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| **Problem Chosen** D | **2020 MCM/ICM Summary Sheet** | **Team Control Number** 1111111 |

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**Summary**

**Have a wonderful soccer game**

本文利用图论，概率论和简单微积分的方法，建立，，，和数据优化模型，为足球教练和球员的训练提供策略。

首先，根据图论知识，在球员之间的传球建立一个网络，每个球员都是一个节点，每一次传球便将球员连接起来。球员之间传球次数用数组记录下来，在每一场球赛中，数组大小为14\*14，在一个赛季中，数组大小为30\*30。

第二，

第三，

最后

**Contents**

**1.Introduction 1**

1.1 Background 2

1.2 Our work 3

**2.Problem restatement 4**

**3.Terminology 1**

3.1 Terms 2

3.2 Symbols 3

**4.Preparation of the Models 4**

4.1 Assumptions 5

4.2 Notations 6

**5.The Models 1**

5.1 Model 1 2

第3级 3

5.2 Model 2 2

第3级 3

5.3 Model 3 2

第3级 3

5.4 Model 4 2

第3级 3

**6.Strengths and Weaknesses 4**

6.1 Strengths 5

6.2 Weaknesses 6

**References**

**1.Introduction**

1.1 Background

足球运动有着悠久的历史，从推广以来就受到了全世界的喜爱，球迷遍布全世界。足球可以说是当今世界普及度最高的运动项目之一，足球这看似简单的一种运动，背后蕴藏着个人能力及团队协作的奥秘。随着时代的发展和科技的进步，足球运动员们和教练在技术上不断提升，给观众们呈现出一场场精彩纷呈的比赛。众所周知，一场精彩的足球赛离不开球员和球队贡献的，通过研究团队中每个人的行动，平衡队内力量，协调团队关系，合理安排上场时间和每个人所在的位置，可以在最大程度上得分。

1.2 Our work

我们的工作是从传统模型开始，在问题一中，我们首先建立每一场中十四位球员（其中包括三位后补球员）的传球次数统计图，再建立整个赛季中

我们的任务时为足球教练提供战略决策，在千变万化的球场上找出一些较为普遍适用在作战规律

在建立模型时，我们使用了Python，vscode，OneNote（开始胡编乱造，要删掉）

**2.Problem restatement**

To respond to the Huskie coach’s requests, your team from ICM should use the provided data to address the following:

Create a network for the ball passing between players, where each player is a node and each pass constitutes a link between players. Use your passing network to identify network patterns, such as dyadic and triadic configurations and team formations. Also consider other structural indicators and network properties across the games. You should explore multiple scales such as, but not limited to, micro (pairwise) to macro (all players) when looking at interactions, and time such as short (minute-to-minute) to long (entire game or entire season).

Identify performance indicators that reflect successful teamwork (in addition to points or wins) such as diversity in the types of plays, coordination among players or distribution of contributions. You also may consider other team level processes, such as adaptability, flexibility, tempo, or flow. It may be important to clarify whether strategies are

universally effective or dependent on opponents’ counter-strategies. Use the performance indicators and team level processes that you have identified to create a model that captures structural, configurational, and dynamical aspects of teamwork.

Use the insights gained from your teamwork model to inform the coach about what kinds of structural strategies have been effective for the Huskies. Advise the coach on what changes the network analysis indicates that they should make next season to improve team success.

Your analysis of the Huskies has allowed you to consider group dynamics in a controlled setting of a team sport. Understanding the complex set of factors that make some groups perform better than others is critical for how societies develop and innovate. As our societies increasingly solve problems involving teams, can you generalize your findings to say something about how to design more effective teams? What other aspects of teamwork would need to be captured to develop generalized models of team performance?

**3.Terminology**

**4.Preparation of the Models**

**5.The Models**

5.1 model 1

影响整个游戏的其他结构指标和网络属性有多个尺度，比如：微观上两两球员之间的行为，包括宏观上所有球员之间的行为以及时间尺度。

在一场球赛中，宏观来看，球员相对于球场可以视为一个个节点，球场可以视为一个网络，每一次传球可以视为节点之间的连线。在每一场球赛中，共有十四位球员有机会上场，其中包括三名后补球员。我们调取passingevents中的数据，“F”表示前锋，“D”表示防守，“M”表示中场，“G”表示守门员，统计出每场球赛中每两位球员间传球的次数并绘制出38张14\*14的表格和一张代表整个赛季的30\*3的表格，以下随机抽取了四张：

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | G1 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | M1 | M2 | M3 |
| G1 | 1 | 2 | 0 | 2 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| D1 | 2 | 0 | 14 | 8 | 1 | 3 | 11 | 1 | 4 | 1 | 0 | 3 | 3 | 1 |
| D2 | 1 | 11 | 0 | 18 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 3 | 0 |
| D3 | 6 | 6 | 6 | 0 | 9 | 0 | 4 | 5 | 6 | 1 | 1 | 1 | 2 | 1 |
| D4 | 0 | 0 | 1 | 4 | 0 | 0 | 1 | 3 | 2 | 1 | 0 | 1 | 2 | 2 |
| D5 | 0 | 1 | 0 | 0 | 0 | 2 | 4 | 0 | 1 | 0 | 0 | 1 | 8 | 0 |
| D6 | 1 | 13 | 3 | 0 | 3 | 2 | 1 | 1 | 8 | 2 | 1 | 5 | 10 | 2 |
| D7 | 1 | 0 | 2 | 2 | 4 | 0 | 1 | 0 | 7 | 0 | 0 | 1 | 0 | 2 |
| D8 | 0 | 6 | 3 | 8 | 2 | 6 | 9 | 4 | 0 | 0 | 0 | 0 | 6 | 1 |
| D9 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 2 | 2 |
| D10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 |
| M1 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 5 | 1 |
| M2 | 0 | 3 | 0 | 4 | 2 | 4 | 14 | 0 | 4 | 2 | 1 | 3 | 0 | 1 |
| M3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 3 | 0 |

