NMRG 2006

An Introduction to Promise Theory

part I

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Pervasive, autonomous computing

- Personal consumer electronics - autonomy
- Multiple services, no central control
  - Today: in data centres and server rooms
  - Tomorrow: in walls and malls
- Agents are autonomous in their policies

Questions?

How do we (can we?) arrange for a consistent policy in a distributed system?

How do we manage (control?) devices and rulesets in a distrubuted system?

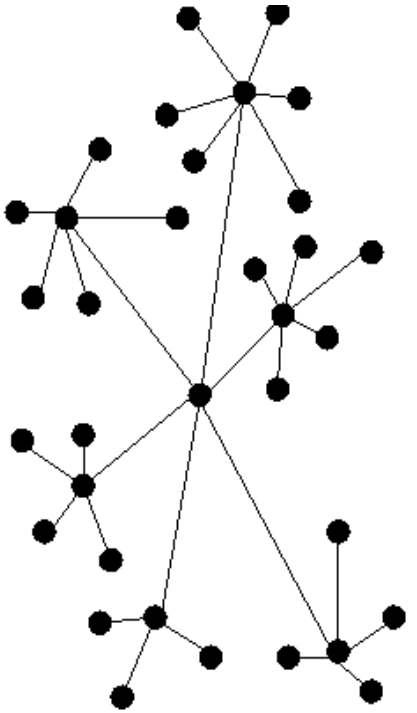
Hard to answer – requires some notion of cooperation between nodes. But who is in control?

Policy conflicts

- Assume that all nodes will follow a consistent set of rules (no conflicts)
  - Assumes they have common goals?
- Often policy is dictated from a central location
  - Is this this obvious solution to harmony?
- What about distributed systems?
  - Pervasive computing
  - Devices have many masters/mistresses
  - Cooperation with policy is voluntary

Bad habits...

- We tend to think in terms of hierarchy and centralization
  - Hard to break out of this mo(u)ld
  - If you build everything on a presumed truth, you are unlikely to exceed it
- Start at too high a level
  - End up tripping over our shoe-laces



Protocol and timing

- Worry too much about ordering
- Event-Condition-Action (ECA)
  - Triggered fire-fighting
  - Policy in farmer or egg?
- Forget about the sequences
  - Timing should matter less if we have stability

Logics?

- (Modal) logic is often used to try to prove whether nodes will have conflicts
  - Doesn't tell us how to fix things
  - Doesn't tell us how to set things up in the first place
  - How do we formulate propositions to be proven?
- Logic = verification
  - Not a “constructive” method
  - Need an architect, not an art critic

Start again

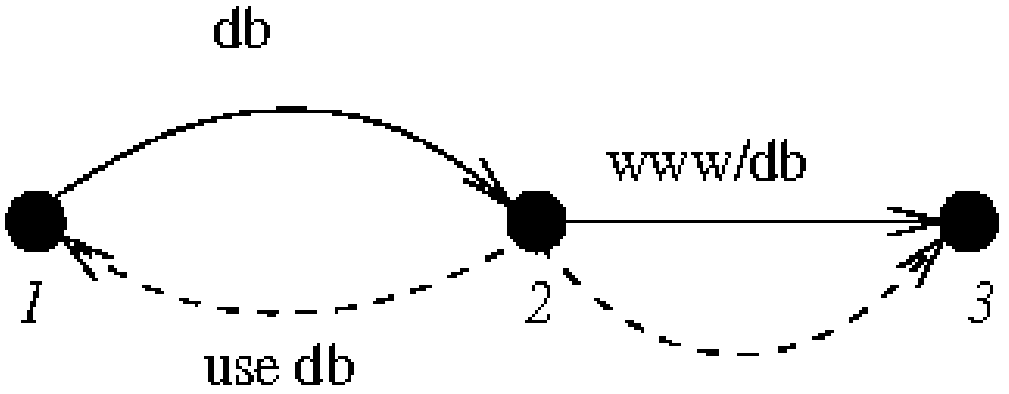
- Try to begin with the extreme viewpoint
  - Make it primitive and constructive
  - Make it intuitive and distributed (graphs)
  - Make it analyzable (labelled graphs)
  - Make sure it is tied to existing research on *autonomy*
- Base it around snapshots/epochs in time
  - Sequential interaction seldom interesting for policy
  - Define what you want not how to get there
  - Triggered events – model as services

