Verification & Validation of Autonomous Systems

Network Activities — http://www.vavas.org

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University of Liverpool

Sheffield, March 2017

Verification & Validation of Autonomous Systems Network

EPSRC funded Academic Network

Website: ..... `http://vavas.org`

Start of funding: 1st Sept 2015, for 3 years.

Aims:

> to stimulate, coordinate, promote, and disseminate academic research on the verification and validation of autonomous systems

Progress: Over 70 academic members so far.

Across all *Techniques*

- Simulation and Testing
- Formal Proof
- User Validation
- Autonomous Agents and Multi-Agent Systems
- Hybrid Control Systems
- Human Robot Interaction
- Probabilistic Verification
- Model-Checking
- ....

Across all *Potential Applications*

- Safety Critical Systems
- Certification of Unmanned air vehicles
- Safe (and road-worthy) driverless cars
- Autonomous robotics in nuclear/chemical/biological processes
- Human-robot teamwork, both in work and home contexts
- Deep underwater/space/underground exploration
- Autonomous ocean surface monitoring and exploration
- Autonomous sensing and control in smart cities
- Trustworthy robotic assistants for home and health-care
- Robotic diagnosis, rehabilitation, or surgery
- Autonomous satellites handling sensing/monitoring/comms
- Precision farming
- Robotic search, cleanup or rescue
- Nano-robotics
- ....

Across all *Issues*

- Legal Issues, Standards, and Certification
- Validation
- Reliability and Robustness
- Robot Ethics
- Predictability and Uncertainty
- Safety and Security
- Fault Tolerance
- Trust and Responsibility
- ...

Events so far

Sep 2015: *Agent Verification Workshop*, Liverpool

Dec 2015: *Winter School on Verification of Mobile and Autonomous Robots*, York

Feb 2016: *Workshop on Autonomous Systems: Legal/Regulatory Aspects and V&V*, London

Jul 2016: *Workshop on Industrial Perspectives on the V&V of Autonomous Systems*, [Innovate UK] Sheffield

Nov 2016: *Workshop on V&V for Autonomous Road Vehicles*, [CCAV] London

Mar 2016: *Workshop on V&V of Sensing and Control Models in Autonomous Systems*, Sheffield

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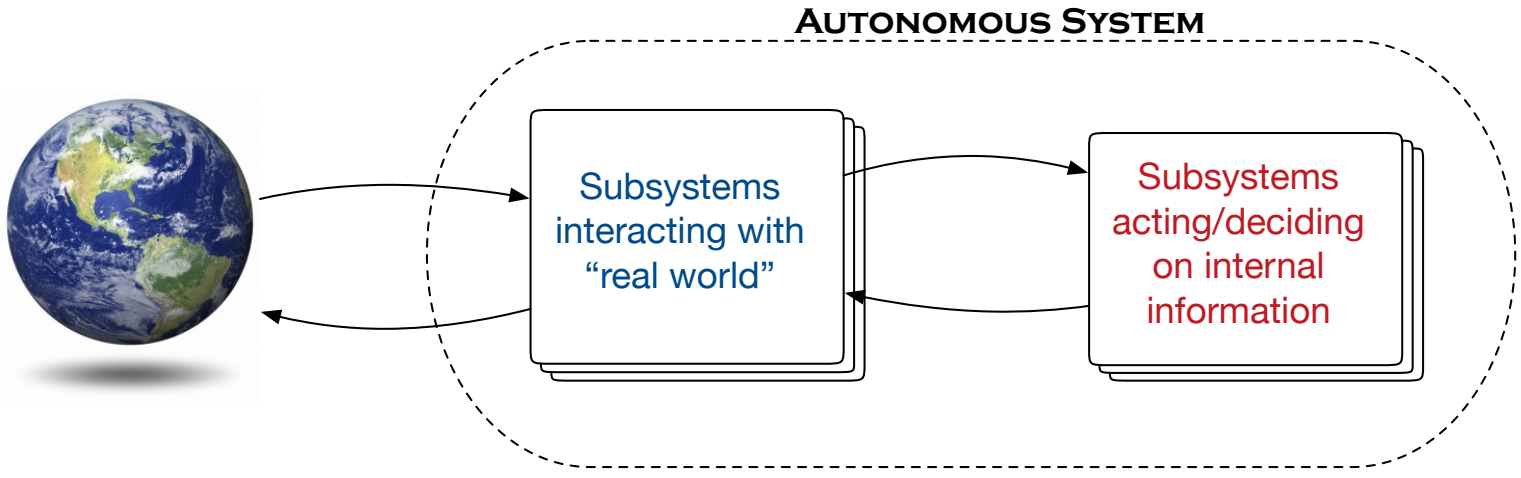
Mar 2016: *Workshop on V&V of Sensing and Control Models in Autonomous Systems*, Sheffield