第1场球赛两两球员间传球次数

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | G1 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | M1 | M2 | M3 |
| G1 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 9 |
| D1 | 1 | 0 | 1 | 4 | 0 | 1 | 1 | 2 | 0 | 2 | 0 | 0 | 1 | 2 |
| D2 | 1 | 3 | 0 | 3 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 4 |
| D3 | 5 | 1 | 3 | 0 | 1 | 1 | 2 | 1 | 0 | 1 | 8 | 2 | 0 | 4 |
| D4 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| D5 | 2 | 3 | 1 | 0 | 0 | 0 | 4 | 2 | 2 | 3 | 1 | 0 | 2 | 5 |
| D6 | 0 | 1 | 3 | 4 | 1 | 5 | 0 | 7 | 0 | 7 | 4 | 0 | 3 | 2 |
| D7 | 0 | 1 | 1 | 1 | 2 | 5 | 5 | 0 | 2 | 3 | 5 | 1 | 1 | 4 |
| D8 | 0 | 0 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 2 |
| D9 | 0 | 2 | 0 | 0 | 0 | 5 | 4 | 1 | 1 | 0 | 1 | 2 | 0 | 2 |
| D10 | 0 | 0 | 2 | 7 | 0 | 2 | 2 | 1 | 3 | 0 | 1 | 2 | 1 | 3 |
| M1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| M2 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| M3 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 2 | 1 | 0 | 1 | 0 |

第13场球赛两两球员间传球次数

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | G1 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | M1 | M2 | M3 |
| G1 | 0 | 3 | 1 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| D1 | 2 | 0 | 1 | 1 | 4 | 1 | 5 | 0 | 7 | 3 | 0 | 4 | 2 | 0 |
| D2 | 1 | 3 | 0 | 3 | 2 | 2 | 3 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| D3 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 3 | 5 | 0 | 7 | 1 | 7 |
| D4 | 1 | 0 | 2 | 0 | 0 | 0 | 3 | 2 | 0 | 7 | 2 | 0 | 2 | 0 |
| D5 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 |
| D6 | 0 | 6 | 2 | 5 | 5 | 1 | 1 | 3 | 9 | 5 | 1 | 9 | 1 | 2 |
| D7 | 0 | 0 | 1 | 2 | 2 | 0 | 2 | 1 | 1 | 2 | 0 | 3 | 0 | 0 |
| D8 | 1 | 4 | 3 | 6 | 2 | 1 | 9 | 2 | 0 | 2 | 0 | 3 | 1 | 1 |
| D9 | 0 | 4 | 0 | 2 | 5 | 1 | 4 | 2 | 6 | 0 | 0 | 2 | 1 | 1 |
| D10 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| M1 | 0 | 0 | 0 | 1 | 2 | 0 | 5 | 3 | 2 | 2 | 0 | 0 | 4 | 3 |
| M2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 2 | 0 | 0 |
| M3 | 0 | 2 | 0 | 4 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |

