Belief State in WrightEagle

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Outline

- Introduction to Belief State
- Representation, Usage and Maintenance
- Summary and Future Work

What is a Belief State?

- A probability distribution over states
- b(s): S → [0, 1]
- Basic concept for
  - POMDPs
  - Dec-POMDPs
- (Dec-)POMDP → belief (Dec-)MDP
  - Intractable in RoboCup 2D

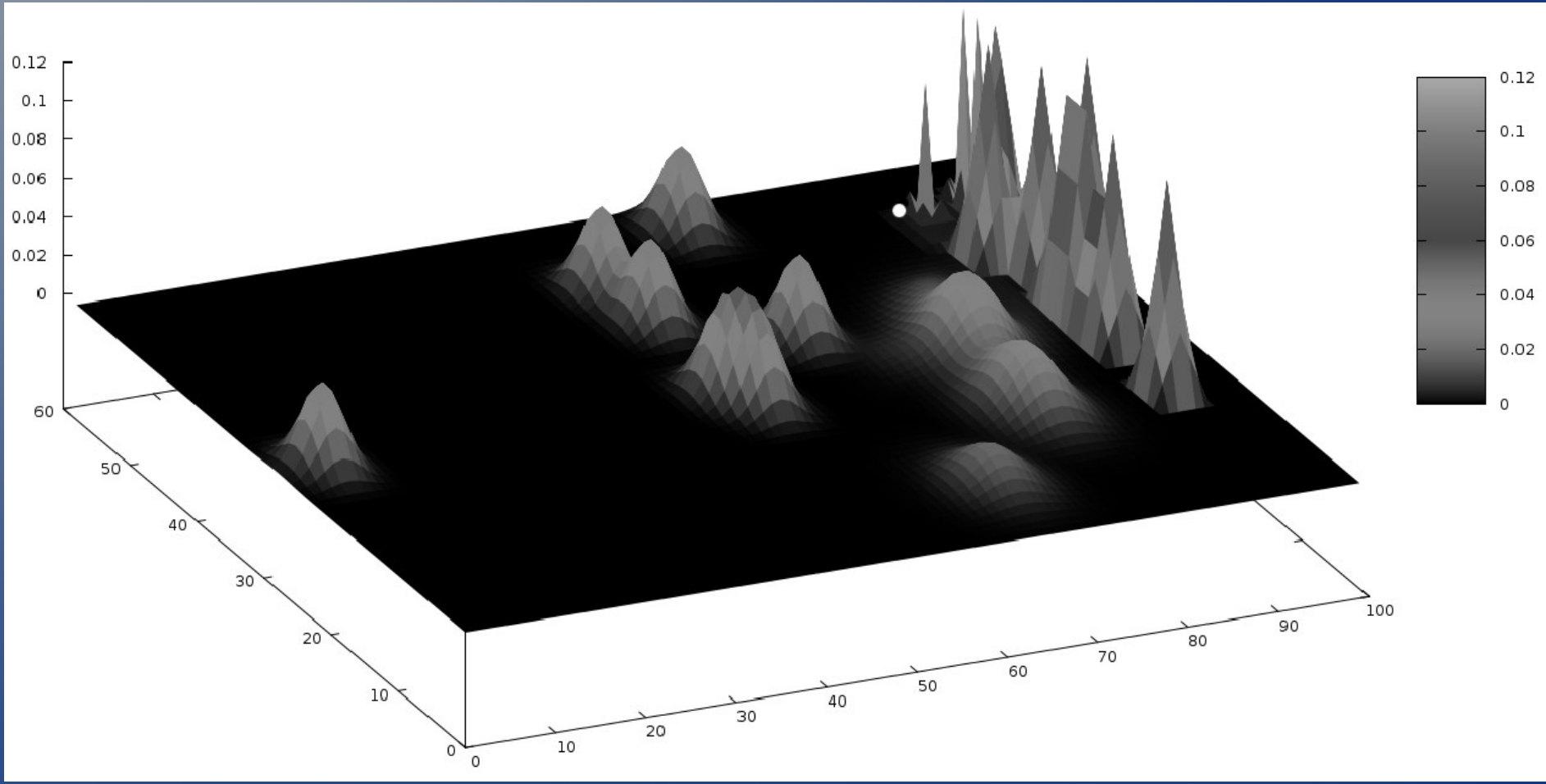
Representation of Belief State

- Assume conditional independence between individual objects

$$b(\vec{s}) = \prod_{0 \leq i \leq 22} b_i(\vec{s}[i])$$

- Use particles to approximate belief states
- Use Monte Carlo methods to maintain particles

The Resulted Belief States



When will it be useful?

