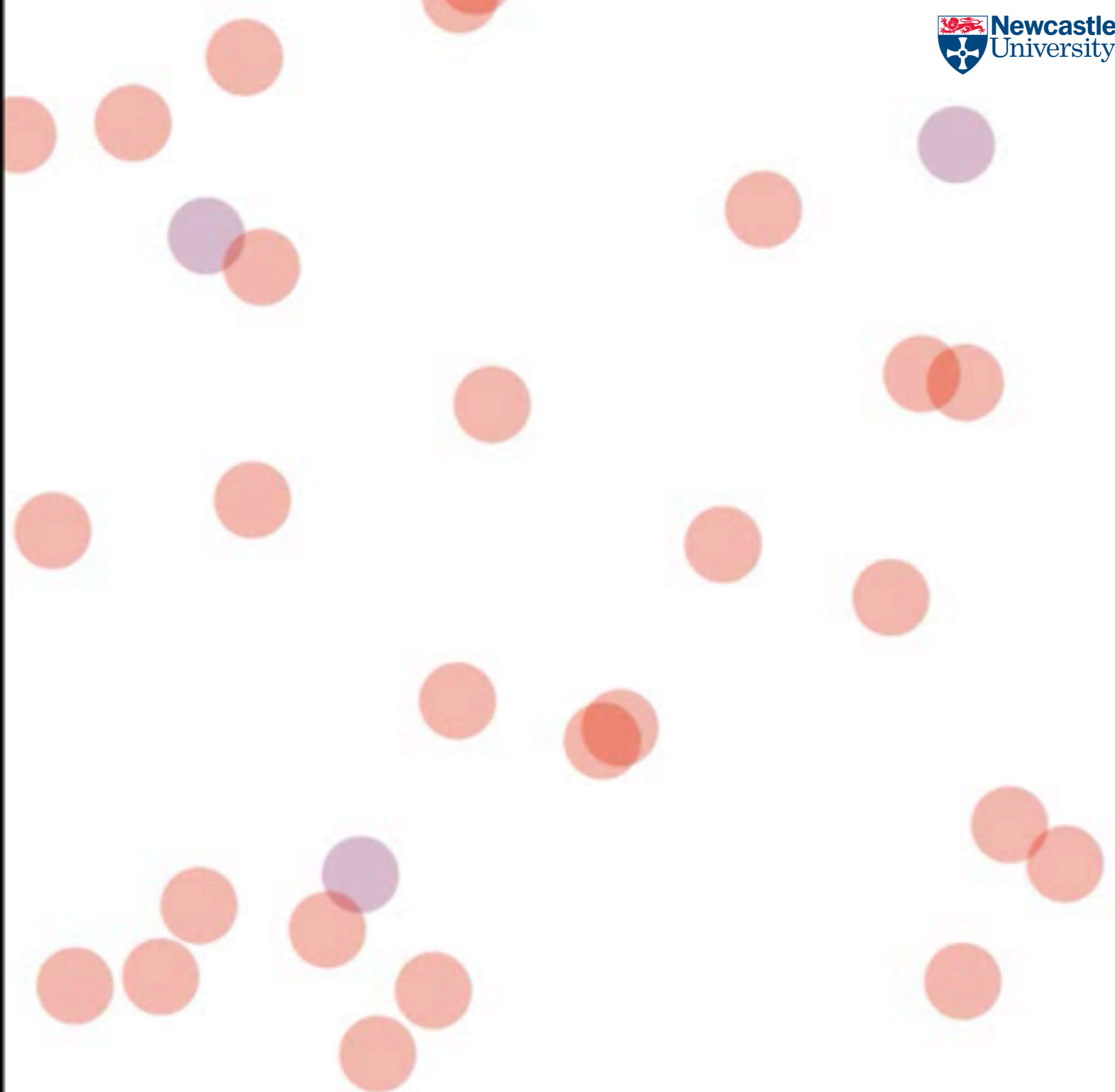
Human Brain:
 ~ 100 Billion Neurons
 ~ 10^{15} Synapses



Gene-like Coding
 for the Self-Organization of
 Neural Tissue



from Bauer et al. 2014, PLoS Comput Biol (in press)



