

spm 9550: Path Dependency

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Lecture goals

- Be able to give a definition of path dependency
- Understand path dependency as a notion of memory (internal to agent)
- Understand path dependency as a notion of history (external to agent, as an emergent system property)
- Understand state-space as a depiction of systems history

Two main conceptions

- Broad conception:
- is that 'history matters' : an accidental choice determines a certain path.
- Narrow conception:
- that there is a reinforcing effect; e.g. the uncoordinated standardization of new products.

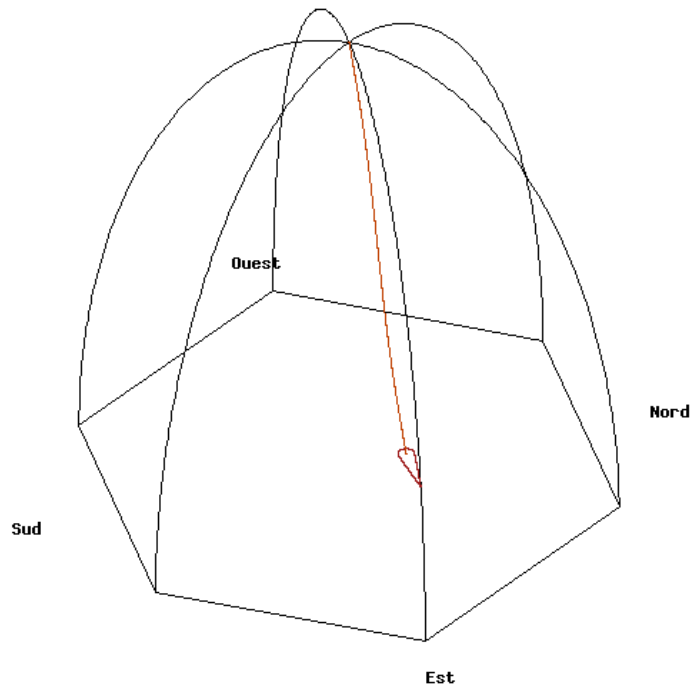
Buchanan, M. (2000) *Ubiquity: The Science of History or Why the World is Simpler than we Think*, London, Weidenfeld.

In physical systems

- A nonholonomic system
 - a system whose state depends on the path taken to achieve it.
- is described by parameters subject to differential constraints,
- As the system evolves along a path in its parameter space (the parameters varying continuously in values) but finally returns to the original set of values at the start of the path, *the system itself may not have returned to its original state.*

http://en.wikipedia.org/wiki/Path_dependence_%28physics%29

Foucault pendulum



<http://en.wikipedia.org/wiki/File:Foucault-rotz.gif>



In social sciences

- Path dependency in economics is caused by high switching costs
 - Production and consumption decisions are based on sizes of installed base and on expectations of its increases over time.
- Psychology / Economy talks about “sunk cost”
- Management science knows it as is group think (Janis 1982).
 - This is a situation in which the perspectives within a group are so aligned that deviation from the chain of thought is not possible.

Janis, I. (1982) *Groupthink: Psychological Studies of Policy Decisions and Fiascoes*, Houghton Mifflin, Boston, MA.

In socio-technical systems

- Prime example are our current infrastructures.
- Dependency on liquid, fossil fuels limits our ability to change to new energy systems, eg. Hydrogen cars
- When this path dependence is absent, technology can leapfrog.
 - i.e. Many, many Africans have mobile phones, even though landlines are almost non-existent
- Side of the road we drive on

T. E. van der Lei, G. Bekebrede, and I. Nikolic. Critical infrastructures: A review from a complex systems perspective. *International Journal of Critical Infrastructures*, 5(4), 2009.