May 2017: *Workshop on Software Verification and Validation for Complex Systems*, [Innovate UK] London

Nov 2017: *Workshop on V&V of Autonomous Systems: Ethical, Social and Trustworthy behaviour*, London

State of the Art??



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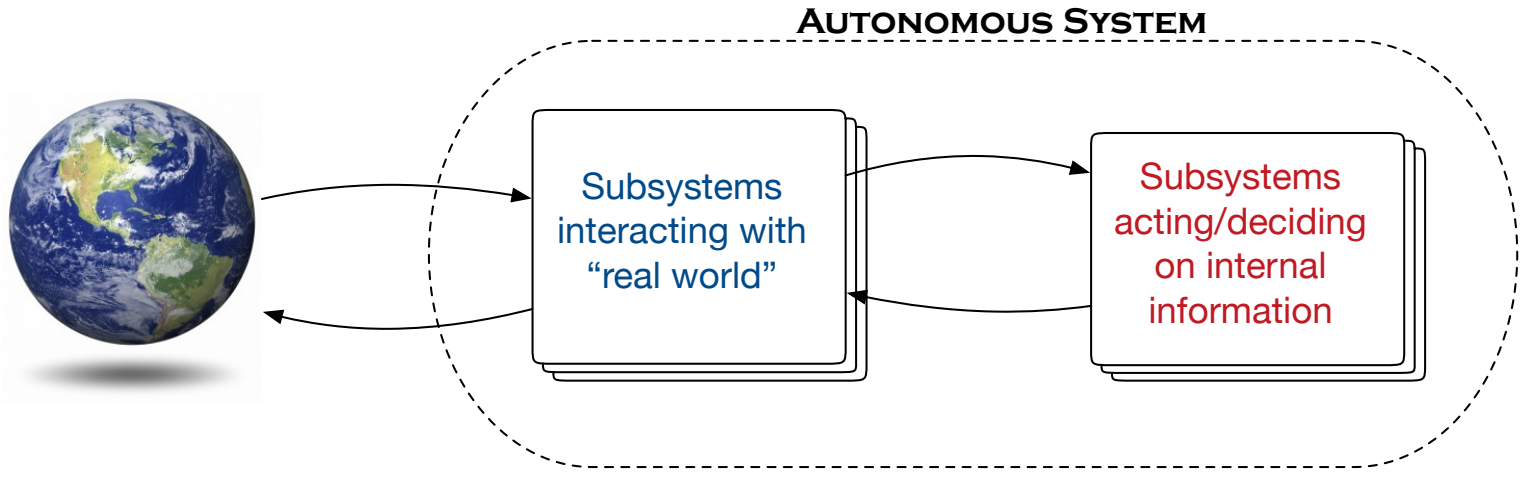
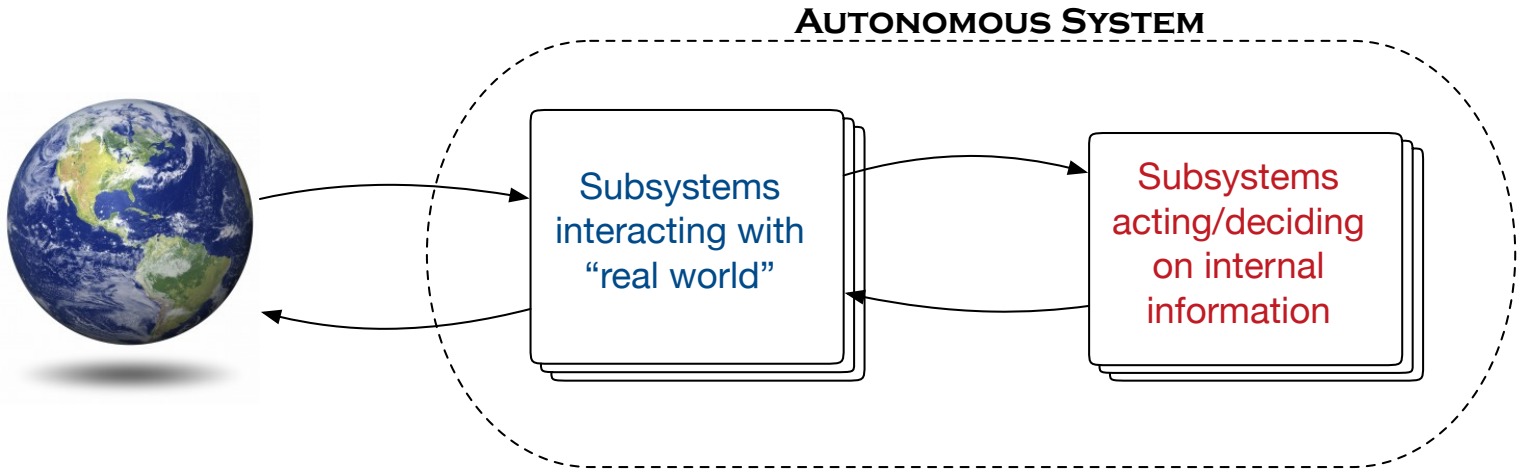