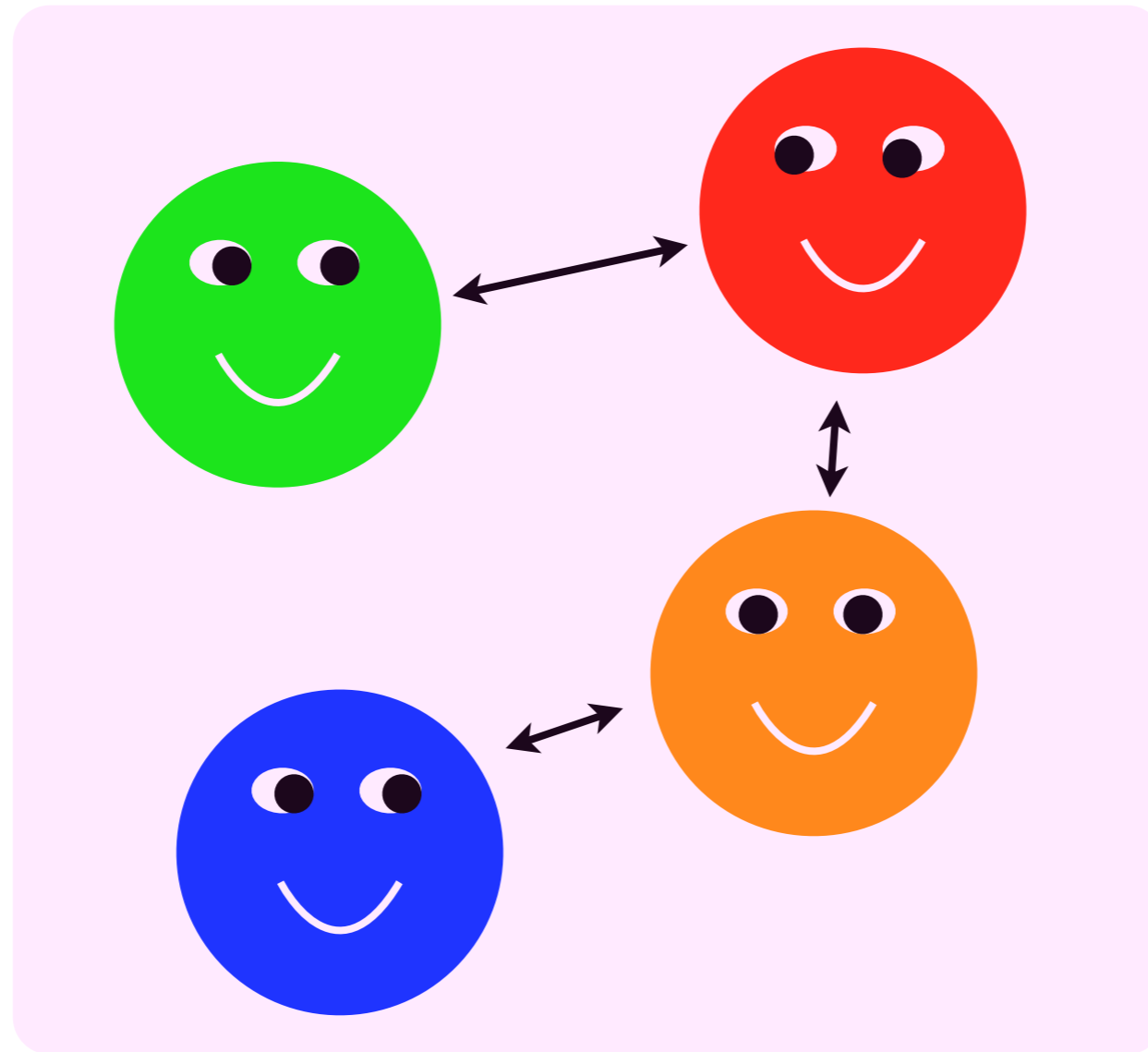
from Bauer et al. 2014, PLoS Comput Biol (in press)