第38场球赛两两球员间传球次数

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | G1 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | M1 | M2 | M3 | M4 |
| G1 | 2 | 76 | 29 | 49 | 14 | 22 | 27 | 18 | 7 | 9 | 6 | 24 | 0 | 19 | 7 |
| D1 | 107 | 2 | 59 | 105 | 73 | 57 | 25 | 34 | 23 | 6 | 2 | 92 | 3 | 51 | 26 |
| D2 | 62 | 62 | 2 | 49 | 39 | 47 | 52 | 26 | 2 | 8 | 0 | 46 | 0 | 44 | 22 |
| D3 | 120 | 98 | 35 | 5 | 59 | 14 | 6 | 18 | 42 | 0 | 9 | 47 | 5 | 54 | 30 |
| D4 | 25 | 57 | 30 | 35 | 2 | 1 | 0 | 1 | 2 | 0 | 3 | 62 | 9 | 63 | 33 |
| D5 | 27 | 36 | 40 | 15 | 0 | 6 | 12 | 3 | 2 | 4 | 0 | 75 | 3 | 69 | 29 |
| D6 | 43 | 12 | 34 | 5 | 1 | 8 | 2 | 25 | 1 | 0 | 0 | 32 | 2 | 30 | 19 |
| D7 | 31 | 18 | 17 | 12 | 1 | 2 | 24 | 1 | 0 | 0 | 0 | 49 | 0 | 21 | 32 |
| D8 | 14 | 12 | 4 | 42 | 0 | 2 | 2 | 0 | 1 | 0 | 0 | 22 | 5 | 9 | 28 |
| D9 | 8 | 7 | 7 | 0 | 0 | 10 | 0 | 1 | 0 | 0 | 0 | 4 | 0 | 6 | 3 |
| D10 | 6 | 1 | 0 | 10 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 5 | 2 |
| M1 | 20 | 85 | 63 | 60 | 79 | 79 | 54 | 70 | 46 | 3 | 3 | 7 | 10 | 143 | 72 |
| M2 | 2 | 2 | 3 | 3 | 12 | 3 | 1 | 0 | 3 | 0 | 0 | 6 | 2 | 12 | 5 |
| M3 | 12 | 74 | 46 | 56 | 88 | 67 | 28 | 44 | 22 | 3 | 6 | 168 | 7 | 0 | 27 |
| M4 | 5 | 30 | 26 | 18 | 28 | 23 | 10 | 41 | 25 | 2 | 1 | 71 | 3 | 26 | 8 |
| M5 | 1 | 1 | 2 | 3 | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 3 | 0 | 0 | 4 |
| M6 | 1 | 16 | 13 | 12 | 50 | 71 | 4 | 20 | 1 | 0 | 0 | 54 | 4 | 28 | 24 |
| M7 | 2 | 3 | 1 | 3 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| M8 | 1 | 1 | 2 | 9 | 1 | 5 | 3 | 31 | 0 | 0 | 0 | 20 | 0 | 6 | 7 |
| M9 | 0 | 4 | 2 | 4 | 10 | 10 | 14 | 7 | 7 | 0 | 0 | 11 | 0 | 8 | 6 |
| M10 | 0 | 3 | 0 | 2 | 1 | 2 | 1 | 9 | 0 | 0 | 0 | 3 | 0 | 3 | 3 |
| M11 | 1 | 0 | 1 | 7 | 2 | 1 | 2 | 7 | 3 | 0 | 0 | 5 | 0 | 7 | 7 |
| M12 | 0 | 4 | 0 | 3 | 24 | 22 | 3 | 8 | 2 | 0 | 0 | 8 | 0 | 9 | 2 |
| M13 | 0 | 3 | 5 | 2 | 0 | 6 | 4 | 12 | 0 | 0 | 0 | 5 | 0 | 12 | 0 |
| F1 | 0 | 5 | 4 | 7 | 18 | 17 | 4 | 12 | 3 | 1 | 0 | 30 | 0 | 14 | 22 |
| F2 | 6 | 55 | 33 | 56 | 64 | 84 | 41 | 32 | 41 | 3 | 0 | 117 | 8 | 58 | 50 |
| F3 | 0 | 2 | 2 | 3 | 3 | 5 | 2 | 4 | 0 | 0 | 0 | 5 | 1 | 3 | 1 |
| F4 | 0 | 0 | 0 | 0 | 6 | 7 | 2 | 2 | 7 | 2 | 0 | 15 | 3 | 5 | 12 |
| F5 | 0 | 1 | 1 | 1 | 20 | 7 | 1 | 4 | 10 | 0 | 1 | 9 | 1 | 2 | 15 |
| F6 | 0 | 8 | 6 | 6 | 7 | 3 | 0 | 15 | 37 | 0 | 0 | 19 | 3 | 10 | 25 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | M5 | M6 | M7 | M8 | M9 | M10 | M11 | M12 | M13 | F1 | F2 | F3 | F4 | F5 | F6 |
| G1 | 1 | 10 | 0 | 5 | 2 | 0 | 0 | 12 | 1 | 77 | 22 | 5 | 15 | 8 | 6 |
| D1 | 0 | 21 | 4 | 3 | 6 | 2 | 2 | 13 | 2 | 23 | 49 | 5 | 19 | 19 | 18 |
| D2 | 1 | 12 | 2 | 1 | 5 | 1 | 4 | 2 | 1 | 13 | 56 | 1 | 8 | 4 | 8 |
| D3 | 4 | 23 | 3 | 14 | 9 | 1 | 4 | 9 | 3 | 21 | 50 | 1 | 8 | 14 | 21 |
| D4 | 8 | 30 | 0 | 0 | 7 | 0 | 3 | 19 | 0 | 25 | 66 | 10 | 25 | 33 | 20 |
| D5 | 2 | 67 | 0 | 7 | 11 | 3 | 1 | 23 | 9 | 42 | 97 | 6 | 27 | 6 | 3 |
| D6 | 0 | 9 | 1 | 6 | 9 | 1 | 1 | 7 | 1 | 28 | 28 | 2 | 5 | 4 | 6 |
| D7 | 2 | 18 | 0 | 39 | 5 | 6 | 7 | 6 | 4 | 36 | 29 | 4 | 16 | 6 | 22 |
| D8 | 0 | 1 | 0 | 0 | 8 | 0 | 1 | 10 | 0 | 5 | 19 | 0 | 11 | 18 | 49 |
| D9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 3 | 0 | 3 | 0 | 3 |
| D10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| M1 | 3 | 77 | 3 | 25 | 10 | 8 | 6 | 20 | 4 | 34 | 182 | 9 | 36 | 13 | 31 |
| M2 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 5 | 2 | 3 | 0 | 0 |
| M3 | 3 | 44 | 0 | 11 | 11 | 4 | 1 | 28 | 8 | 21 | 63 | 4 | 13 | 12 | 16 |
| M4 | 4 | 34 | 0 | 14 | 5 | 6 | 3 | 7 | 0 | 20 | 50 | 3 | 12 | 6 | 16 |
| M5 | 1 | 1 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 3 | 7 | 2 | 0 | 0 | 0 |
| M6 | 1 | 3 | 4 | 15 | 15 | 2 | 4 | 12 | 4 | 40 | 52 | 6 | 24 | 14 | 14 |
| M7 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| M8 | 4 | 3 | 0 | 1 | 2 | 1 | 0 | 0 | 3 | 14 | 18 | 0 | 4 | 1 | 0 |
| M9 | 0 | 15 | 0 | 2 | 0 | 1 | 2 | 0 | 5 | 4 | 9 | 0 | 4 | 4 | 1 |
| M10 | 0 | 3 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 |
| M11 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | 8 | 2 | 1 | 1 | 1 |
| M12 | 0 | 6 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 2 | 11 | 0 | 8 | 14 | 4 |
| M13 | 0 | 6 | 0 | 0 | 5 | 0 | 0 | 2 | 1 | 2 | 4 | 0 | 1 | 3 | 1 |
| F1 | 2 | 27 | 1 | 12 | 3 | 2 | 2 | 3 | 2 | 1 | 27 | 4 | 9 | 3 | 3 |
| F2 | 5 | 58 | 0 | 15 | 15 | 0 | 6 | 18 | 3 | 30 | 5 | 6 | 12 | 15 | 23 |
| F3 | 0 | 8 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | 11 | 0 | 1 | 0 | 0 |
| F4 | 0 | 20 | 0 | 2 | 3 | 2 | 0 | 4 | 0 | 5 | 9 | 1 | 3 | 5 | 10 |
| F5 | 0 | 16 | 0 | 0 | 5 | 0 | 0 | 11 | 3 | 7 | 23 | 0 | 2 | 1 | 17 |
| F6 | 0 | 11 | 0 | 0 | 1 | 0 | 1 | 6 | 3 | 6 | 22 | 0 | 16 | 18 | 0 |