Subsystems interacting with "real world" typically involve

- testing

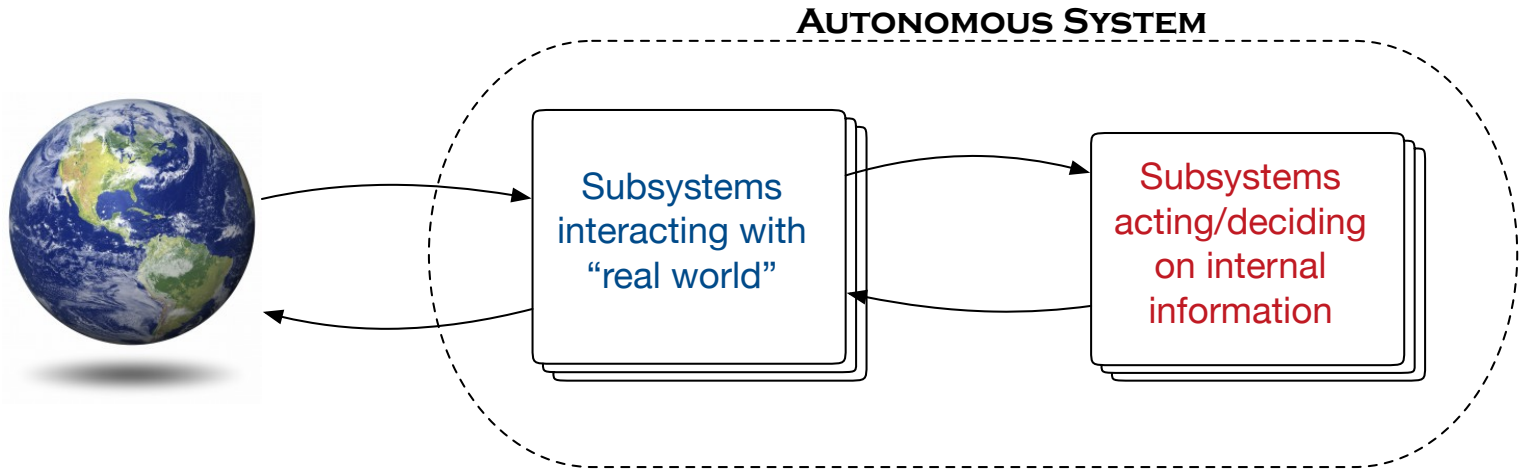
State of the Art??



Subsystems interacting with "real world" typically involve

- testing
  — requires suitable models of interaction/world?