Bauer et al. 2014, Cerebral Cortex

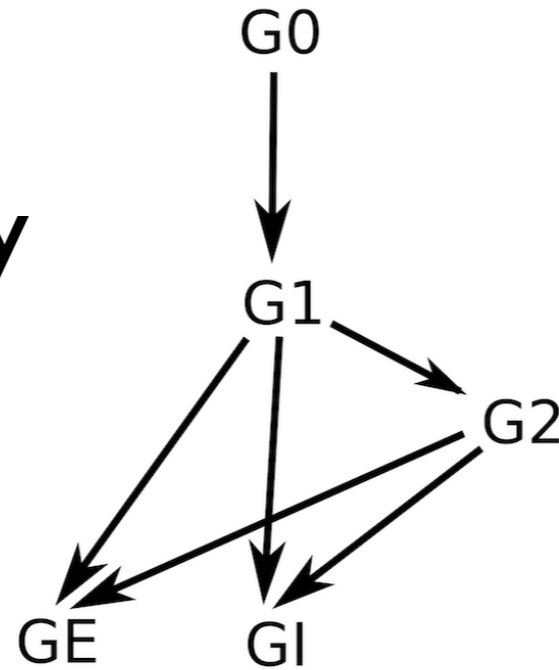
Integrity of the Model

Integrity of the Model



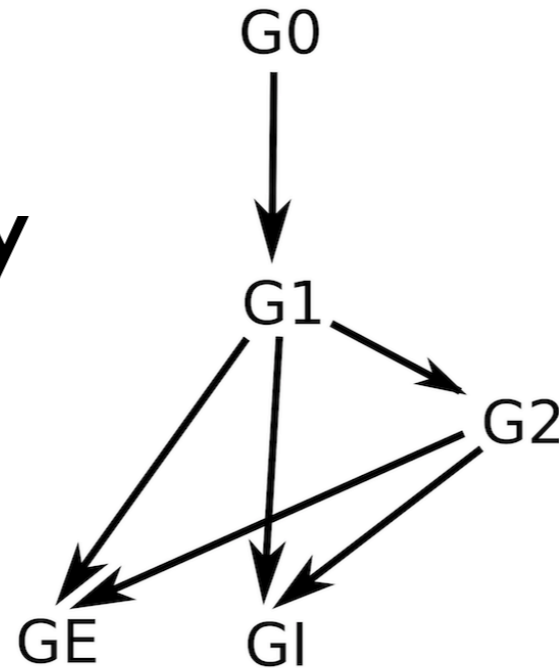
Integrity of the Model

Biology