整个赛季两两球员间传球次数

在三人传球的评价体系中，我们引入边权的概念，将三个节点用三条边连接起来，图的每条边上带的一个数值，其代表的含义可以是长度等等，这个值就是边权。边的权值我们考虑由以下四部分组成：距离权，干扰权，类型权。其中，类型权是传球的类型，包括“头传球”、“简单传球”、“发射”、“高传球”、“手传球”、“聪明传球”、“交叉传球”之一。

通过生活经验和数据挖掘所发现的规律可以得出以下公式表格：

1. 传球类型权重表：α=f（传球类型）



1. ，其中，x为球员到对方球门的横坐标
2. 那么单次的价值评价：

边权=，其中，为传球人坐标带入得到的值，为接球人坐标带入得到的值。

那么，由边权的计算公式我们可以得出单次传球的价值评价图：

Match3

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | G1 | D1 | D2 | D3 | D4 | D6 | M1 | M4 | M6 | M7 | M8 | F1 | F2 | F3 |
| G1 |  | 1.4 | 2.5 | 4 |  | 1.3 | 2.3 | 0.5 |  |  |  | 2.3 | 1.3 | 0.6 |
| D1 | 6.7 |  | 9 |  |  | 5.9 | 1 | 2 |  | 4.1 |  | 1 | 3.3 | 1.2 |
| D2 | 2.4 | 6.6 |  | 9 |  |  | 3.9 | 3.2 | 3.3 | 2.1 |  |  | 6 |  |
| D3 | 5.9 | 2.8 | 5.5 | 1.9 | 13.8 |  | 2.1 | 2.8 | 1 | 3.3 |  |  |  |  |
| D4 | 0.7 | 1 | 1.9 | 5.3 | 1.2 |  | 4.5 | 1.9 |  |  |  | 1.3 | 1.2 |  |
| D6 | 1.6 | 3.5 | 1 |  |  | 1.1 | 1.2 |  | 3.4 | 1 |  |  | 7.5 | 2.4 |
| M1 |  | 4 | 1.7 | 3.2 | 3.1 | 1.2 |  | 5.6 | 4.6 | 3.6 |  | 1.3 | 7 | 2.1 |
| M4 | 0.8 | 2.7 | 2.8 | 1.7 | 1.1 | 1.8 | 7.3 |  |  |  |  |  | 4.9 | 1.2 |
| M6 |  |  |  |  | 9.2 |  | 3.4 |  |  | 4.4 | 1.3 |  | 4.4 | 1.4 |
| M7 | 1.7 | 3.1 | 1.2 | 3.1 | 1.1 | 3.5 | 5.9 |  | 2 |  |  |  | 2.3 |  |
| M8 |  |  |  |  |  | 1.3 | 1.5 |  |  |  |  |  |  |  |
| F1 |  |  |  |  |  | 1.2 |  |  | 1.3 |  |  |  |  |  |
| F2 |  | 2.1 | 0.9 | 2.3 |  | 10.8 | 2.4 | 2.5 | 7.2 |  | 1.7 | 2.7 |  | 5.3 |
| F3 |  |  |  | 1 |  | 2.5 | 2.3 |  | 1 |  |  |  | 4.1 |  |

