Branden INGRAM

ROBOCUP

Modelling and Optimisation in the RoboCup domain

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STRUCTURE

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INTRODUCTION

WHAT IS ROBOCUP ALL ABOUT?

- The WITS RoboCup Team was founded in July 2019
- Affiliated with the RAIL Lab from the School of Computer Science and Applied Mathematics at the University of the Witwatersrand
- Goal is to develop a sustainable and competitive team that competes in the annual international RoboCup robotics competition
- RoboCup is a platform for testing learning scenarios where multiple skills, decisions and controls have to be learned by a single agent and agents have to cooperate or compete in the game of soccer.

AIM P1

WHY ARE WE DOING THIS?

- Kicking is necessary to field a competitive team in order to score goals and defend effectively
- Currently, there exists a parameterised policy which executes a basic kicking behaviour within a fixed time window
- Can we optimise the values of these parameters to maximise the distance travelled?

AIM P2

WHY ARE WE DOING THIS?(P2)

- Soccer is a multi-agent dynamic environment which requires cooperation between teammates to succeed
- Balance needed between minimising space for opponent players and allowing teammates to occupy free space
- Given set of all player positions (teammate and opponent) and ball position, can we optimise positions to:
  - Minimise defensive threats
  - Maximise counterattack opportunities

MODEL P1

MODEL P1

- Basically we are trying to define the maximum distance that a ball can reach, considering that the position of the ball is known, and it is not in motion.
- The equation below possible mathematical model to find the optimum possible distance.

$$R_{max} = (\omega, v, a)$$

- ω spin rate velocity, v is velocity of the ball, and a is angle of ball defined by the parameter.

- From the 22 parameters, the parameters of the leg are described as:

$$IK_{pti} = \begin{cases} IK_{Ai} \rightarrow foot \\ IK_{Bi} \rightarrow Knee \\ IK_{Ci} \rightarrow Hip \end{cases}$$

- $i = \{0, 1, ..., 3\}$ which are dimensions of the joints and $p = (x, y, z)$ which are components describing.
- From the last two equations, we get:

$$R_{max} = a_0 + (\omega v_x - D_f) IK_{xti} + (\omega v_y - g) IK_{yti} + FIK_{zti}$$

a_0 initial position of the ball, D_f is a frictional force on the horizontal surface, g gravitational force taken as positive in the downward motion, and F is the force applied by the foot when n contact with the ball.

ISSUES

PROBLEM(S) ENCOUNTERED

- Mathematical approach to optimize IK_{pti} for best possible values or position.
- One approach was to use linear simplex method, but the difficulties was to contract the constrains as we are dealing with a dynamical problem.
- The second way is to scale the values directly, but it will take to long because there are so many parameter.

MODEL P2

MODEL P2

Level of importance

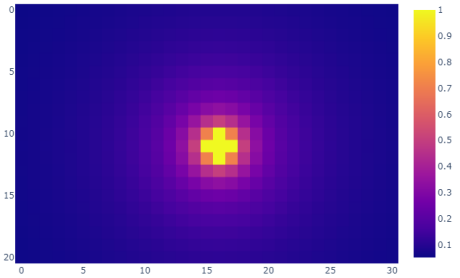
- Understand the most important positions to occupy on the field in relation to the ball
- Model player behaviour based on position taken

Let call by $B(b_x, b_y)$ the position of the ball in the field and $I(x, y)$ any position of the field. The position of I to the ball is given by the formula:

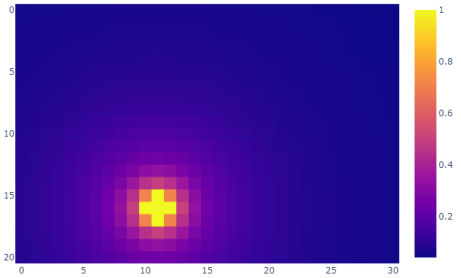
$$d(B, I) = \left[(x - b_x)^2 + (y - b_y)^2\right]^{1/2}$$

MODEL P2 RESULTS

BASE CASE



$B = (0, 0)$



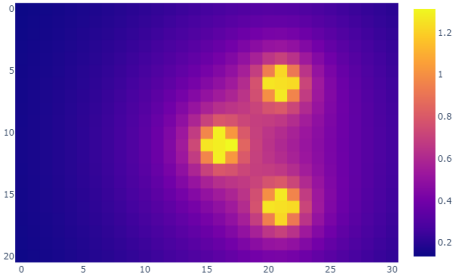
$B = (-5, 5)$

2 OPPENENTS AND BALL

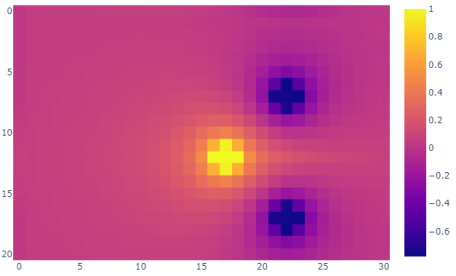
Given the position of the two opponents, we can known the most important position in the field by the formula:

$$D = d(B, I) + d(Op1, I) + d(Op2, I)$$

2 OPPENENTS AND BALL...



without intersection



with intersection

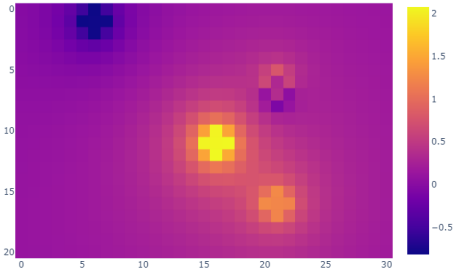
$B(0,0)$; $Op1(5,5)$; $Op2(5,-5)$

2 OPPENENTS CASE AND 2 TEAMATES AND BALL

If we consider as important the place of all the players and the ball, the formula is given:

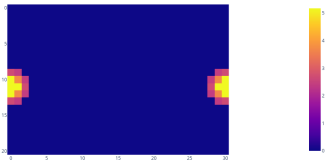
$$D = d(B, I) + d(Op1, I) + d(Op2, I) + d(T1, I) + d(T2, I)$$

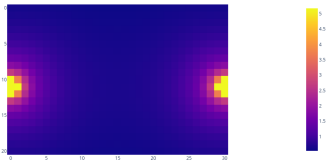
2 OPPENENTS CASE AND 2 TEAMATES AND BALL



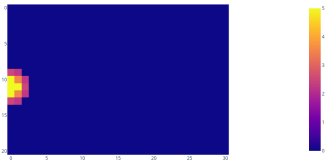
$B(0,0)$; $Op1(5,5)$; $Op2(5,-5)$; $T1(5,-4)$; $T2(-10,-10)$

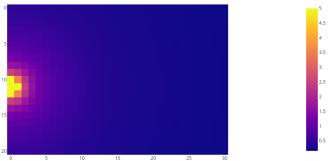
OFFENCE MAX 2 OPPONENT CASE AND MIN 2 TEAMATES AND BALL WITH/WITHOUT THRESHOLD





DEFENCE MAX 2 OPPONENT CASE AND MIN 2 TEAMATES AND BALL WITH/WITHOUT THRESHOLD





The End

We **STILL** love robots

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