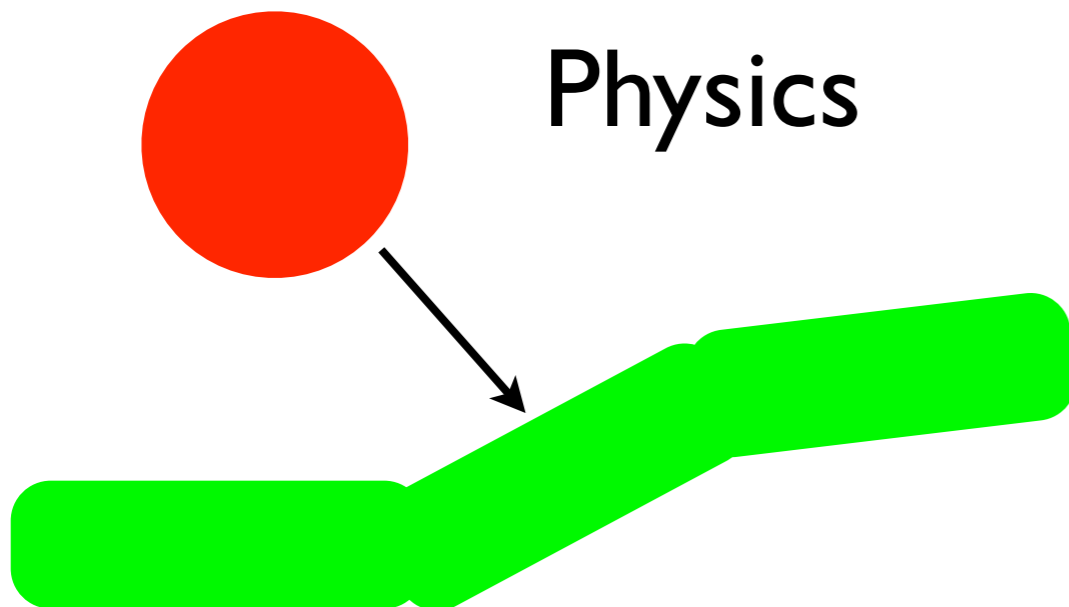


Integrity of the Model

Biology

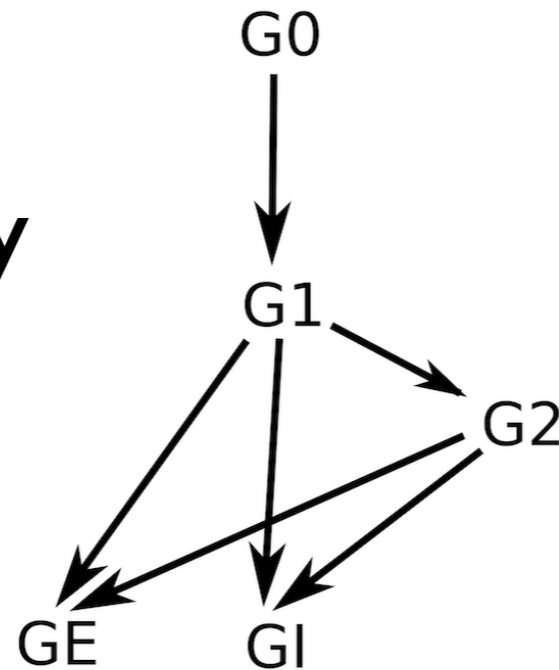


Physics

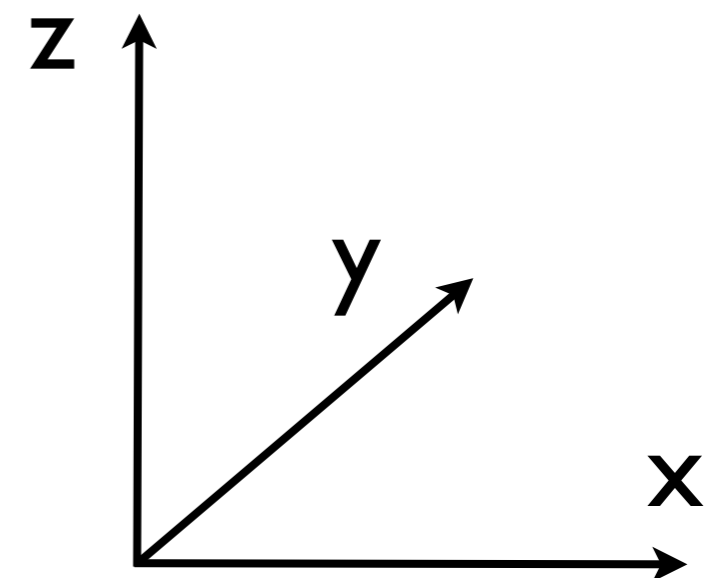
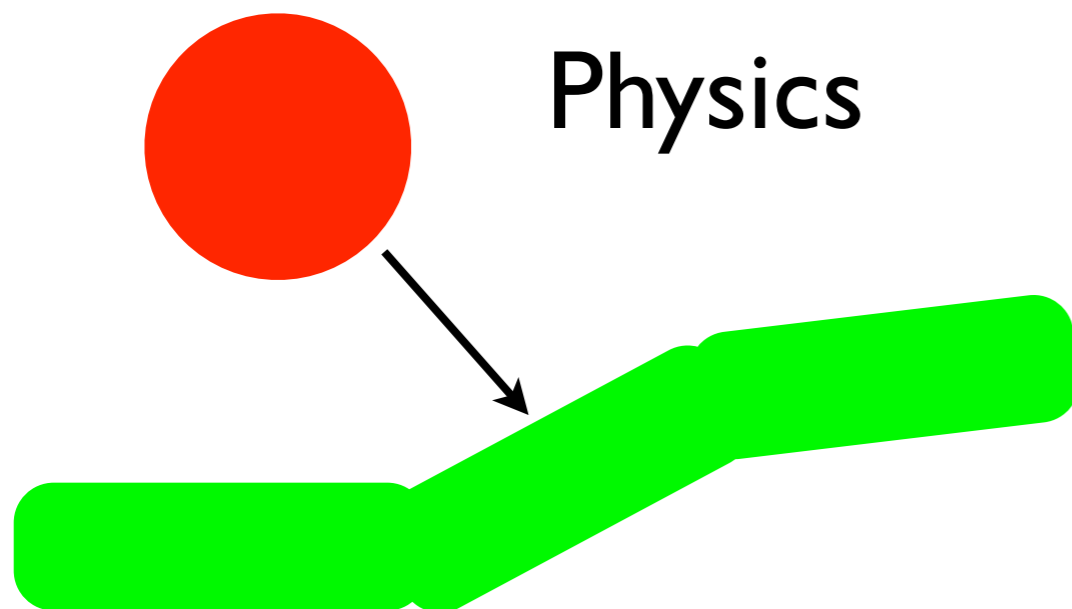


