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An Architecture for Behaviour Coordination Based on Fuzzy Logic

Application to a Robotic Goalkeeper

5th ISLab Workshop

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Summary

- **Motivation**
- Decision with Fuzzy Logic
- Robotic Goalkeeper
  - Behaviors Set
  - States Set
  - Cost function (Behaviors, States)
  - Goal and Constraints
  - Decision

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Motivation

- Inference with traditional methods are limited in uncertainly ambient.
- Fuzzy Logic allows decision making above uncertainly information.
- We need a smart Goalkeeper ;-)

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Decision with Fuzzy Logic

- Define a **set of behaviors**, to choose the best one of them based in world state
- Define a **set of states** with **fuzzy logic**
- Make a **cost function** with (behaviors, states) domain and take goal range
- Define a **Goal** for decision
- Define the **Constraints** for decision
- **Make inference** with appropriate operator (e.g. T-norm(min) and Co-norm(max))

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Robotic Goalkeeper - Behaviors Set

- **B1. Clear Ball**: kick ball to free place (can be out of field)
- **B2. Outlet Pass:** Pass to unmarking teammate
- **B3. Intercept Ball**
- **B4. Steal Ball**: When an opponent have ball, steal it
- **B5. Cut Down The Angle**: move forward to minimize the angles where ball come in to goal
- **B6. Marking**: avoid easy pass (cut down pass line)
- **B7. Home Position:** Back to default position

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Robotic Goalkeeper – States Set (1)

- **Ball Position**
  - **Near final line**
  - **Middle field**
  - **Near own goal**
  - **Opponent field**
- **Ball Velocity direction**
  - **Own goal**
  - **Opponent goal**
- **Ball Velocity**
  - **Stopped**
  - **Low**
  - **Medium**
  - **High**
- **Ball Owner**
  - **Goalkeeper**
  - **Teammate X**
  - **Opponent Y**
  - **Nobody**

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Robotic Goalkeeper – States Set (2)

- **Teammate X state**
  - **Marked**
  - **Unmarked in bad place**
  - **Unmarked in good place**
- **Opponent Y state**
  - **Unmarked in danger zone**
  - **Marked**
- **Angles between GK, Ball, Post**
  - **Minimized**
  - **Not minimized**

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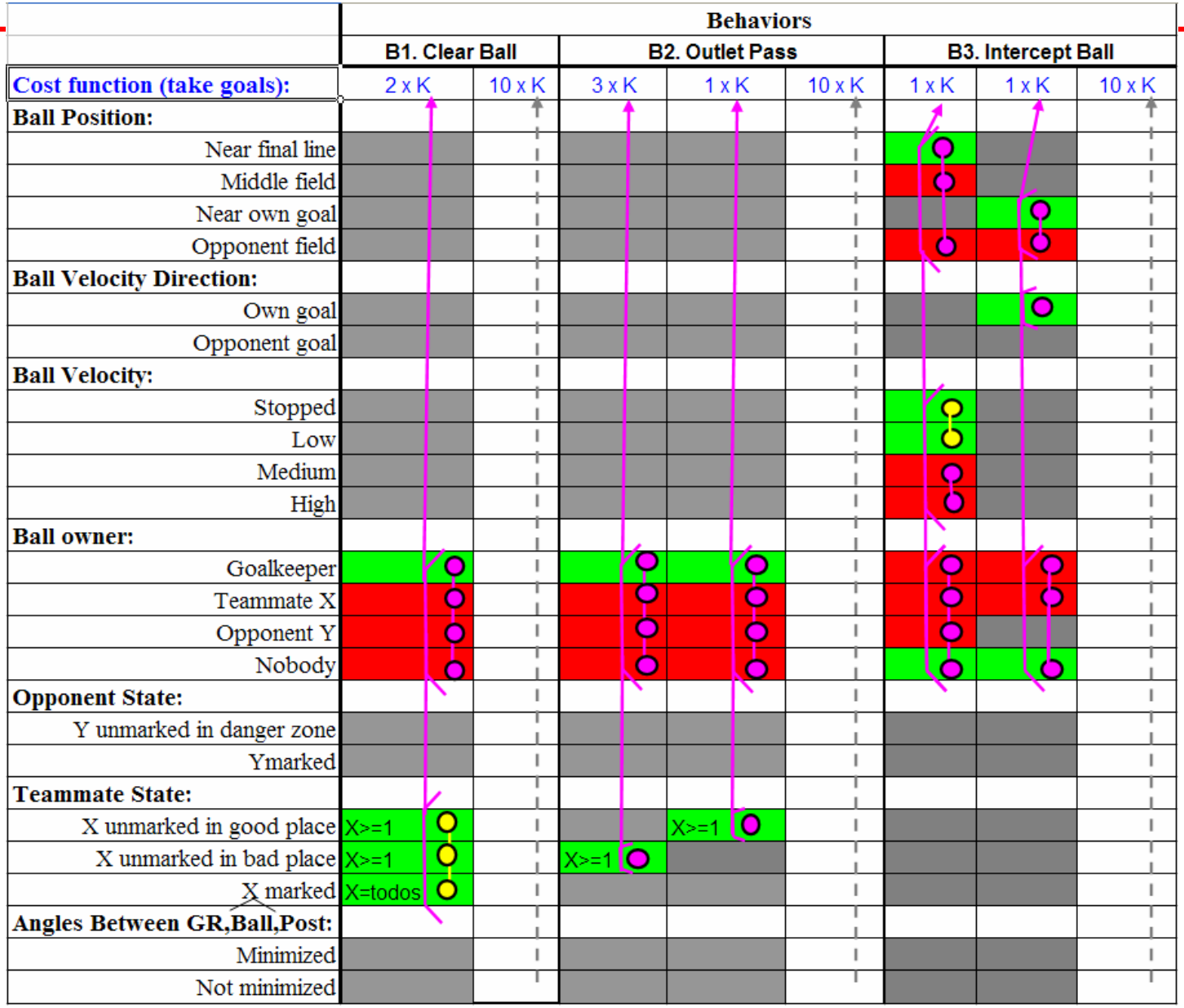
Cost function (Behaviors, States) (1)



