





An Architecture for Behaviour Coordination Based on Fuzzy Logic

Application to a Robotic Goalkeeper

5th ISLab Workshop

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- 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







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)

	Behaviors B1. Clear Ball B2. Outlet Pass B3. Intercept Ball											
Cost function (take goals):	B1. Clear Ball			B2	2. Outlet Pas	s	B3. Intercept Ball					
	2 x	K.	10 x K	3 x K	1 x K	10 x K	1 x K	1 x K	10 x K			
Ball Position:		†	†	<u>†</u>	†	†	1.	<i>†</i>	†			
Near final line			i				(O		i			
Middle field			. !				•	L				
Near own goal			i					O	i			
Opponent field			1					•	I.			
Ball Velocity Direction:			i									
Own goal			!					0				
Opponent goal												
Ball Velocity:			I			1			I			
Stopped							(0					
Low			!			1	O					
Medium						-	•					
High			ı.			1			I			
Ball owner:						1			1			
Goalkeeper		/ •	I	7	(-	7	Ī			
Teammate X		•		•	•		•	•				
Opponent Y		•	İ	•	•	ı			i			
Nobody		16	ļ.		6		6	6	1			
Opponent State:			ı			İ			İ			
Y unmarked in danger zone												
Ymarked			l l			Ī			Ī			
Teammate State:			- 1			_						
X unmarked in good place	X>=1	O	Ì		X>=1 O	Ì			Ì			
X unmarked in bad place		0		X>=1 O		1						
X marked		0	ì			ì			i			
Angles Between GR, Ball, Post:		/	- 1			1						
Minimized			i			i			i			
Not minimized						ı			1			





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Cost function (Behaviors, States) (2)

	Behaviors														
	B4. Stea		al Ba	all	B5	B5. Cut Dow		n The Angle		B6. Marking		B7. Hom	e Position		
Cost function (take goals):	1	хK	3 x	κĶ	10 x K	1 x K	2	хK	2 x K	10 x K	1 x	ίK	10 x K		
Ball Position:		1		1	Î	<i></i>		<i>†</i>	Υ.	Î		1.	Î		
Near final line					1				0	1		<u>/o</u>	- 1		
Middle field				_	i	Q				i			i		
Near own goal		0		O	- 1			0.0				0	I		
Opponent field		•	Ļ	b	i			•	•	i		O	i		
Ball Velocity Direction:		, ,											I		
Own goal		0		P	i								i		
Opponent goal		0	L	•									1		
Ball Velocity:				,	i								i		
Stopped		0		O											
Low		0		Ó	i								i		
Medium		0		0	- 1								!		
High		0		0	i								i		
Ball owner:	П			_	- 1				/			/	!		
Goalkeeper	ŀ	•	1	P				•	•			P	i		
Teammate X		•		•		Ç		0	C			•	1		
Opponent Y		0		Ç	i	0		0	0			O	i		
Nobody		O		O		Ó		O	•			O	!		
Opponent State:		/		`	i	T			1,			Ľ	i		
Y unmarked in danger zone					- 1						Y>=1	0	!		
Ymarked															
Teammate State:					1					. –			1		
X unmarked in good place															
X unmarked in bad place					I								I.		
X marked					i					i			i		
Angles Between GR,Ball,Post:					I .					1			I .		
Minimized		0			ı					i		0	i		
Not minimized			-	0	1	O		0	0	Т			I		







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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										
Destric # a a .	I		-		B5. Cut Down	I .	B7. Home				
Restrições:	Ball	Pass	Ball	Ball	The Angle	B6. Marking	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 (Tnorm – min). The Behavior where this value is maximum, is the behavior that seems best choice for the current condition.







Conclusion

- Decision 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