Electricity: Evolution

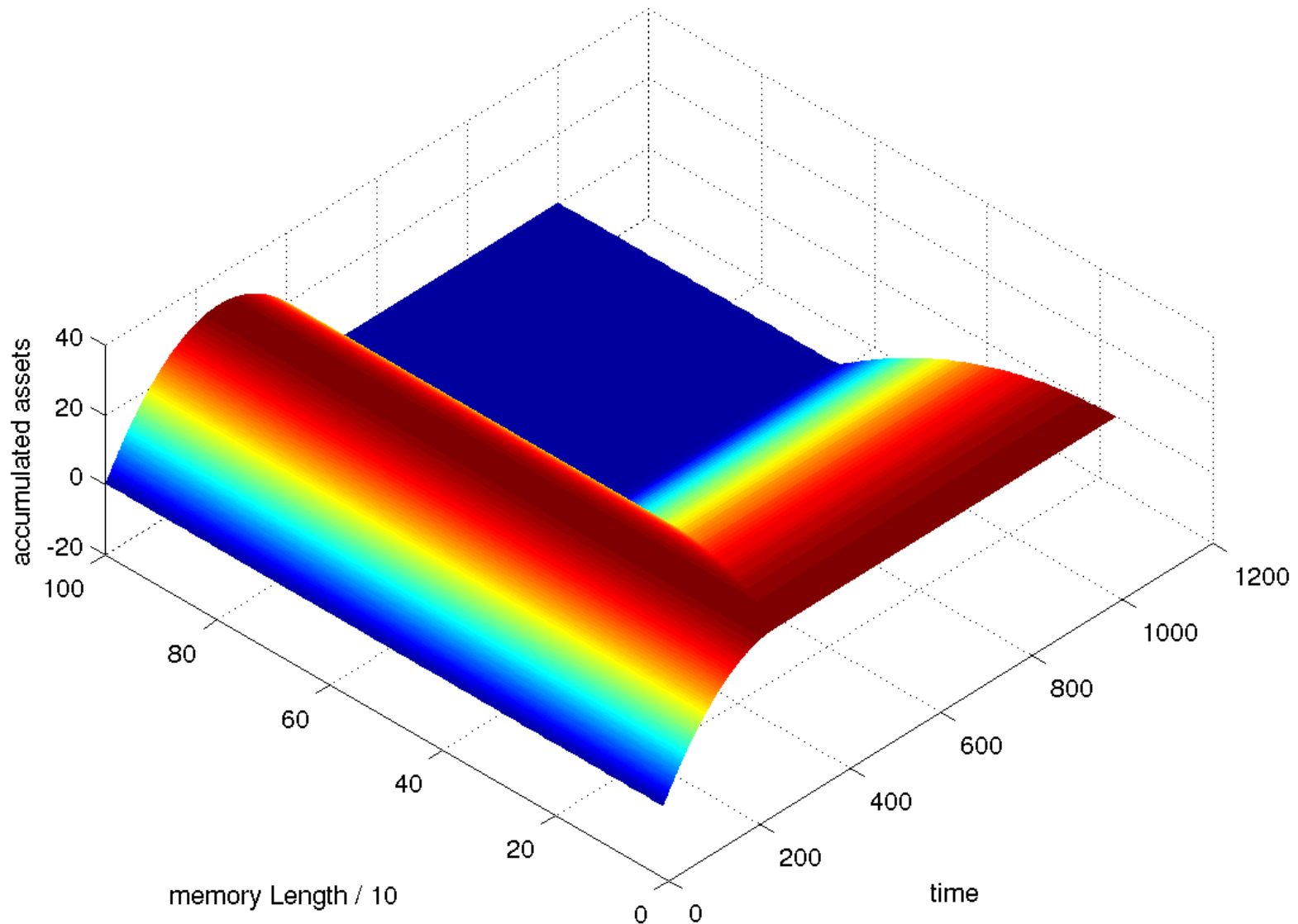
- 1880-1910: City
- 1910-1950: Province
- 1950-1980: Country
- 1980:..
International
Interconnectors