第三次传球的价值评价图

Match10

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | G1 | D2 | D3 | D4 | D7 | M1 | M4 | M5 | M6 | M8 | M11 | F1 | F2 | F4 |
| G1 |  | 0.5 |  | 1 |  |  | 0.5 |  |  |  |  | 2.2 |  | 1.9 |
| D2 | 2.2 |  | 7.9 | 8.3 | 0.9 | 4.4 | 1.2 |  | 1.4 |  | 2.2 | 2.2 | 6 |  |
| D3 | 3.1 | 5.1 |  | 3.6 | 8.3 | 5.4 | 2.3 | 2.2 |  | 4.8 | 1 | 1.2 | 5.2 | 1 |
| D4 |  | 3.7 |  |  |  | 11 | 2.5 | 7.8 | 1.2 |  |  | 1.4 | 13.1 | 8.2 |
| D7 | 1.6 |  | 5.9 |  |  | 4.7 | 6.4 |  | 1.5 | 10.3 | 3.7 | 6.2 | 7.1 | 5.2 |
| M1 | 0.8 | 5.8 | 4.1 | 14.6 | 8.2 | 0.6 | 5.3 | 2.3 | 2.5 | 0.5 | 0.9 |  | 11.4 | 4.5 |
| M4 | 1.7 | 3.5 | 4.3 | 2.1 | 12.3 | 2.1 |  | 5 |  | 1.2 | 1.3 |  | 3.7 | 2.4 |
| M5 | 0.7 |  | 1.2 | 4.7 | 2.5 | 3.4 | 3.5 |  |  | 3.2 |  | 1.2 | 6.7 |  |
| M6 |  |  |  | 2.7 | 1.6 |  |  |  |  |  |  |  |  |  |
| M8 |  |  |  |  | 5.2 | 1.2 | 2.1 | 1.3 |  |  |  |  | 3.7 |  |
| M11 |  | 0.9 | 1.3 | 1.3 | 2.4 | 2.3 | 5.3 |  |  |  |  | 2.6 | 3.6 |  |
| F1 |  |  | 0.9 | 1.4 | 2.4 | 1.2 | 1.5 | 1.2 |  |  |  |  |  | 2.7 |
| F2 |  | 4.5 | 2.2 | 10.9 | 8.1 | 8.7 | 4.9 | 4.9 |  | 6.4 | 3.7 |  |  | 2.7 |
| F4 |  |  |  |  | 1.6 |  |  |  |  |  |  | 1.4 | 2.7 |  |

第十次传球的价值评价图

Match30

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | G1 | D1 | D3 | D4 | D6 | D8 | M2 | M4 | M6 | M12 | F1 | F2 | F5 | F6 |
| G1 |  | 2.6 | 3.4 |  |  |  |  |  | 0.5 | 2 |  | 0.8 | 0.5 | 0.9 |
| D1 | 2.3 |  | 5.5 | 7.2 |  | 1.3 |  |  | 2.2 | 1 |  | 5.3 | 3.4 | 1.4 |
| D3 | 3.9 | 6.6 |  | 1.1 | 3.1 | 0.9 |  | 9.2 | 1 |  |  | 10 | 2 | 4.5 |
| D4 | 1.4 | 8.7 | 0.9 |  |  |  |  | 2.4 | 5.4 | 4.3 |  | 13.4 | 10.7 |  |
| D6 | 0.9 |  | 1.8 |  |  |  | 1.2 | 1 |  |  |  | 0.9 |  |  |
| D8 | 0.7 | 1.7 | 2.9 |  | 1.1 |  | 1.5 | 6.7 |  |  | 1.4 |  | 0.9 | 9.6 |
| M2 |  | 1.1 |  | 1.2 |  | 1.6 |  |  |  |  |  | 1.4 |  |  |
| M4 |  | 1.1 | 6.5 | 2.9 | 1 | 3.2 |  |  | 2.2 | 1.1 |  | 8 | 2.5 | 6.3 |
| M6 |  | 2.8 | 0.8 | 8.1 |  |  |  | 2.1 |  | 5.1 |  | 3.4 | 1.2 | 6.9 |
| M12 |  |  |  | 5.3 |  |  |  |  | 1.4 |  |  |  | 2.9 | 7 |
| F1 |  |  |  |  |  | 1.6 |  |  |  |  |  | 1.3 |  |  |
| F2 |  | 5.3 | 10.1 | 8.7 |  | 4.8 | 2.4 | 8.5 | 8.8 | 4.1 |  |  | 3.7 | 1.5 |
| F5 |  |  |  | 10.3 |  | 1.7 |  | 2.4 | 6.2 | 5.2 |  | 2.4 |  | 1.4 |
| F6 |  | 1 |  |  |  | 7.2 |  | 5.3 | 4 | 2.5 |  | 1.9 | 2.4 |  |

第三十次传球的价值评价图



整个赛季单次评价图

时间尺度也是影响球赛。。。（什么）的重要因素之一，球赛刚开始时，球员才稍加热身，身体还未舒展开而导致传球概率密度较小，5—10分钟过后，球员们已经活动开了，传球效率逐渐提高并大致趋于稳定，赛程过半时，球员们体力消耗较大，传球概率密度开始降低，即传球概率的增速减缓（虽然一场球赛中成功传球次数仍在增加，但传球失败概率开始增加），此后传球概率密度大致呈现下贱趋势。纵观整个赛季中38场球赛球员们的传球概率密度，整体上看可以与单场球赛所展示出的概率密度变化趋势相同，大体体现为先增加，在趋于稳定一段时间后开始降低。我们以时间为横坐标，成功传球的概率密度为纵坐标作图，以下随机抽取两张：