Integrity of the Model

Biology



3D Space



Physics Engine



from racing video game Grid 2

Human Green Brain Project



<http://www.greenbrainproject.org/>

Human Brain Project



<https://www.humanbrainproject.eu/>

Goals

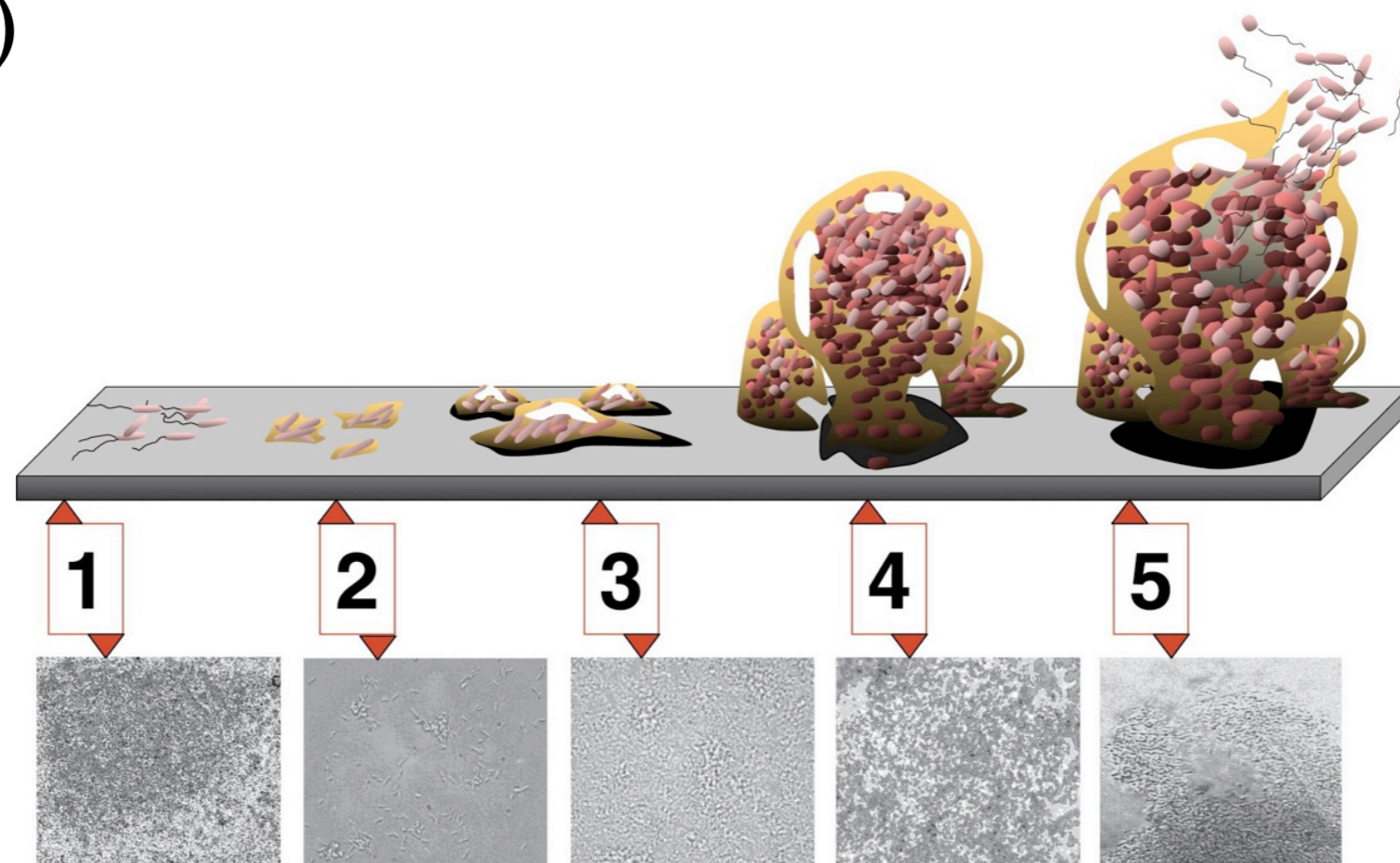
Primary:
simulations of human brain development

