# CS 182

Week 8

Computational Level

# Computational level

- Actions
  - hierarchical
  - goal-oriented
- Representations
  - Petri Nets
- If we have time
  - Grammars

# Actions

- Hierarchy present in humans
  - e.g. reflexes
  - plans are usually hierarchical
- Rod Brooks
  - hierarchical action system
  - goal-oriented
  - different levels and components interact
    - e.g. exploring behavior versus safety behavior

# X-Schemas and Petri Nets

- Petri nets
  - Finite State Machines – but better!
  - Places
    - hold tokens
    - have semantic meaning
  - Transitions
    - can be enabled
    - can fire
      - consume tokens at inputs

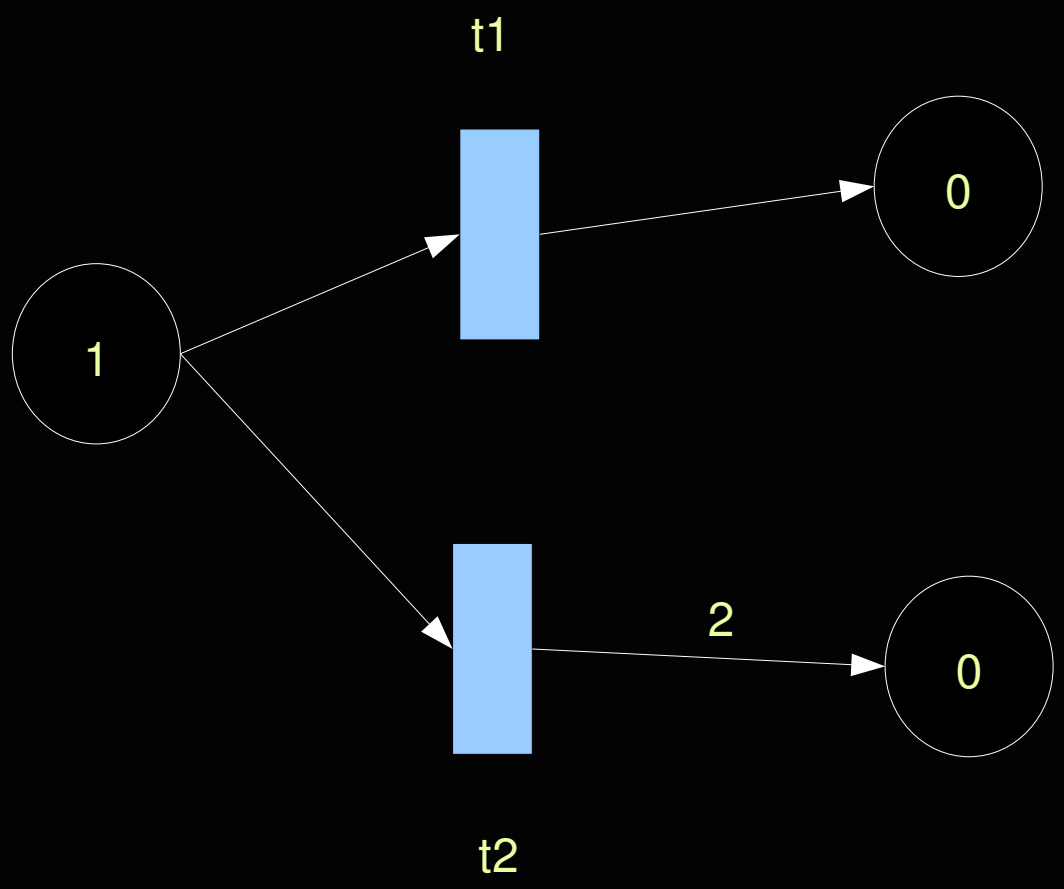
# Petri Nets

- Asynchronous
  - any enabled transition can fire
  - or not fire
  - so we reason about what states are possible
- Analysis
  - determine what states are possible
  - determine how many times a transition might fire
  - determine whether deadlock is possible

# X-Schemas

- Add several things
  - timed
  - stochastic
  - inhibitory arcs
  - enabling arcs

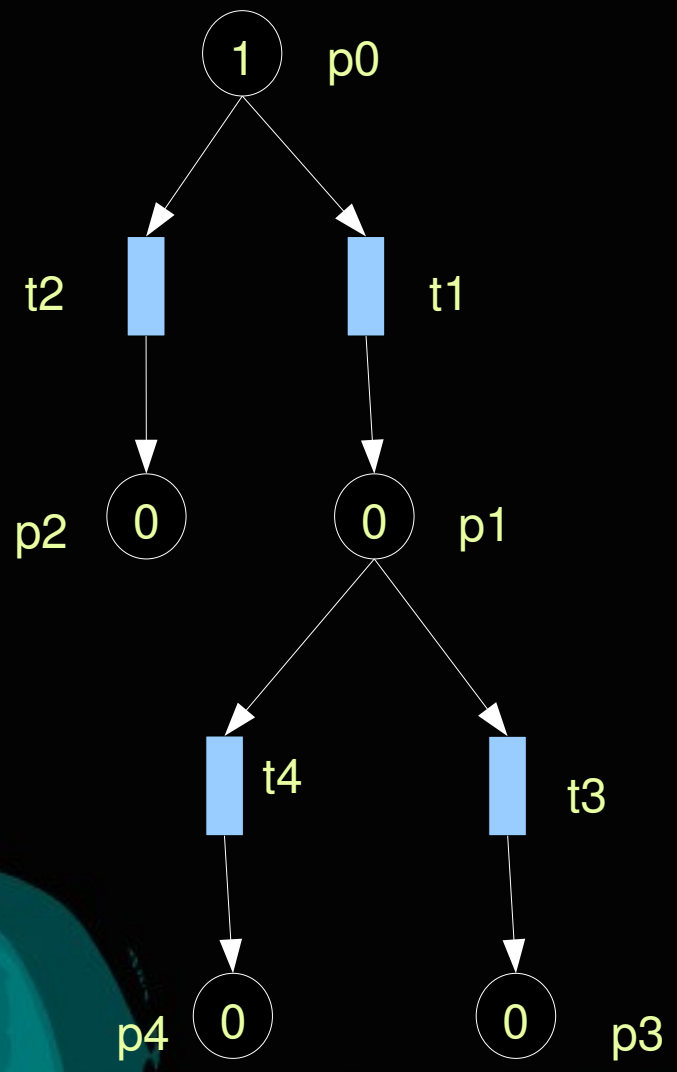
# Stochastic petri nets



# Stochastic petri nets

- Random timing of transition firing
  - exponential distribution
  - gives rise to random choice of which transition will fire
  - P(transition fires in the next tiny time|enabled) = f(transition)
  - Then P(transition fires next|enabled) = f(transition) / sum(f(enabled transitions))

# Stochastic petri net example




- What is P(t3 ever fires)?
  - Under what conditions will it fire?
  - What is P(t3 fires|token in p1)?
  - What causes there to be a token in p1?
  - What is P(t1 fires)?
  - How do you combine

# X-Schemas

- Active representation
- Has hierarchical actions
  - defined by network structure
- Actions have structure (e.g. ready, iterating, ongoing, failed, complete)
  - defined by network structure
- Properly-designed nets will be goal-directed
  - take best actions to reach goal, given current context