第1场传球概率密度

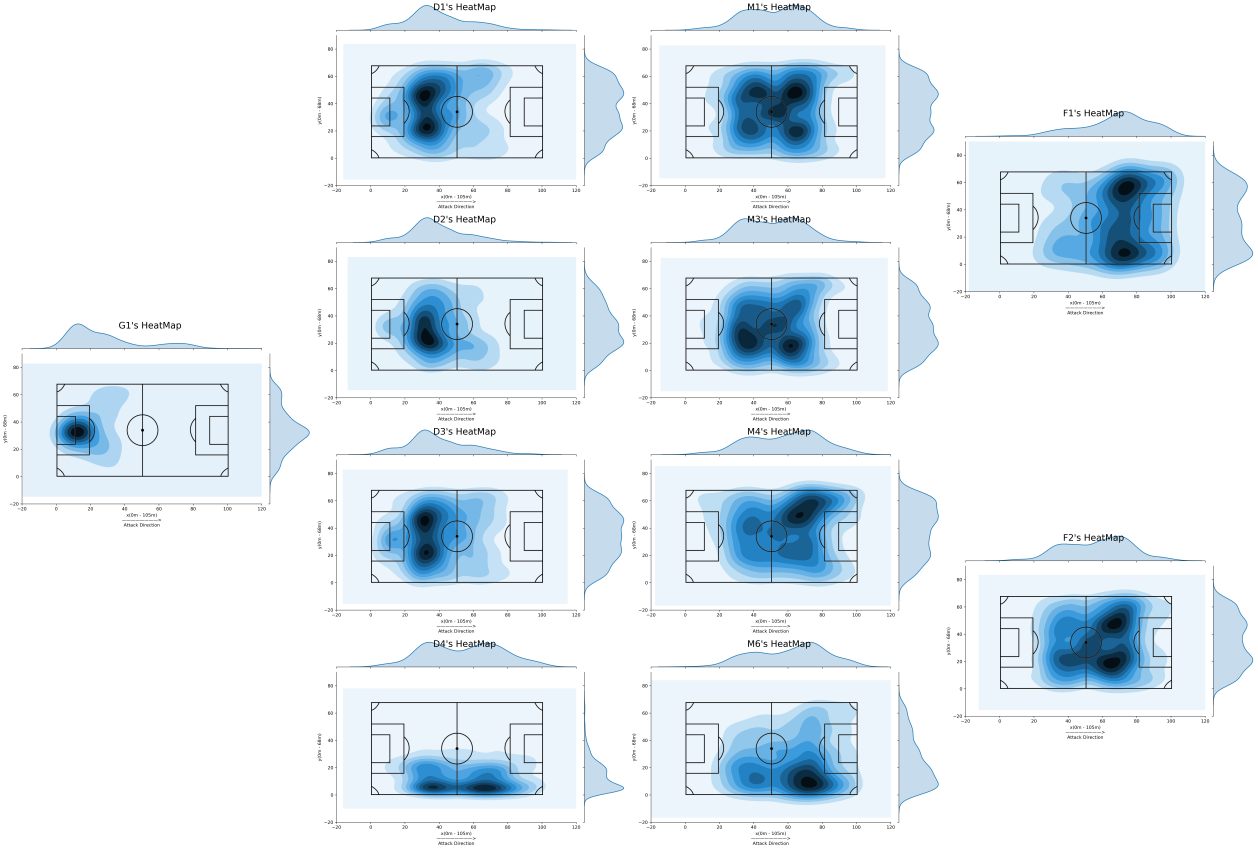


整个赛季传球概率密度

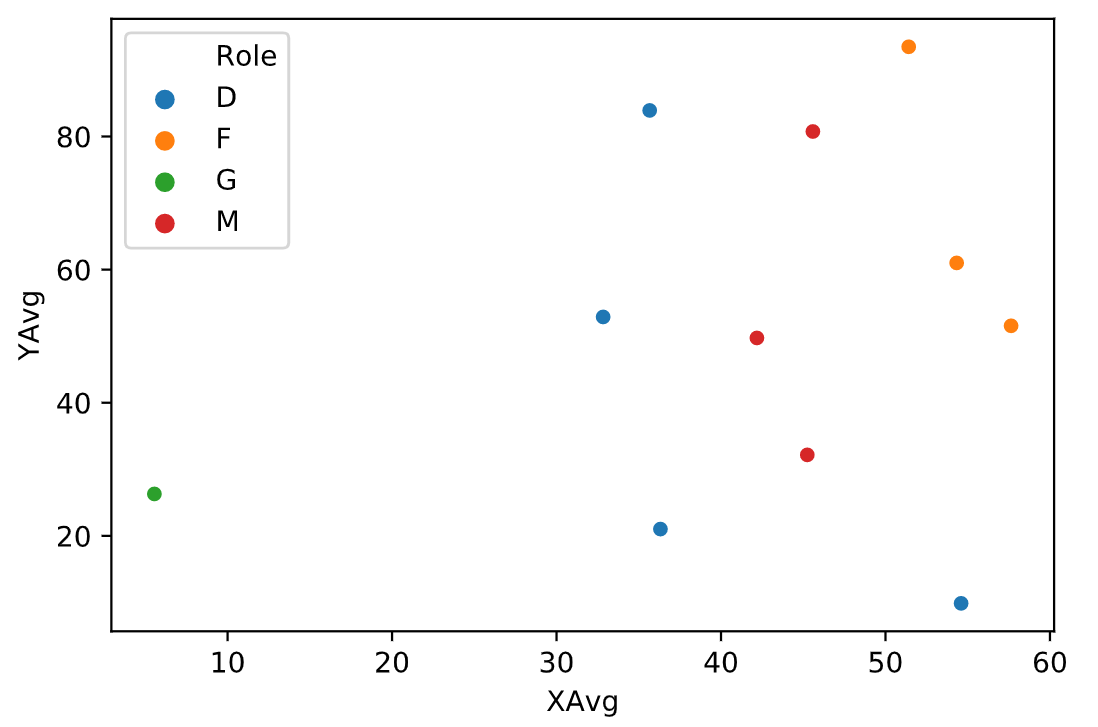
5.2 model 2

成功团队合作有许多指标，通过fullevents发数据分析和实际经验，我们主要考虑以下指标：球员位置、球员阵型、球员协调配合和动态类型多样性。

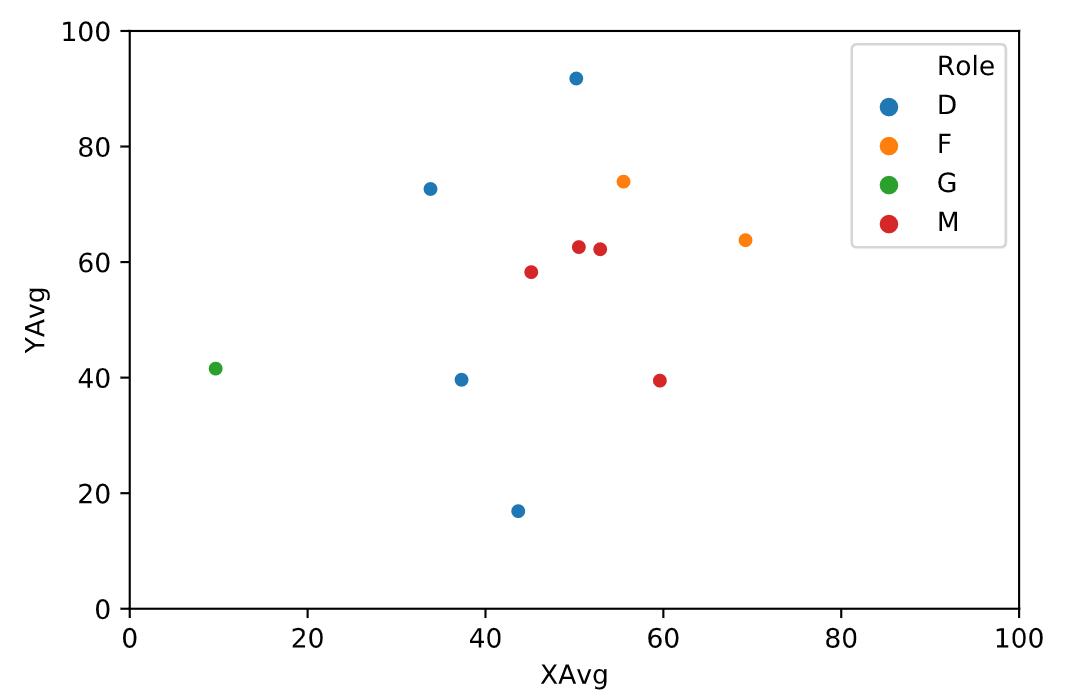
