Hidden non-Markovian Models

- Motivation
  - M-OK-F machine
  - trace of costs: (2,30);(4,20) ...
  - what happened to produce this trace?
- discrete stochastic models
  - system--> behavior
  - graphical representation
  - must be completely specified
  - wait until the sequence appears (multiple times)
- HMM
  - based on DTMC
  - not completely observable systems
  - hard to model
  - determine trace probability for simplified model
- combining DSM und HMM
  - utilizing protocol data for system analysis
- HnMM
  - real DSM as hidden model
  - time dependent transition probabilities == continuous distribution functions
  - emissions dependent on state transitions (or sometimes states)
  - trace and path have time stamps now
- advantages
  - new questions possible
    - possible disease development from symptoms
    - check manufacturer specifications through protocol data
    - failure sequence-> car repair cost & time
  - more flexible hidden model
  - system does not have to be completely observable
- Problems
  - long time periods without symbols result in many possible paths
    - solution: variable time steps ==> emission driven proxels
    - regeneration points where history is deleted
  - remembering route eliminates possibility of merging
    - general solution: define relevant system behavior and only save that
    - implementation solution: stack / depth first search
- what is a valid path?
  - emissions independent of state changes
    - have to be checked separately when they occur depending on the state
  - no symbol has been emitted
    - stay in state
    - transition that may not emit symbols
  - symbol has been emitted
    - transition (or state) that can emit the given symbol
    - scale the overall path probability with the symbol emission probability
- implementation issues
  - logarithmic probability
  - normalization
  - global cutoff probability might not be practical, rather local decision
- general idea of Proxel solution
  - more flexible and powerful than original HMM algorithms
  - remember generating path (state, age, probability, route) (for Decoding)
  - eliminate paths where observed symbol sequence was impossible
  - generate Proxel tree only of valid generating paths
  - M-OK-F example
  - Goal: find all possible paths for a trace with probability
- mention
  - symbols emitted by states, rather than state changes