Goals

Primary:
simulations of human brain development

Impact:

- synthetic biology (e.g. models of Interdisciplinary Computing and Complex BioSystems research group (ICOS), Newcastle University)



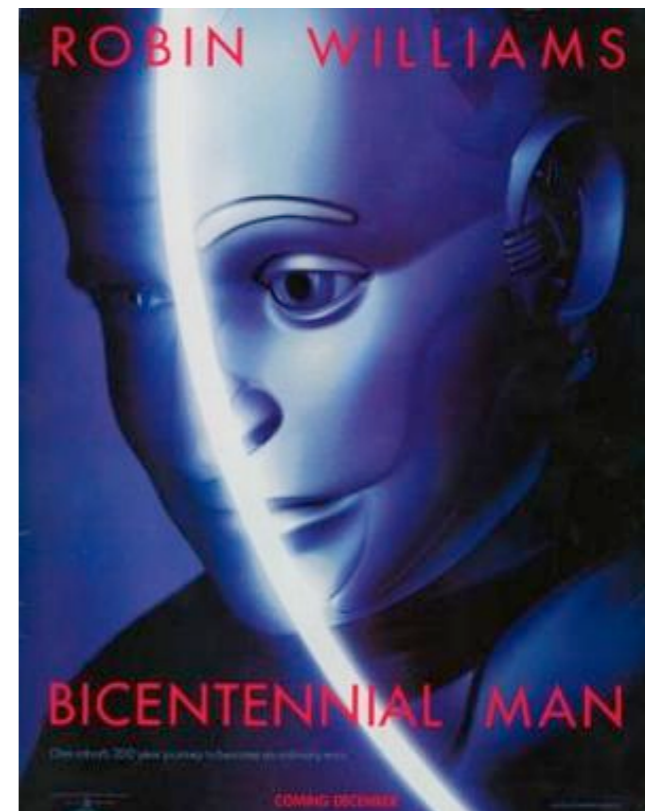
from Monroe 2007,
PloS Biol

Goals

Primary:
simulations of human brain development

Impact:

- synthetic biology (e.g. models of Interdisciplinary Computing and Complex BioSystems research group (ICOS), Newcastle University)
- artificial intelligence and robotics



Goals

Primary:
simulations of human brain development

Impact:

- synthetic biology (e.g. models of Interdisciplinary Computing and Complex BioSystems research group (ICOS), Newcastle University)
- artificial intelligence and robotics
- biological / medical research

Bauer et al. 2014. A computational model incorporating neural stem cell dynamics reproduces glioma incidence across the lifespan in the human population. PLoS ONE (in press)

Understanding brain diseases

Brain Disease	Estimated Prevalence (worldwide)
Epilepsy	50 million
Schizophrenia	25 million
Autism	45 million
Dementia	35 million



Total cost of brain diseases in Europe: 798 billion €

numbers from recent WHO reports, Elsabbagh et al. (2012) and Olesen et al. (2012)