为了考虑球员位置分布，我们采出每个球员在整个赛季中的位置坐标，用Python做出球员运动位置的热点图，颜色越深则表示出现在此处的概率较大，越浅表示出现的概率越小。部分球员的位置热点图如下：



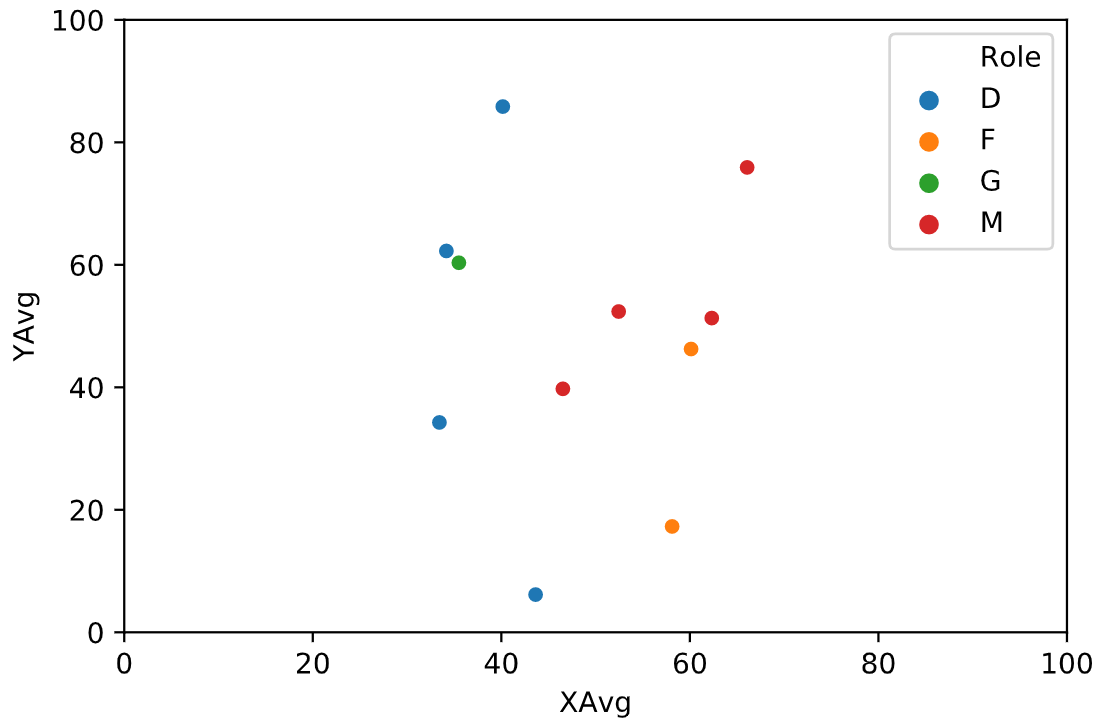
在一场球赛中，球队的阵型对团队协作起到重要作用，我们考虑在一场球赛中球员阵型，我们采取每一场比赛中每一位球员的运动坐标，采用坐标对时间加权的方法，找出每场球赛中，每一位球员最有可能出现的位置，将这十一位球员的位置标在图中绘制出每场球赛的阵型图，部分阵型图如下：