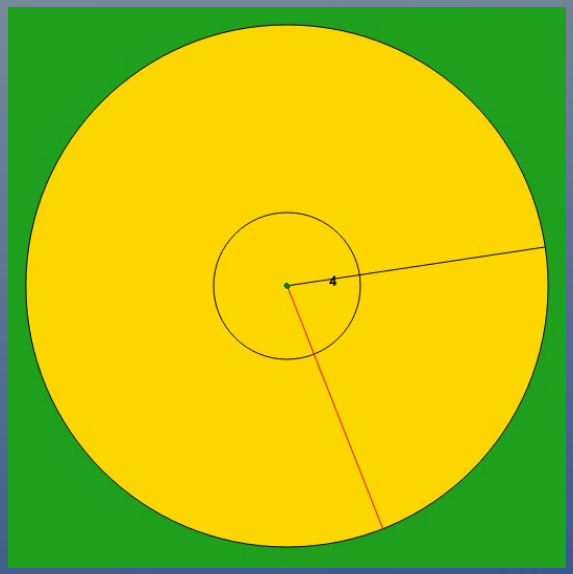
- Observation Planning
  - Plan areas to be observed detailedly
  - Selected scene from 3512 to 3529
- Current State Estimation
  - Good estimation from belief states
  - Selected scene from 244 to 245
- Probability Computation
  - Consider all possible situations
  - Selected scene from 1309 to 1318

Monte Carlo Methods

- Predicate step
  - Motion model – p(s'|s,a)
    - Agent self – completely known
    - Other players – randomly walk or kick
    - Ball – physically decay or randomly be kicked
- Update step
  - Sensor model – p(o|s)

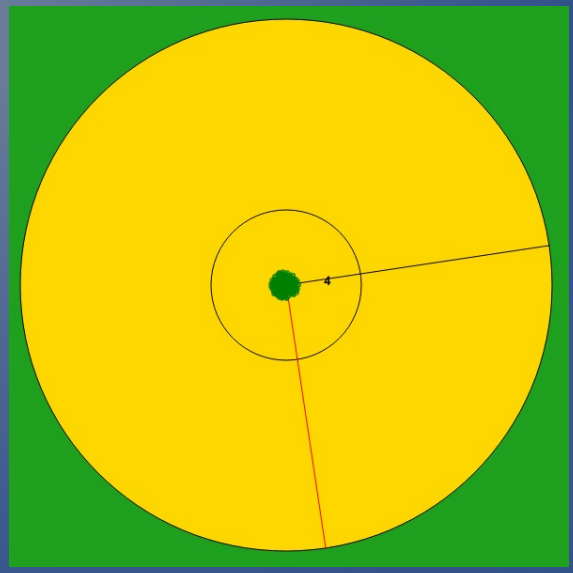
Example – Agent Self

Belief



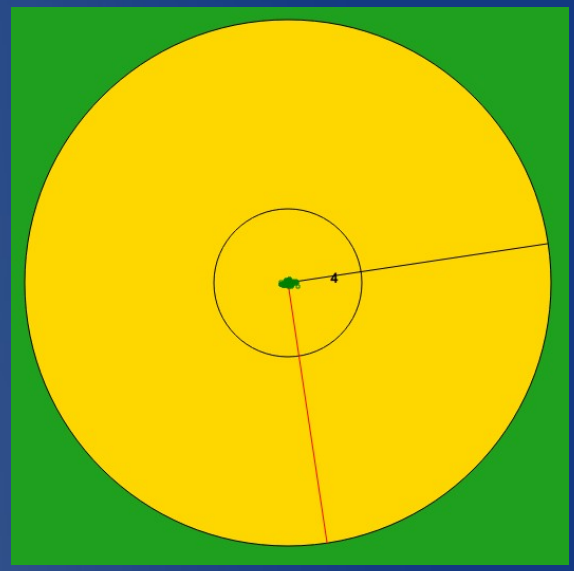
(1) b

Predicated



(2) b=p(b,a)

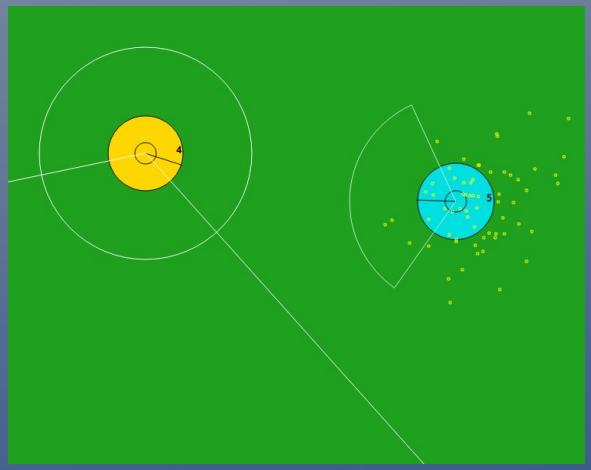
Updated



(3) b=u(b,o)