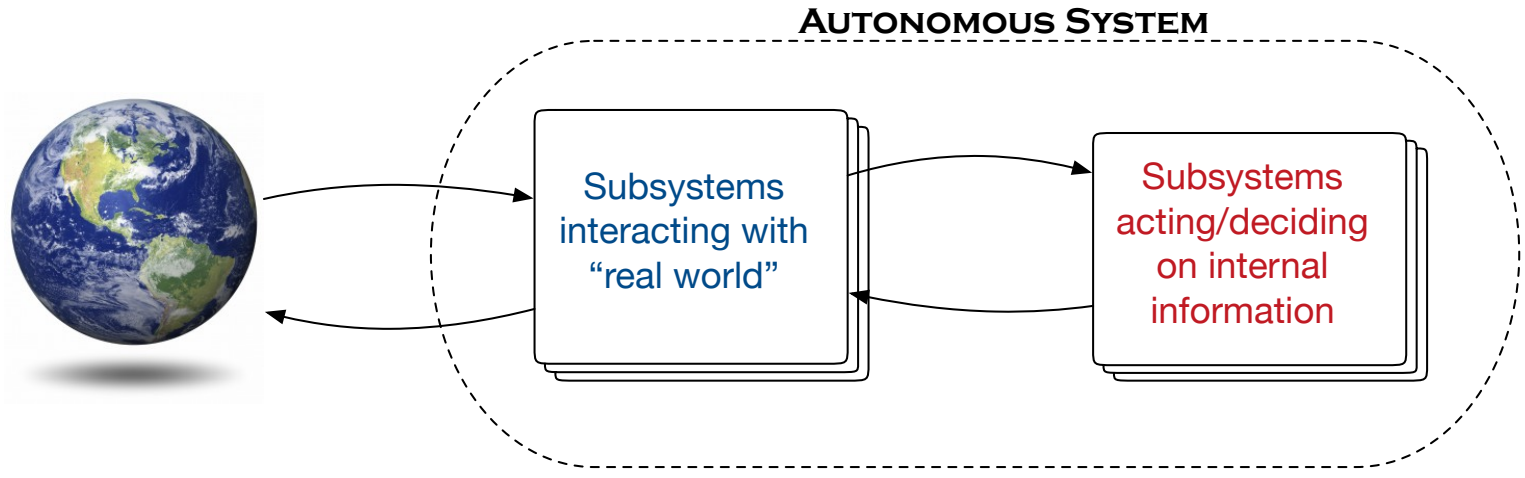
State of the Art??



Subsystems interacting with "real world" typically involve

- testing
  — requires suitable models of interaction/world?
- verification using abstract models of real world

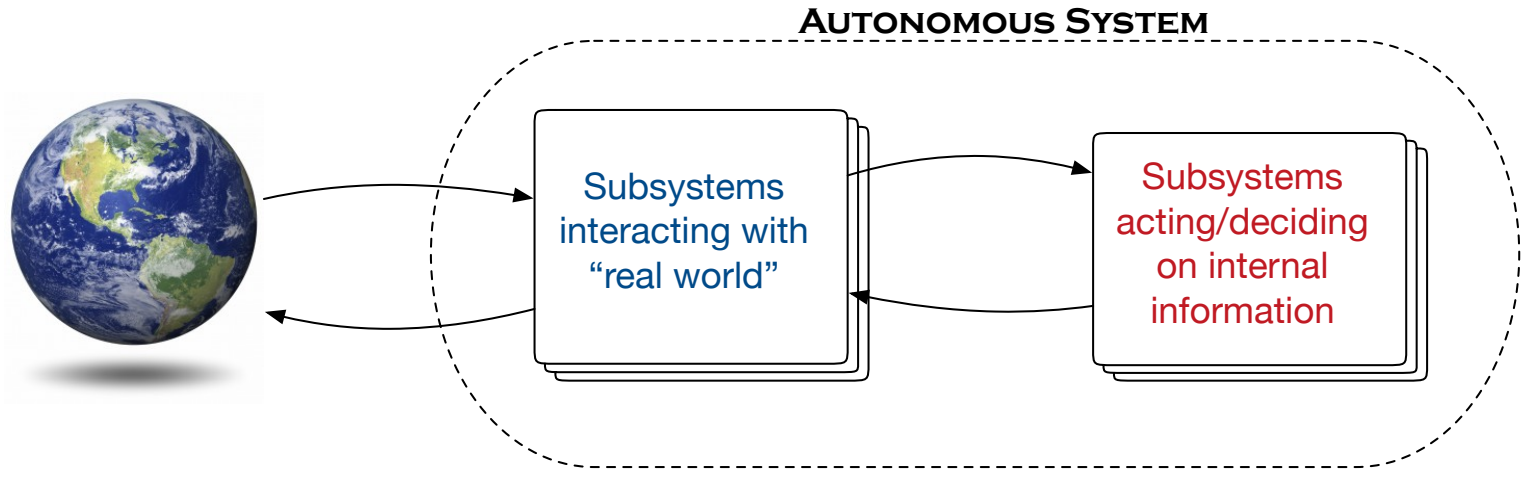
State of the Art??