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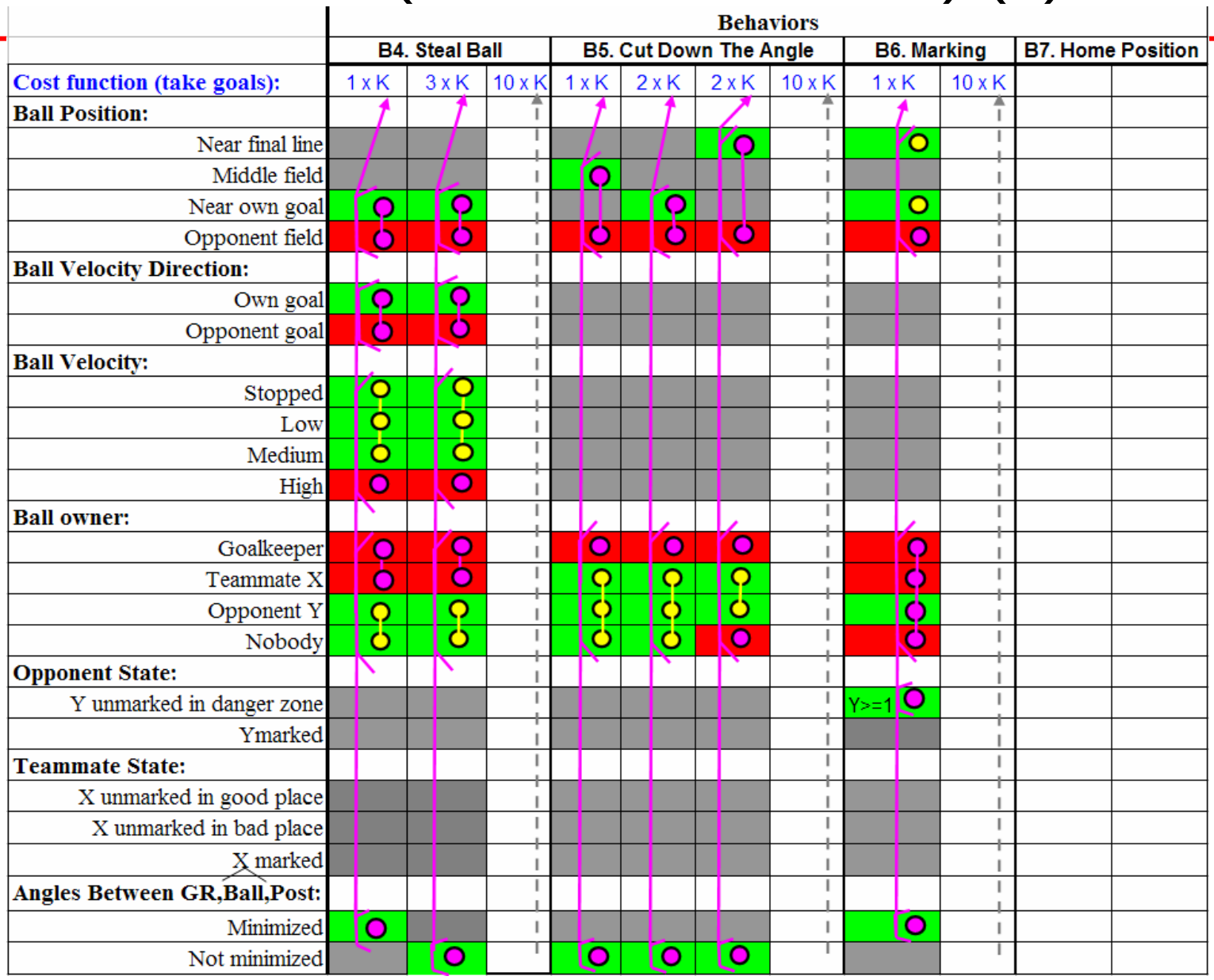
Cost function (Behaviors, States) (2)



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Goal and Constraints

- **Goal: "take few goals"**

$$u\_SPG(f(b)) = \begin{cases} 1, & \text{se } 0 <= y < 2 \\ -0.5y + 2, & \text{se } 2 <= y < 4 \\ 0, & \text{se } y >= 4 \end{cases}$$

- **Constraints:**

	Behaviors						
Restrições:	B1. Clear Ball	B2. Outlet Pass	B3. Intercept Ball	B4. Steal Ball	B5. Cut Down The Angle	B6. Marking	B7. Home Position
u_WE_LOOSING	1	0,4	1	0,4	1	0,3	1
u_OPPONENT_HAVE_STRONG_KICK	1	1	1	0,3	1	0	1
u_OPPONENT_KICK_UP	1	1	1	1	0,6	0	1
u_OPPONENT_DONT_PASS	1	1	1	1	1	0	1
u_OPPONENT_ARE_FAST	1	0,2	1	0,2	1	0,8	1

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Decision

- **Intersect the goal with the constraints (T-norm – min). The Behavior where this value is maximum, is the behavior that seems best choice for the current condition.**

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Conclusion

- **Decison making with fuzzy seems very intuitive.**
- **Scability, because the number of behaviors can increase, without complicate the decision.**
- **Real competitive behaviors**

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Q & A