Don't forget autonomy

- *Voluntary* cooperation
- Each atom is an autonomous agent
  - You cannot force one to do anything
  - It decides for itself
  - Want centralization? Build it from the bricks!
  - Direct relationship to cooperative game theory (economic cooperation)

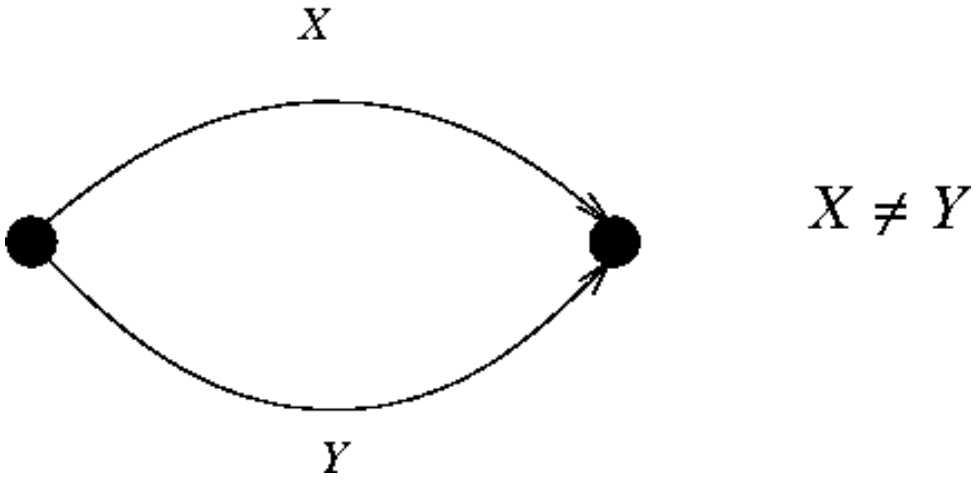
Promise theory

- A combination of graph theory and set theory
  - Exceeds “Boolean” logic - constructive
  - Handles constraints on possible behaviours
  - Handles relationships, not just true/false rules
  - Service model: “I promise you service S” *(SLA)*
- Directed graph