Subsystems interacting with "real world" typically involve

- testing
  — requires suitable models of interaction/world?
- verification using abstract models of real world
  — requires suitable stochastic/real-time abstraction?

State of the Art??



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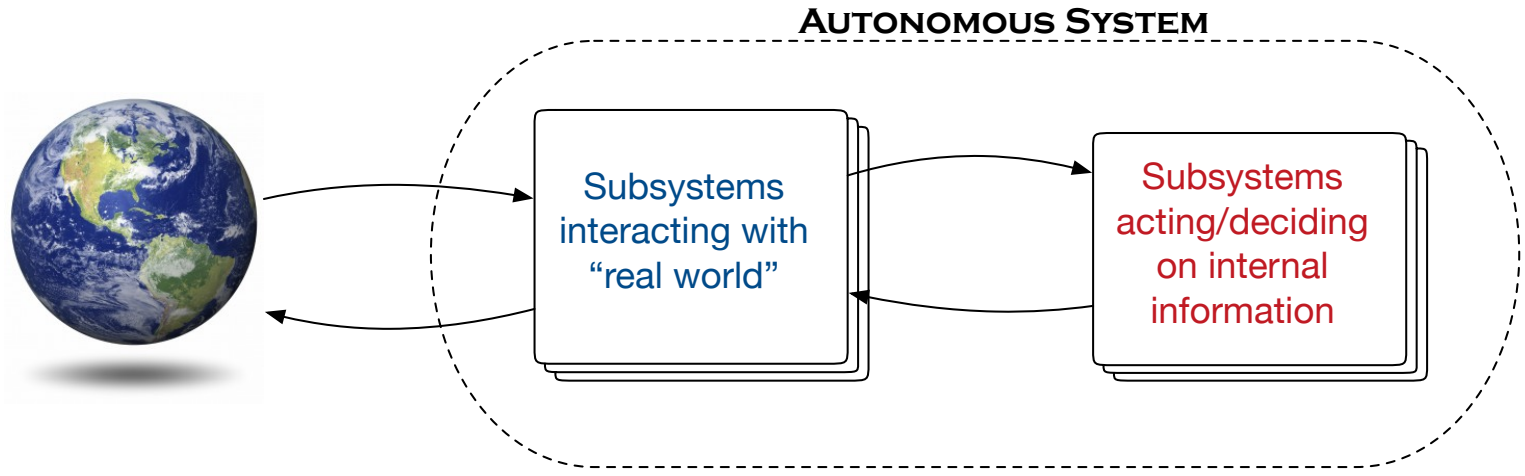
- verificaiton using complex (Physics) model of real world

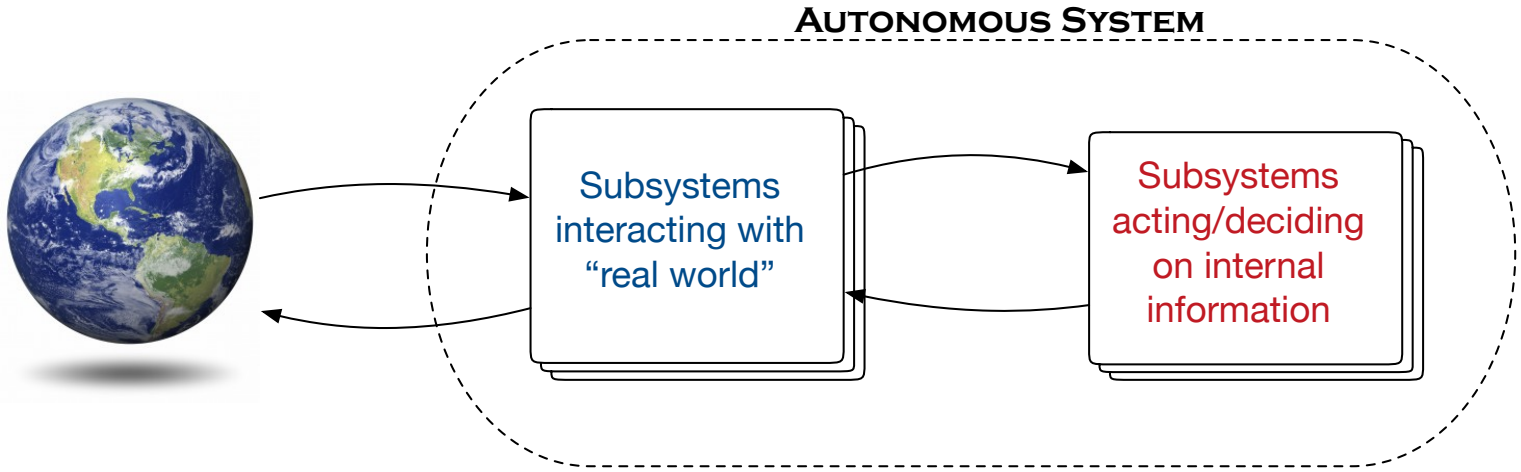
State of the Art??



