SPM 9550 – Path Dependence
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.

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

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.

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-existant

- Side of the road we drive on

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

http://wiki.tudelft.nl/bin/view/Research/TheoVanRuijvenMScThesisNotes
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

This cluster has 11 nodes
methanol from NaturalGas has most inputs (10)
SyntheticNaturalGas Clone 154.0 has most outputs (1)

This cluster has 20 nodes
membraneElectrolysis has most inputs (10)
membraneElectrolysis has most outputs (3)
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.