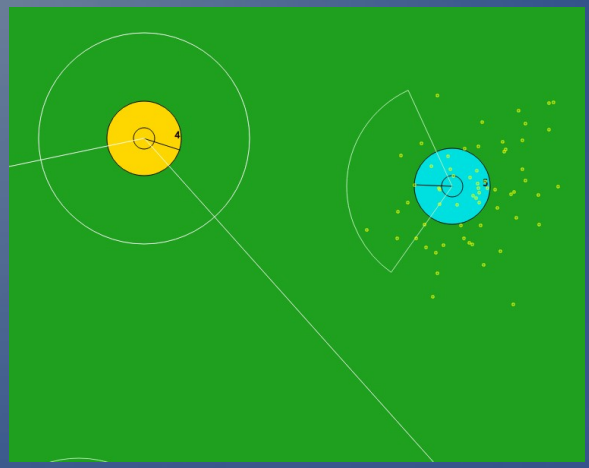
Example – Other Players

Belief



(1) b

Predicated



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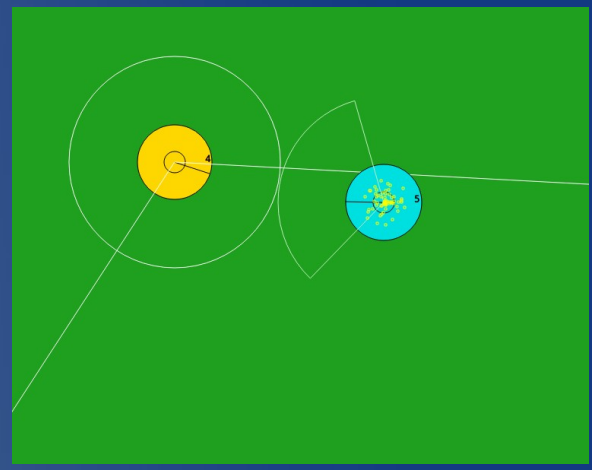
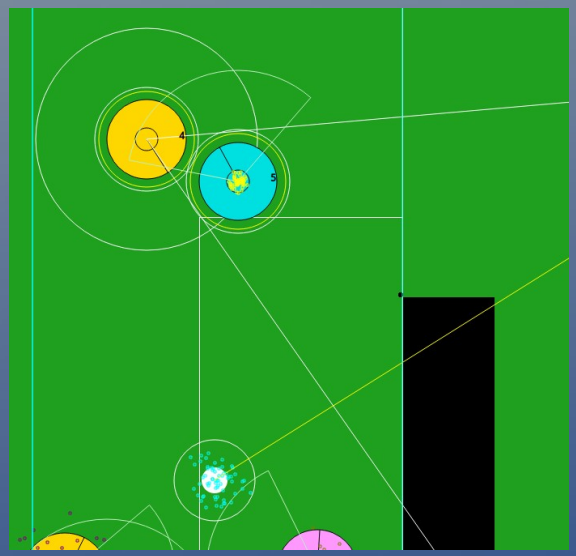


(3) b=u(b,o)

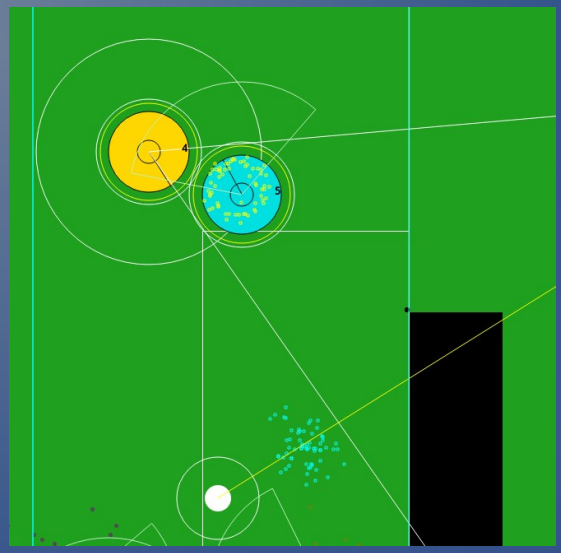
Example – The Ball

Belief



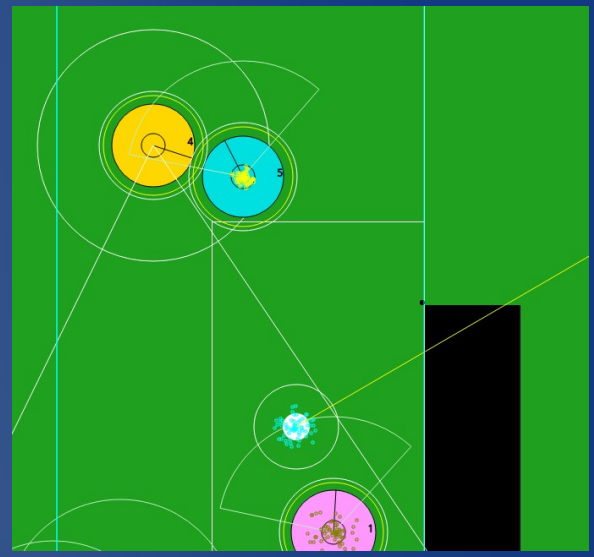
(1) b

Predicated



(2) b=p(b,a)

Updated



(3) b=u(b,o)

Summary and Future Work

- Particles
- Monte Carlo Methods
- Usage
  - Observation Planning
  - Current State Estimation
  - Probability Computation
- Opponent Model