Subsystems interacting with "real world" typically involve

- testing
  — requires suitable models of interaction/world?
- verification using abstract models of real world
  — requires suitable stochastic/real-time abstraction?
- verificaiton using complex (Physics) model of real world
  — requires hybrid (differential equations?) description?

State of the Art??



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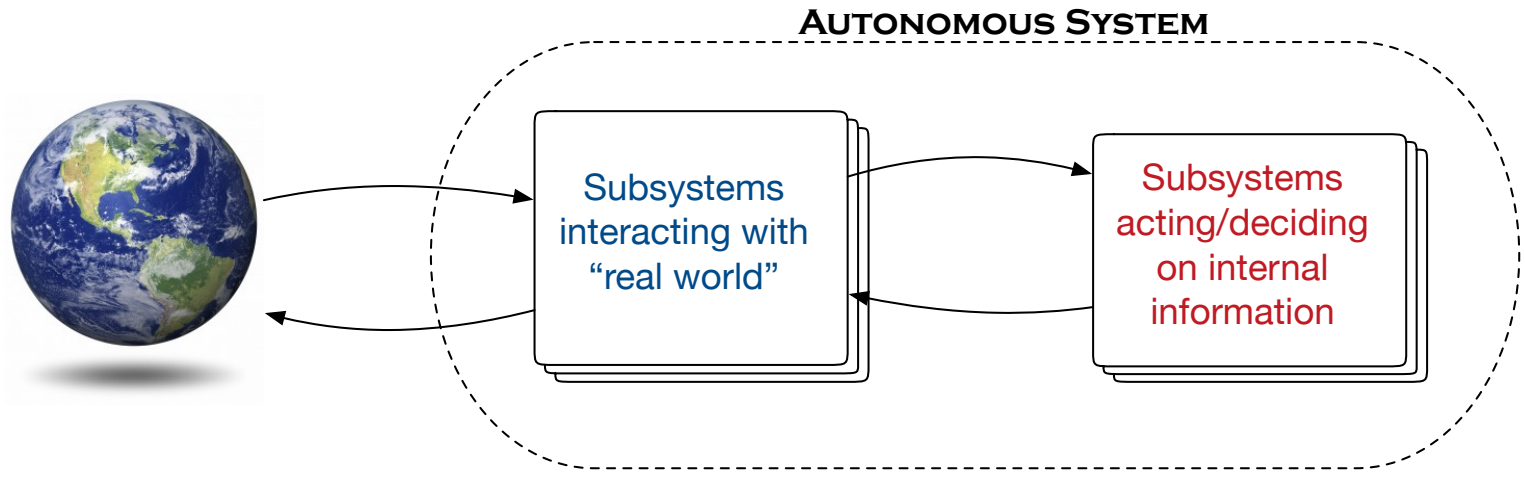
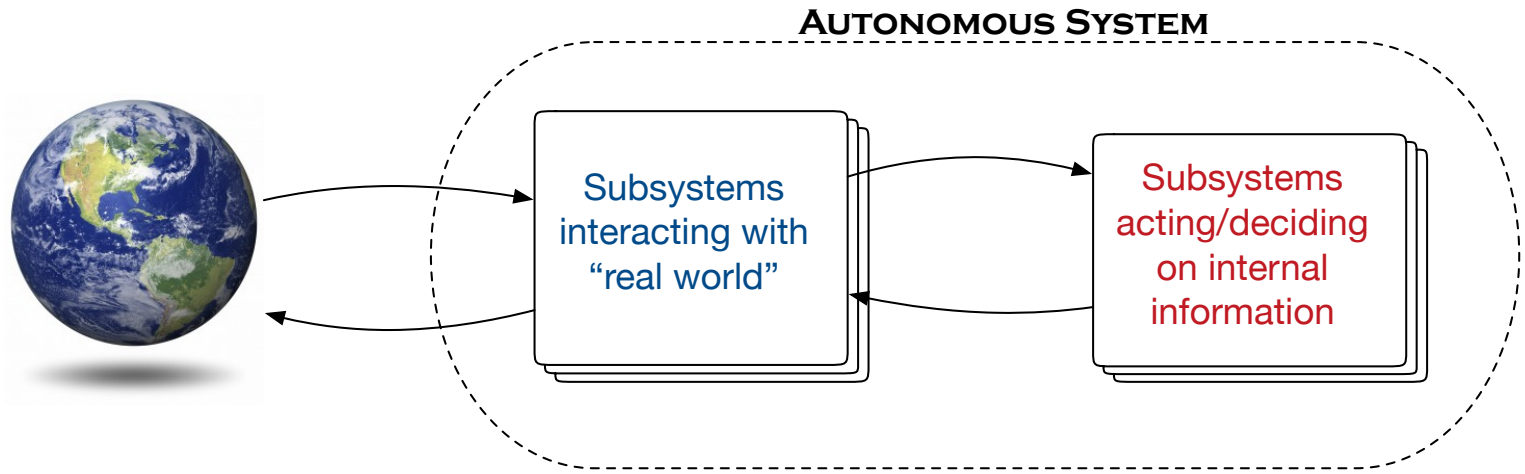