Path dependency as agent memory

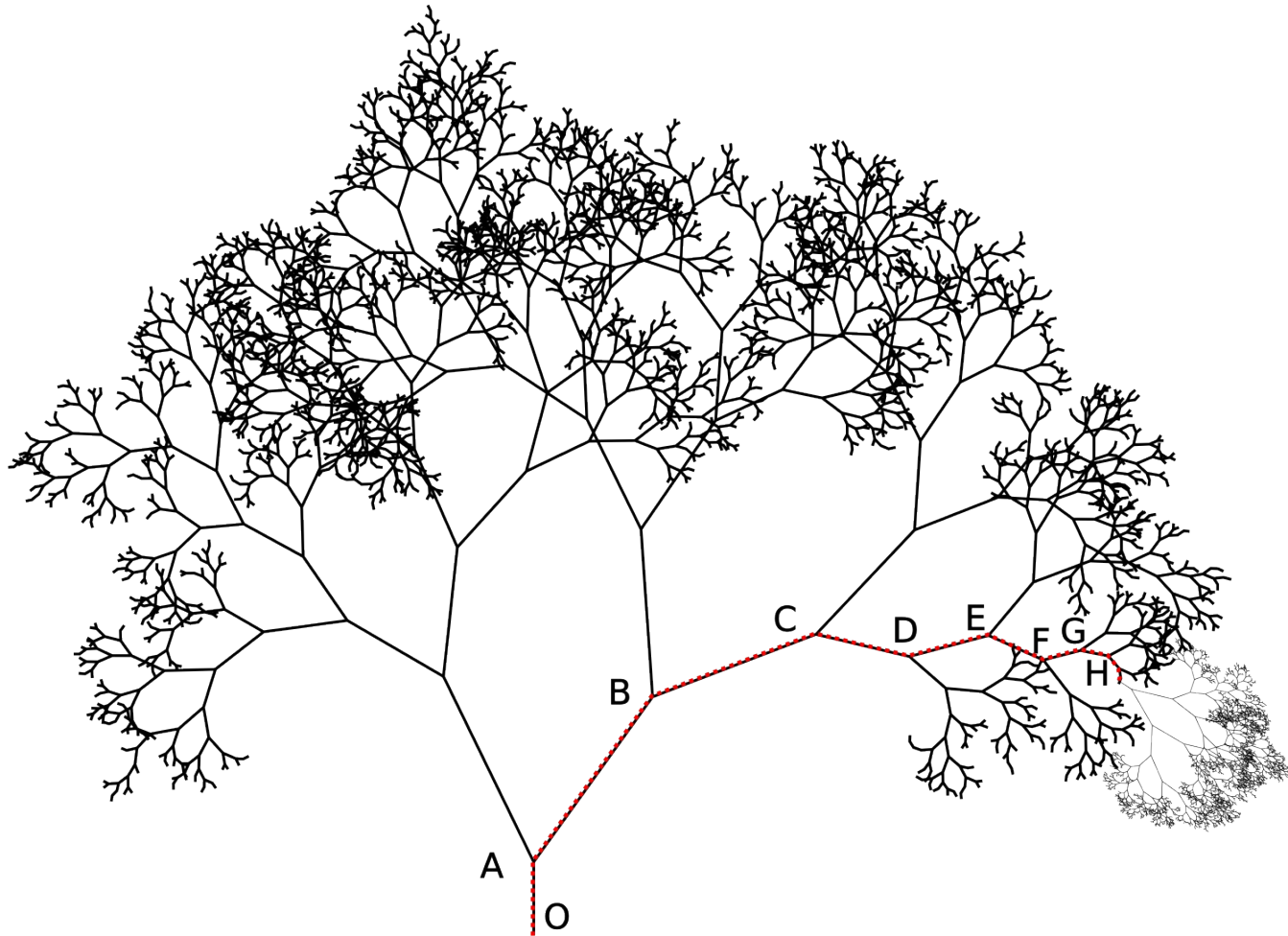
- When agents have memory
 - the past starts has effect on the present actions
- The agents history influences the emergent properties of the system