第一场球赛球员阵型图

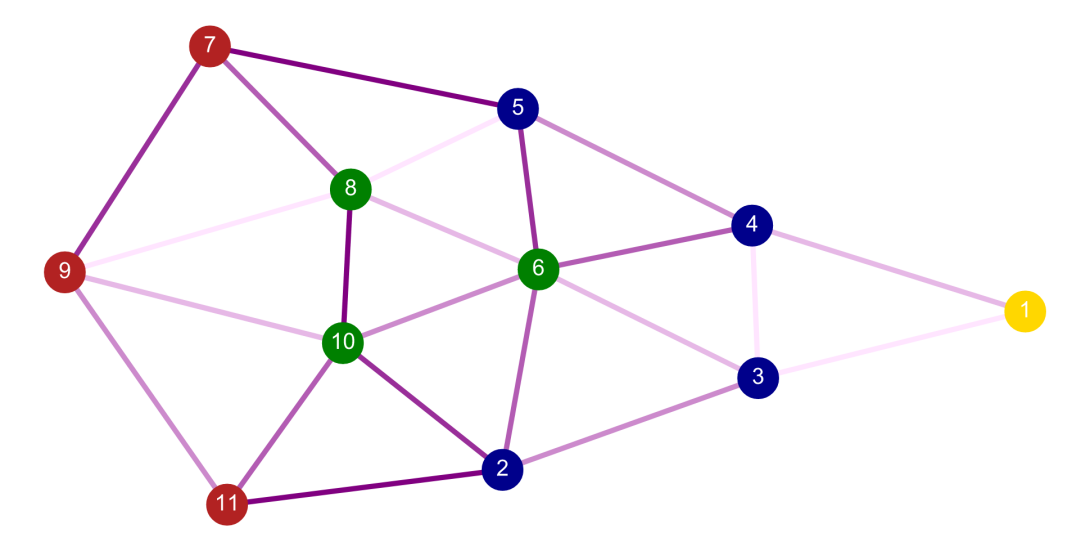


第六场球赛球员阵型图



第八场球赛球员阵型图

球员间的协调配合是影响成功团队合作的关键因素，在球员阵型的基础上，考虑球员之间的联系，宏观上体现为球员间传球的次数多少，我们用线将球员之间连起来，用线的深浅表示传球次数的多少，颜色越深，传球次数越多，反之，颜色越浅，传球次数越少。部分球员传球图如下：



第一场球员传球次数图

动态类型的多样性我们考虑其影响因素有比赛类型多样性、教练多样性、对手水平、主客场。比赛类型我们可以简单分为传球，进攻，失败和进球四个方面。进攻主要包括了射门控球率，传球，传球成功率，盘带过人，触球，角球，越位，失去控球权，防守，铲球（尝试铲球），抢球，空中对抗胜利。拦截主要包括了解围，封堵，扑救，犯规。

在我们建立动态类型的模型时，我们为每场比赛加上评价等级标签，通过数据处理来量化比赛类型的特征。通过机器学习来估计出变量间两两相关性。特征装箱 降为思想 PCA(Principal Component Analysis) 用One-Hot编码 --> 哑变量 维度增加 主客场，（讲了啥我又忘了，自己写吧TT 我只是个关键词记录者）



相关性分析

交叉验证

5.3 model 3

一次成功的团队合作离不开结构策略。作为一名成功的教练应该具备较好的统筹规划，协调合作，人员安排能力。我们认为，具体的结构策略应该体现在以下几个方面：球员位置安排。。。

一次成功的团队合作离不开金牌球员的贡献，金牌球员应该是一名传球效率高，进球能力强（会不会过于绝对？补充）的球员，他在队中能很好地起到连接比赛的作用。为了寻找哈士奇球队的金牌球员，我们。。。。。

同样的，选择默契度高的小分队有利于提高传球和进球的效率。默契度高的小组往往配合能力较强，有助于比赛的成功。由第一题中单次传球的价值评价表和第二题中球员传球次数图（？名字不准确），建立。。。模型，由。。。。分析可知，。。。为金牌球员。

主客场因素也是必须要考虑的，有的球员适应性较强，在主场和客场都能较好的发挥出原有的水平，我们称之为适宜性强的选手。而有些适应性较差的球员只在主场发挥出原有的水平，甚至有时会超常发挥，环境对他的表现有较大的影响，在客场时，环境的变化有较大可能会使他不能发挥出原有水平。那么在主客场时，应该安排不同的球员上场。通过统计。。。。我们得出。。。适合安排在主场，。。。适合安排在客场。

球员的耐力也是决策时应该考虑的因素，有些球员耐力强，整个赛季的出席率可以达到百分之九十以上，而有些球员的耐力较差，整个赛季的出席率大致只有百分之五十（猜的），在单场比赛中出场时间。。。。。

此外，替补球员。。

球运动轨迹不能模拟？