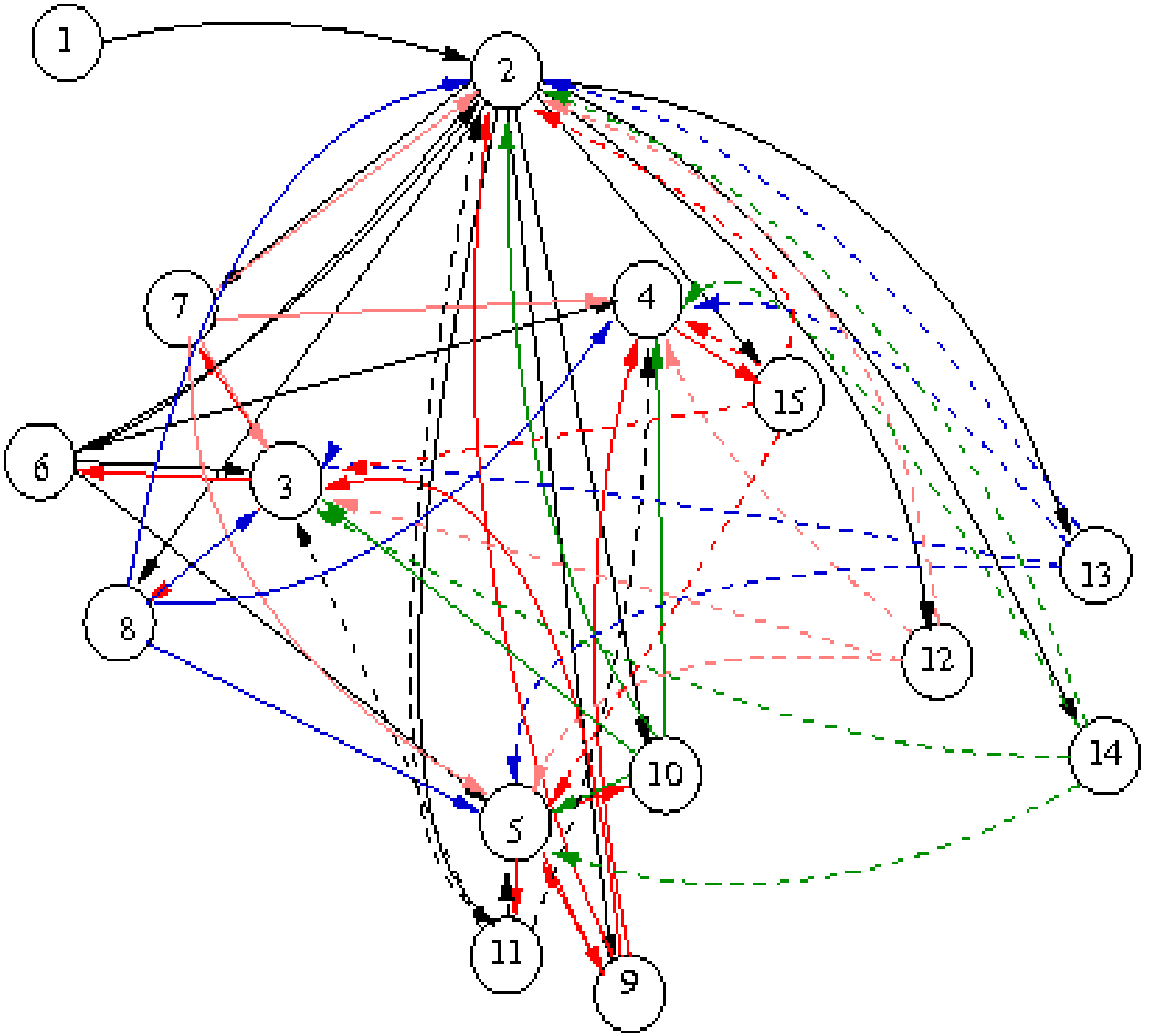


Typed/labelled graph

- Promise types:
  - Service promises (promise to constrain behaviour)
  - Cooperative promise (promise to do the same as)
  - Usage promise (promise to make use of)
- Atomicity rule:
  - Only *one* promise of a given type per pair:
  - Broken promise => two different promises