Agents memory matters

EVC All Memory Lengths,rampDown25



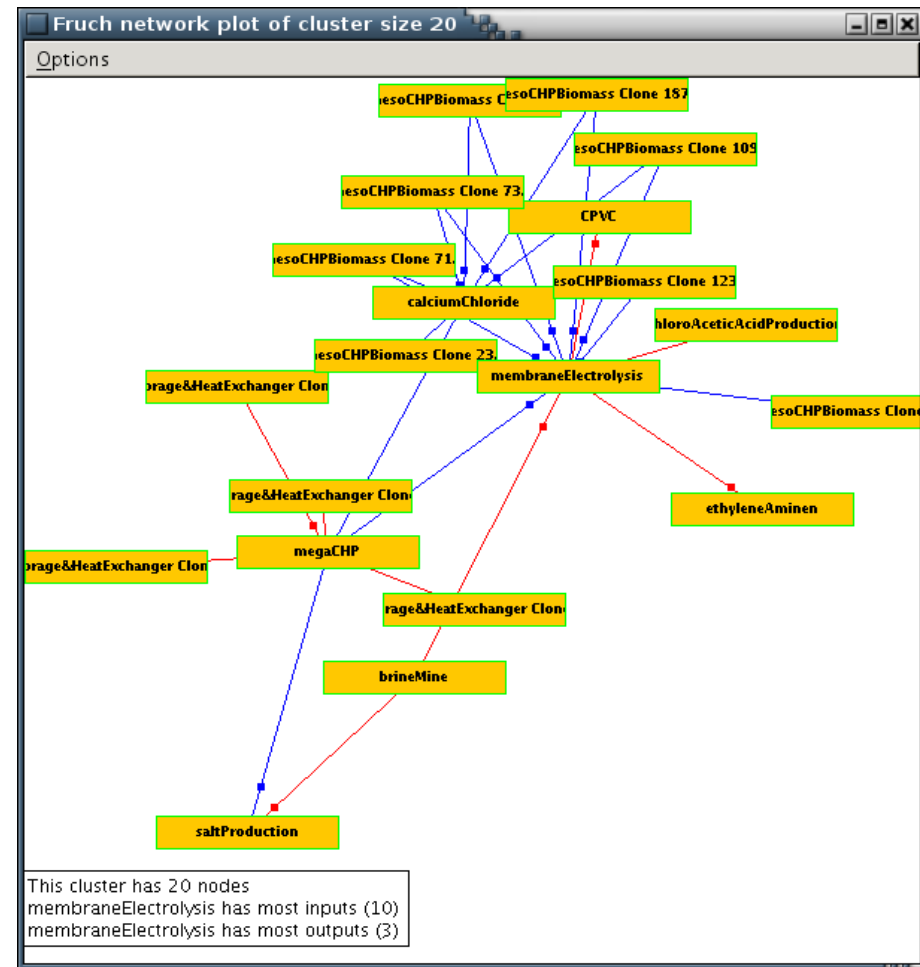
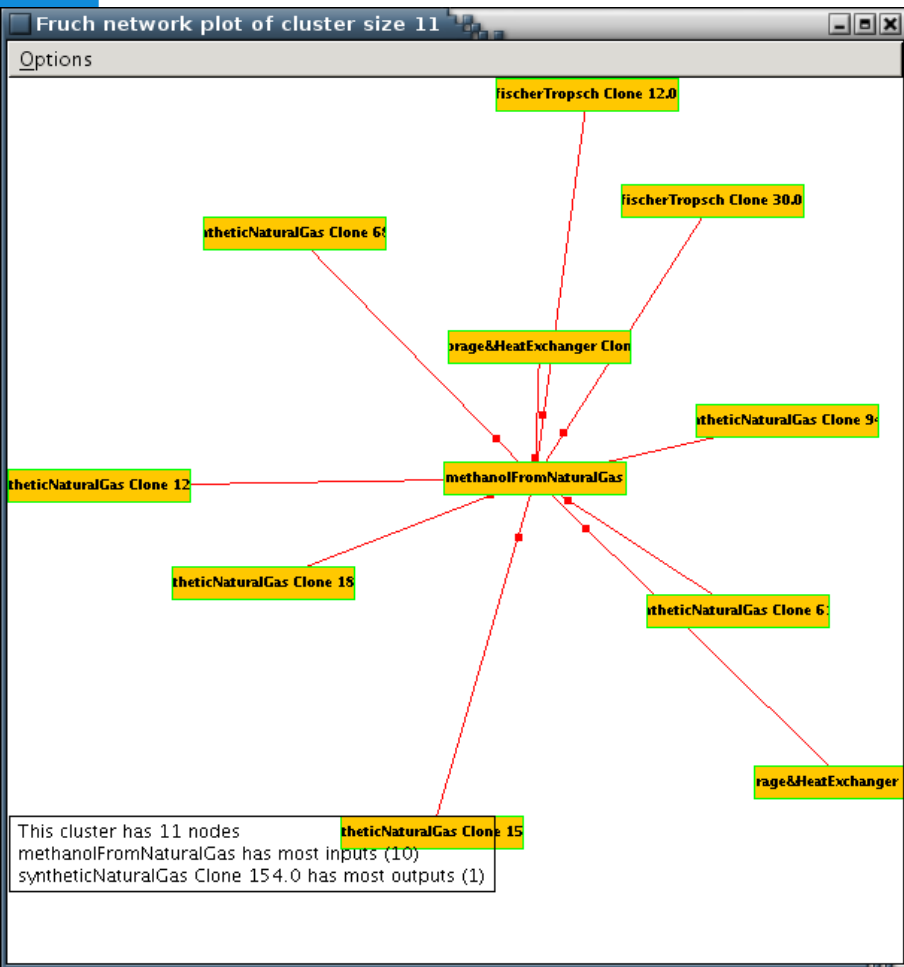
System History matters