School of Computing Science Newcastle University



Marcus Kaiser, Reader



Roman Bauer, Research Associate



Natalio Krasnogor, Professor



Harold Fellerman, Postdoctoral Research Fellow



Graham Morgan, Senior Lecturer

Institute of Neuroinformatics, UZH / ETHZ



Advisor: Rodney Douglas, Professor

institute of
neuroinformatics



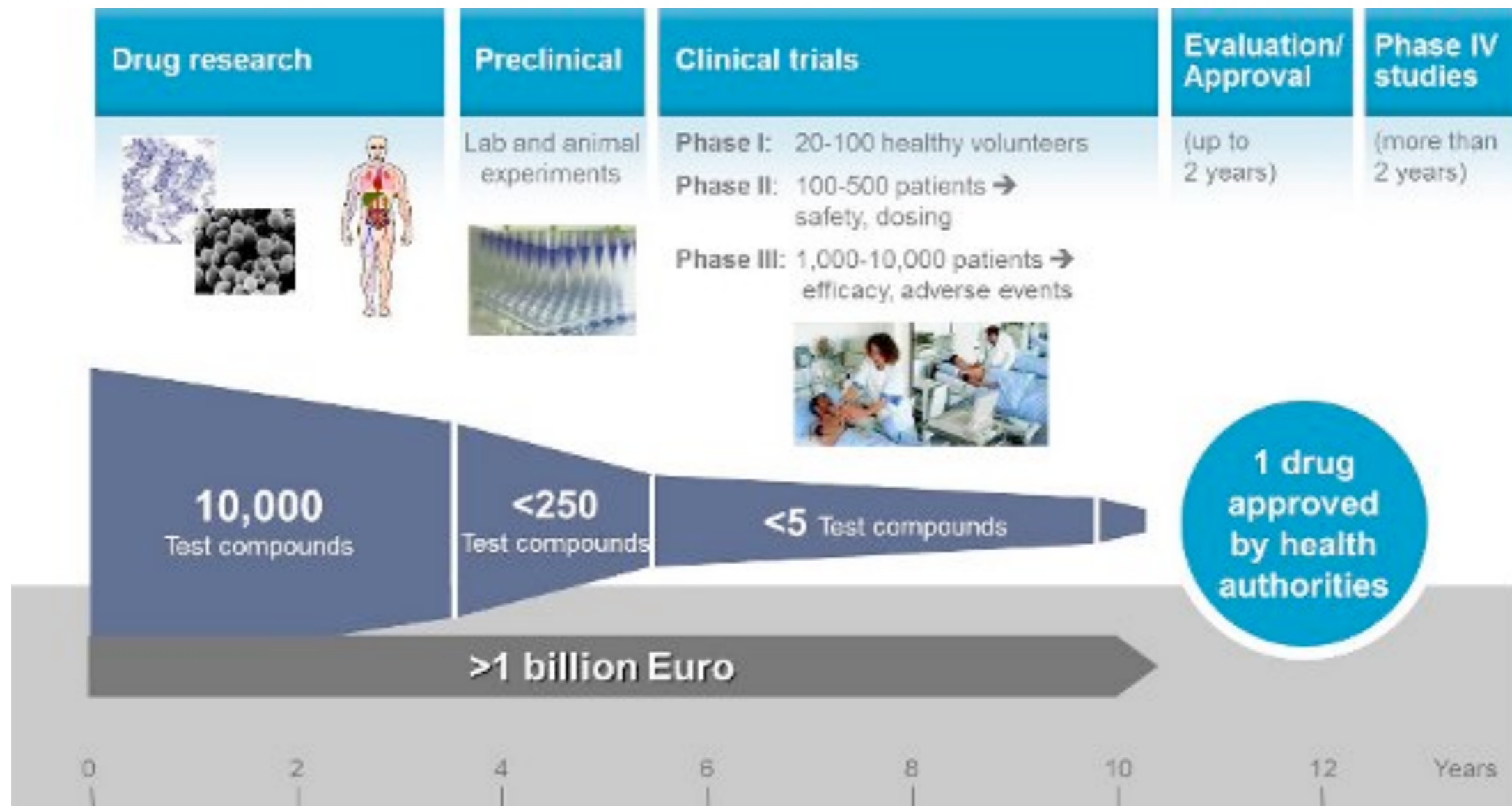
Why I am here



Simulations on cloud computers using
CPU / GPU brokering

- large-scale developmental simulations
- hybrid and elastic computation
- closed-loop interaction between structure and function

Vision



Source: based on PhRMA Profile Pharmaceutical Industry 2010

Thank you!



from <http://ep.jhu.edu/graduate-programs/applied-biomedical-engineering>