Subsystems acting/deciding on internal information typically

- verification

State of the Art??



Subsystems acting/deciding on internal information typically

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  — requires suitable/accurate models of abstract input

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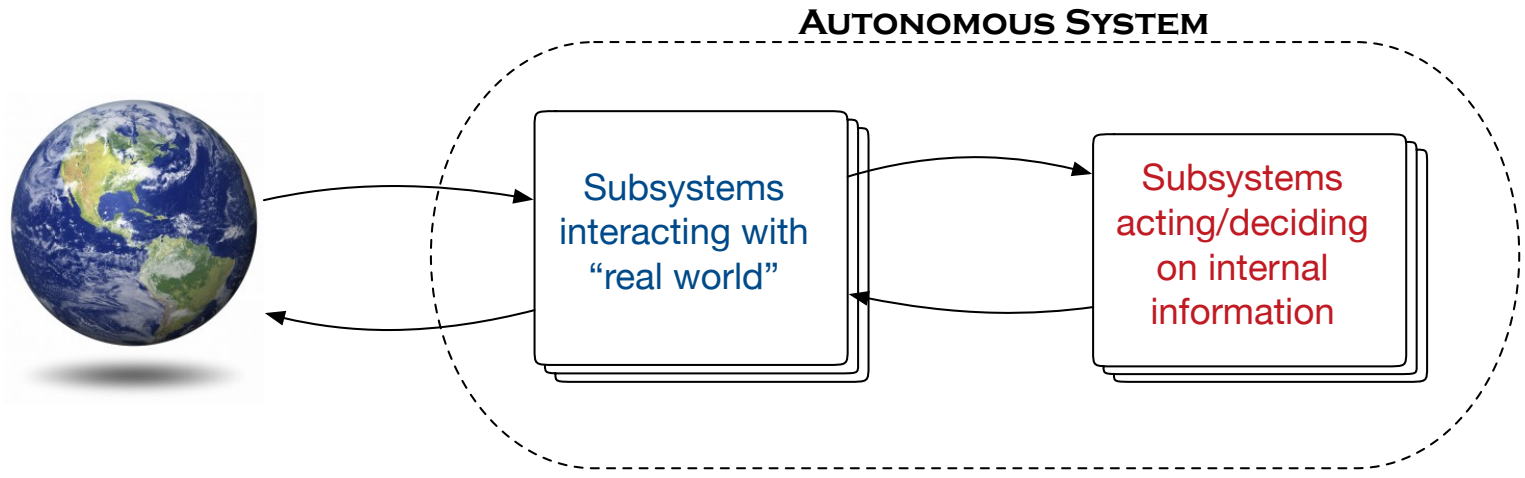

Subsystems acting/deciding on internal information typically

- verification
  — requires suitable/accurate models of abstract input

So:

testing for subsystems interacting with "real world"

formal verification for subsystems acting/deciding on internal information

State of the Art??

But: Verification also requires some transparency in the way the system works — not always possible.