Path dependence as system history

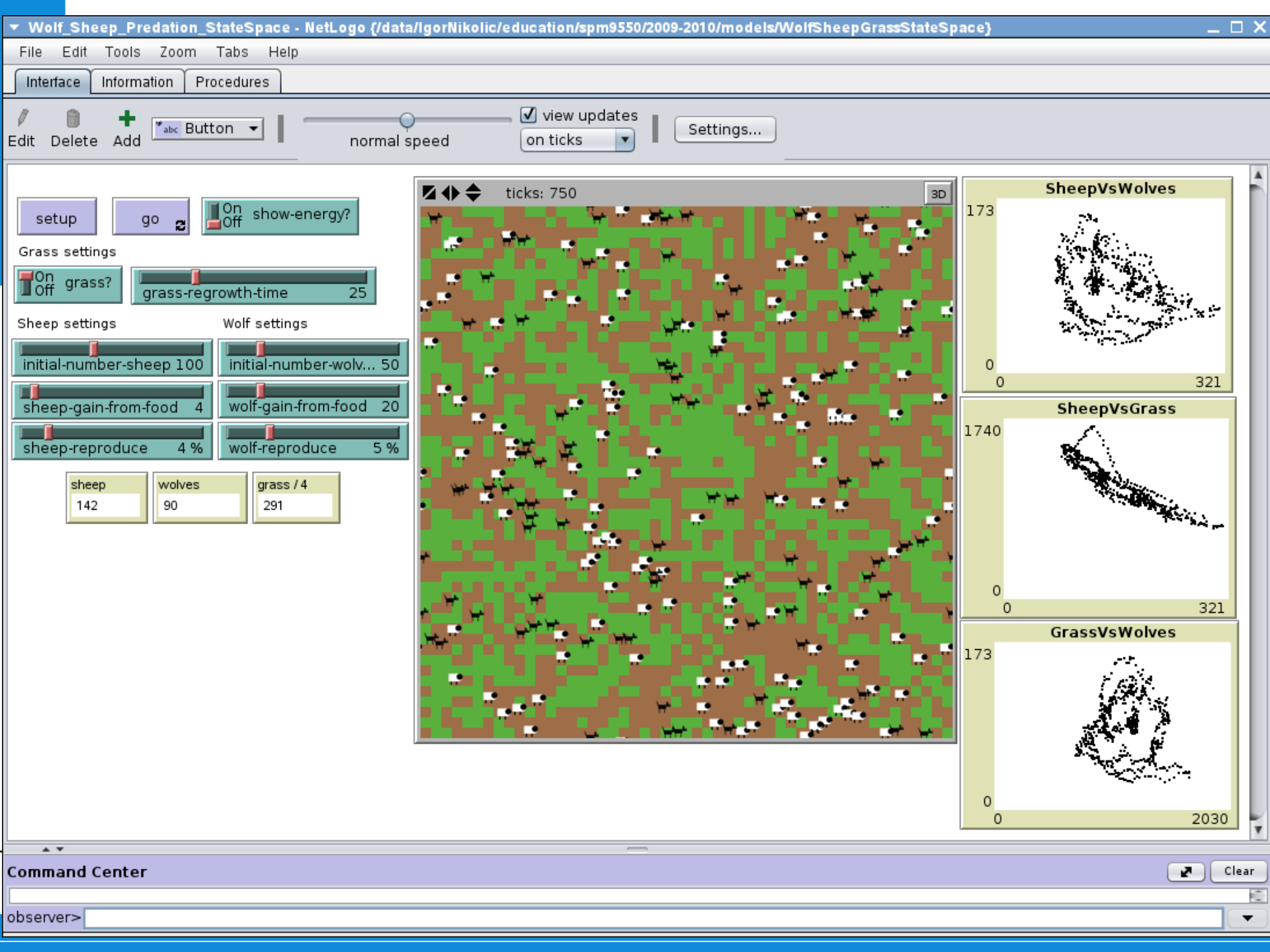
- When agents have no memory, the system can still be path depend
 - combined states
 - interaction of the agents
- System structure acts as the systems “memory”