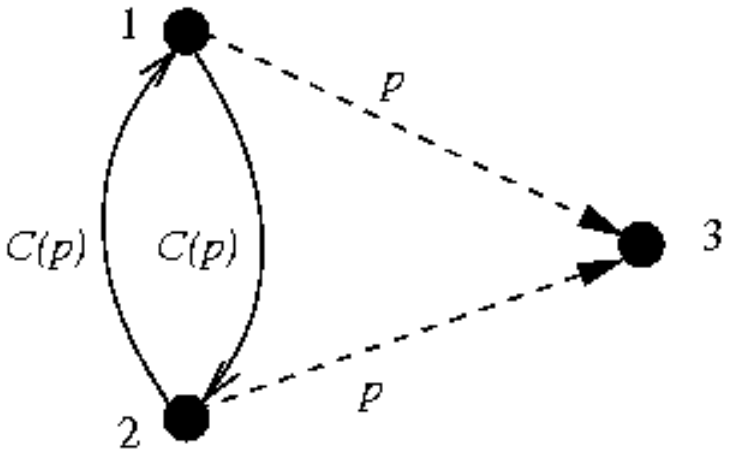


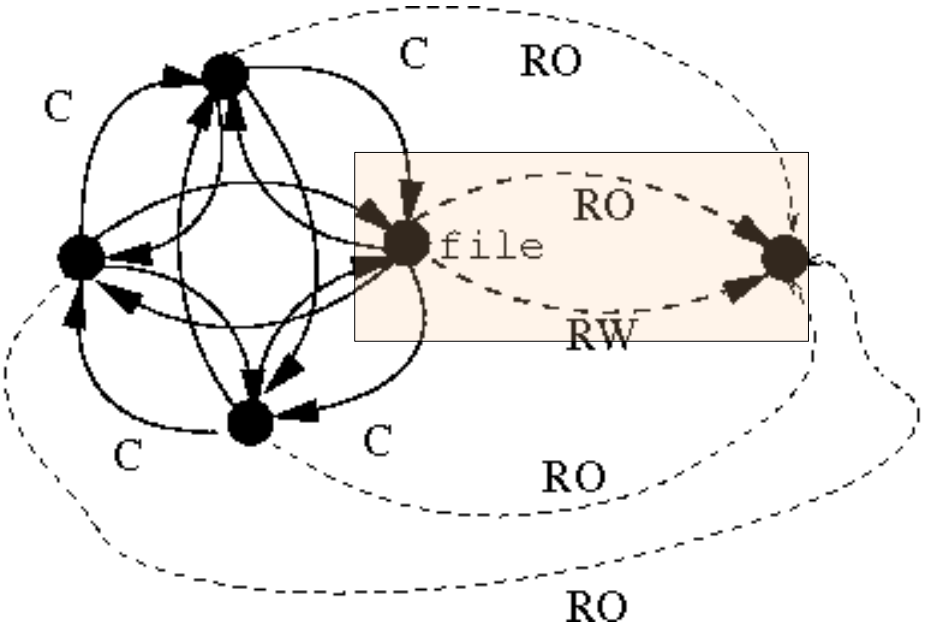
Example



Consistency

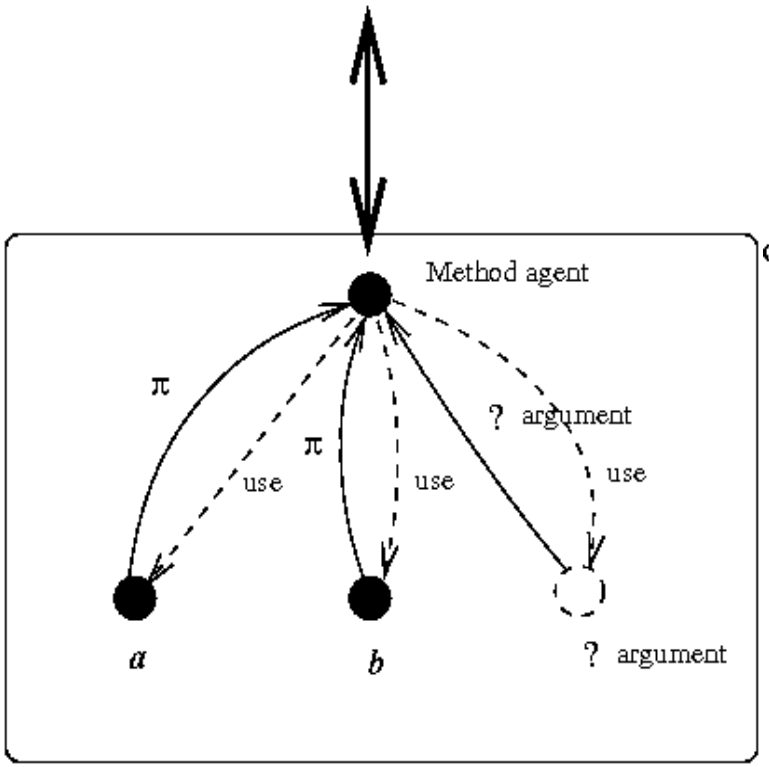
- Any node is free to promise anything
- But when is it breaking its promises (SLA)?
  - Basic promise S
  - C(S) and U(S) tell us about structural dependency
  - Use these to reconstruct cooperative structure

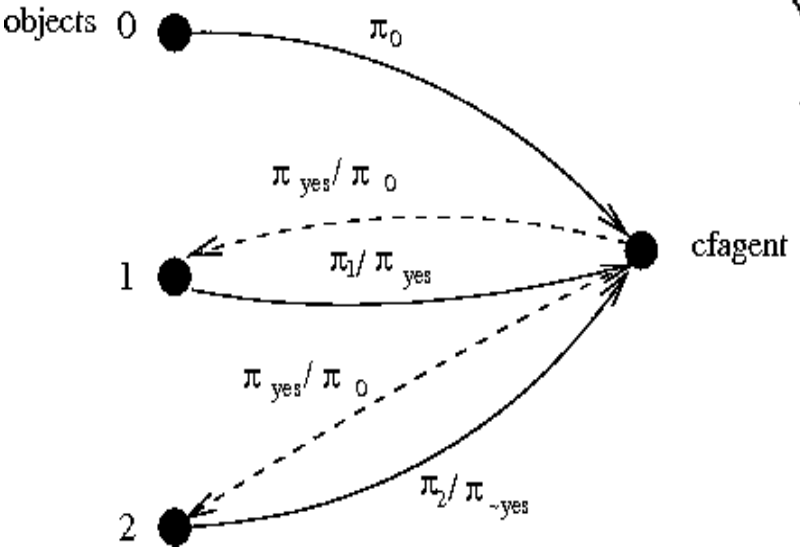


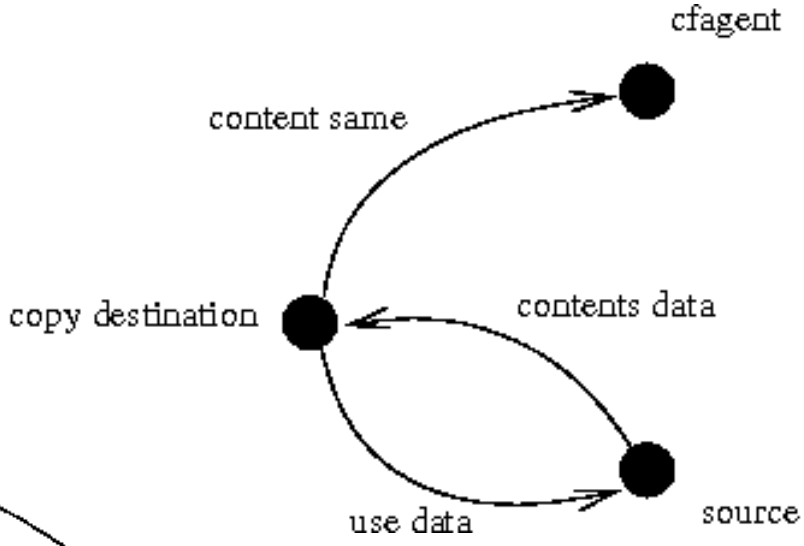


Other examples

- Cfengine is an autonomous agent –
  - how do we model it?







Summary

- Integrates logic, planning and heuristics
- Promises describe steady equilibria
- Time is only a distraction – we want stability
- Very easy to use – lots of graph theory results
- Lots of theorems to be proven (re-enter logic)
- A theory for *pervasive peer computing*

"I will speak daggers to her, but use none

My tongue and soul in this be hypocrites"

--WS (Hamlet)