Different histories

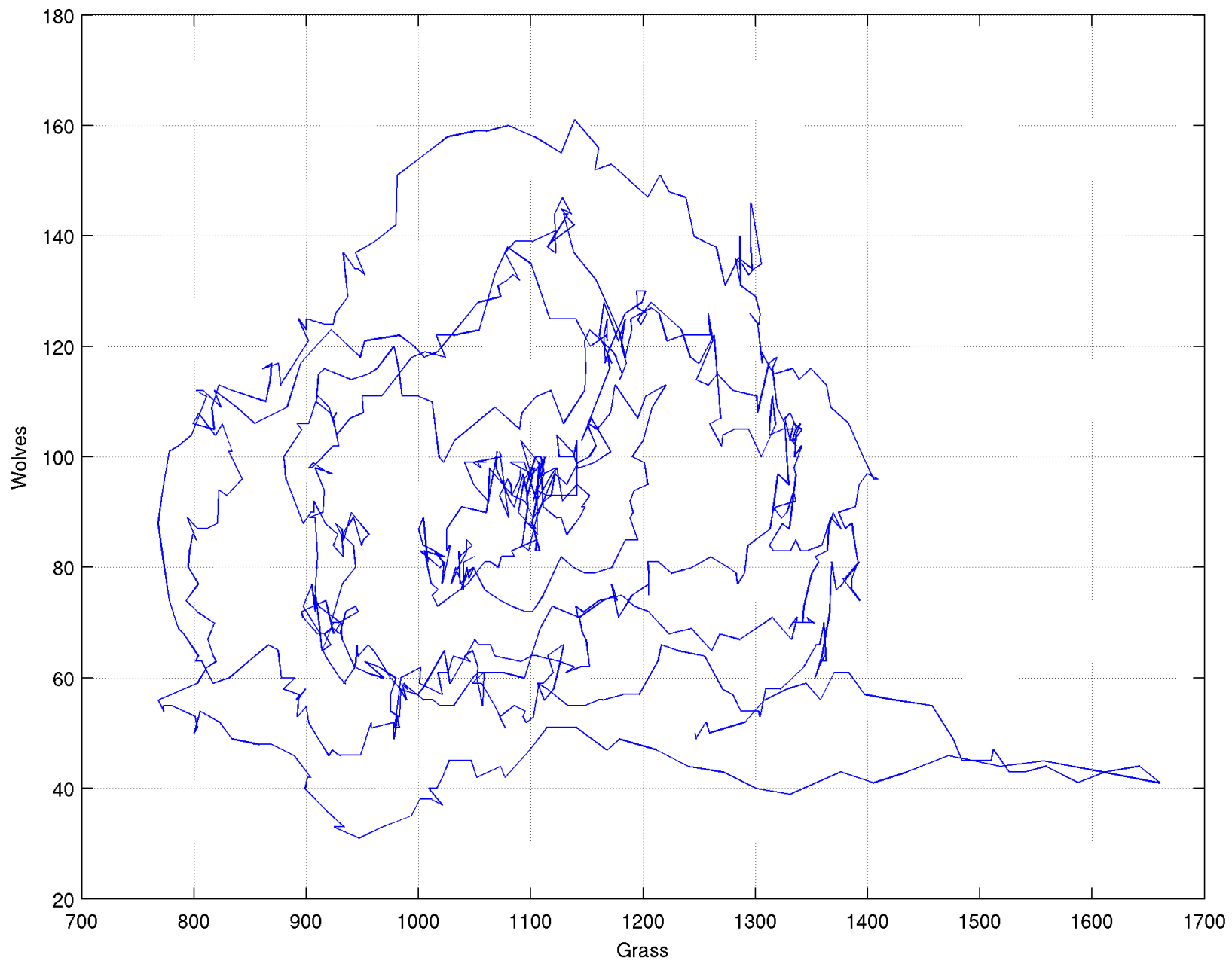


State space / Phase state

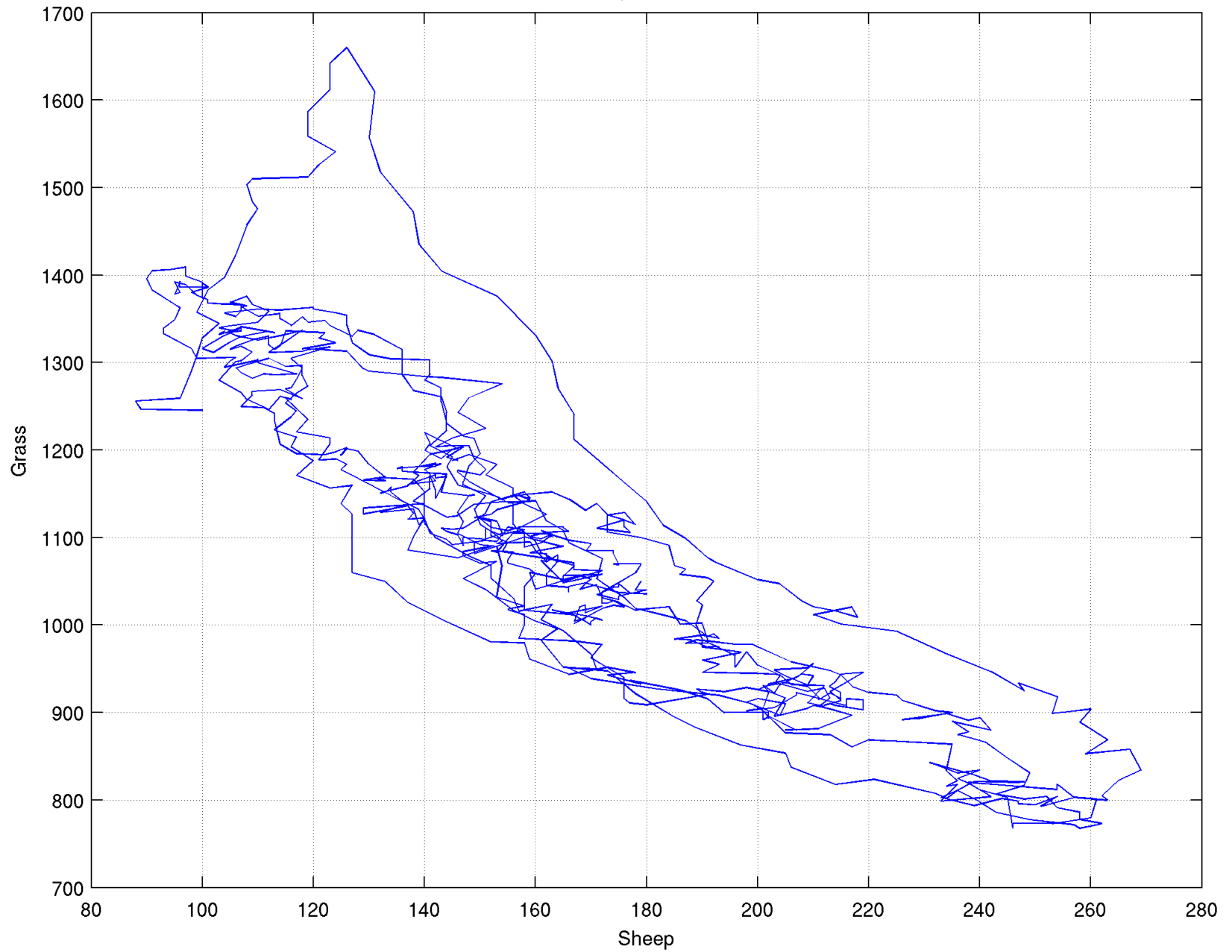
- Space in which all possible states of a system are represented
 - with each possible state of the system corresponding to one unique point in the phase space.
- Every parameter
 - of the system is represented as an axis of a multidimensional space.
- For every possible state
 - of the system is a point plotted in the multidimensional space.
- Succession of plotted points
 - analogous to the system's state evolving over time.
- Represents all that the system can be
 - Can elucidate qualities of the system that might not be obvious otherwise.



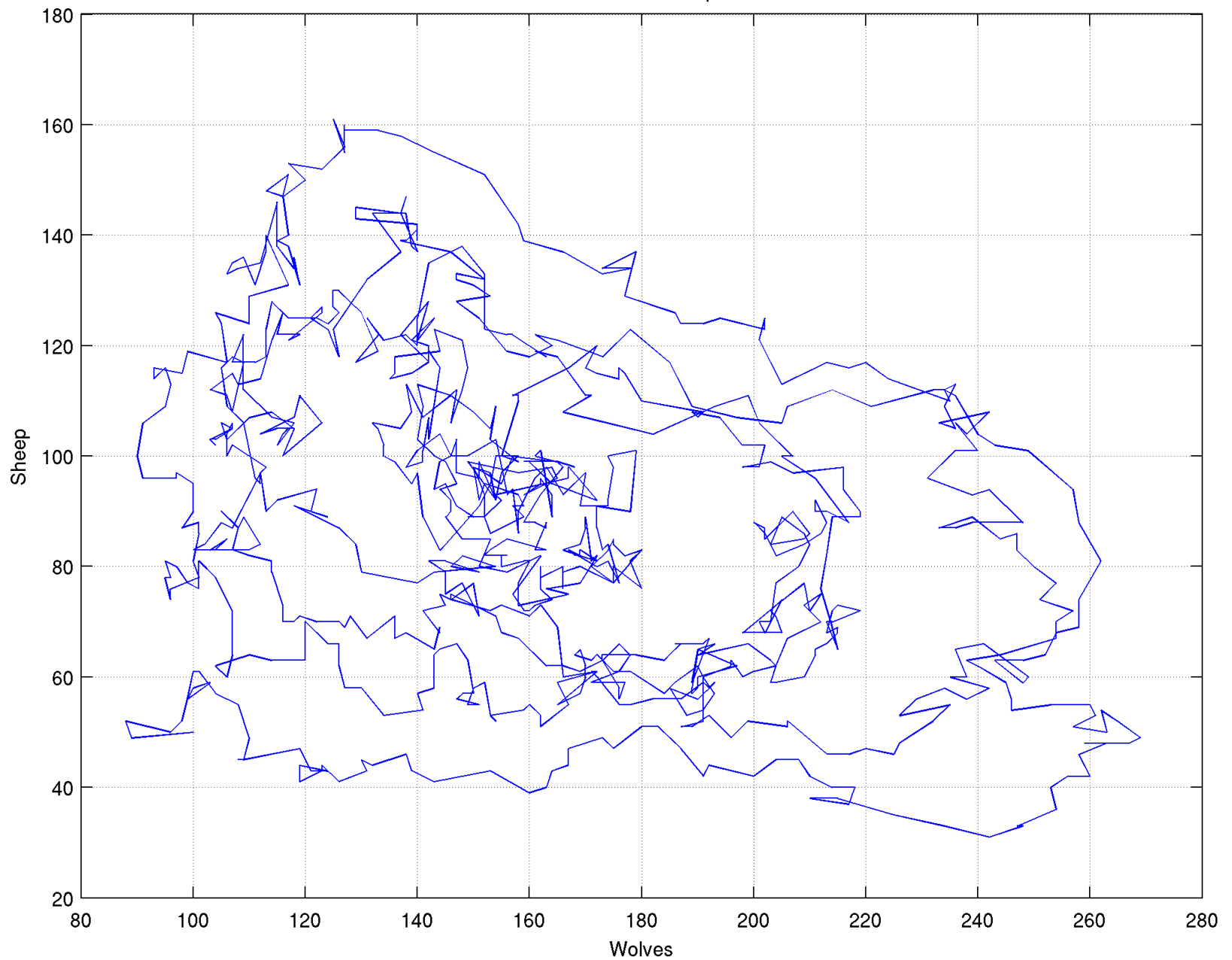
Grass vs Wolves



Sheep vs Grass



Wolves vs Sheep



Sheep vs Grass vs Wolves - state space

