MAT4MDS **Comprehension task, Term 2, 2025**

Due date for draft presentation (pdf format) 23:59 on Wednesday, March 26 (Week 4).
Due date for the final presentation (pdf of PowerPoint slides + video presentation) 23:59 on Monday, April 7 (the first day of week 6).

Dominance matrices in AFL **Do they actually work?**

Objectives

The method of the so-called dominance matrices is a simple mathematical tool that allows to rank teams in a round-robin tournament when not all teams have played each other. Before attempting this project, read the article by Roger Walter Dominance Matrices: Your Secret Weapon in Footy Tipping and watch tree videos about dominance matrices available in week 2 (topic 3). The purpose of this project is to determine the degree of reliability of the dominance matrix method using historical AFL data which is freely available online, e.g. on `www.footywire.com`.

Detailed project description

Historical AFL data is obtained from `www.footywire.com`. Consider the 2022 season as an example. In that year Geelong Cats became champions, defeating Sydney Swans in the Grand Final. The AFL footy ladder after all 23 rounds is given in Fig. 1.

2022 AFL Season Ladder sorted by Premiership Points

Position	Team	Played	Win	Loss	Draw	%Won	Points	For	Against	Percentage	Movement	Streak
1	Geelong Cats	22	18	4	0	81.82%	72	2146	1488	144.22%	+0	Won 13
2	Melbourne Demons	22	16	6	0	72.73%	64	1936	1483	130.55%	+1	Won 2
3	Sydney Swans	22	16	6	0	72.73%	64	2067	1616	127.91%	-1	Won 7
4	Collingwood Magpies	22	16	6	0	72.73%	64	1839	1763	104.31%	+1	Won 1
5	Fremantle Dockers	22	15	6	1	70.45%	62	1739	1486	117.03%	+1	Won 3
6	Brisbane Lions	22	15	7	0	68.18%	60	2147	1799	119.34%	-2	Lost 1
7	Richmond Tigers	22	13	8	1	61.36%	54	2165	1780	121.63%	+0	Won 4
8	Western Bulldogs	22	12	10	0	54.55%	48	1973	1812	108.89%	+1	Won 2
9	Carlton Blues	22	12	10	0	54.55%	48	1857	1714	108.34%	-1	Lost 4
10	St Kilda Saints	22	11	11	0	50.00%	44	1703	1715	99.30%	+0	Lost 3
11	Port Adelaide Power	22	10	12	0	45.45%	40	1806	1638	110.26%	+0	Won 2
12	Gold Coast Suns	22	10	12	0	45.45%	40	1871	1820	102.80%	+0	Won 1
13	Hawthorn Hawks	22	8	14	0	36.36%	32	1787	1991	89.75%	+0	Lost 2
14	Adelaide Crows	22	8	14	0	36.36%	32	1721	1986	86.66%	+0	Lost 1
15	Essendon Bombers	22	7	15	0	31.82%	28	1737	2087	83.23%	+0	Lost 3
16	GWS Giants	22	6	16	0	27.27%	24	1631	1927	84.64%	+0	Lost 2
17	West Coast Eagles	22	2	20	0	9.09%	8	1429	2389	59.82%	+0	Lost 8
18	North Melbourne Kangaroos	22	2	20	0	9.09%	8	1337	2397	55.78%	+0	Lost 5

Figure 1: 2022 AFL footy ladder after 23 rounds.

All 2022 AFL fixtures with the final score for each match can be found in the file

`AFL_Fixture_2022.pdf`

or under the link: `https://www.footywire.com/afl/footy/ft_match_list?year=2022`.

Our goal is to see if the dominance matrix method applied to the 2022 season after a certain number of rounds $m < 23$ will give similar team rankings, as the actual AFT footy ladder after 23 rounds in Fig. 1. In these 23 rounds each out of 18 teams played 22 games, some teams played with each other twice.

By preparing your report proceed as follows:

- Choose several values of m (at least three), such that $10 \leq m < 23$. For example, $m = 13, 15, 18, 20$.
- Use the data in

  `AFL_Fixture_2022.pdf`

  to create an 18×18 dominance matrix $D(m)$ for each value of m that you have chosen. For constructing dominance matrices $D(m)$ you have a choice between the win-loss records method described on page 8 by Roger Walter article or the ratio-scores method described on page 9. If you choose the ratio score matrices, to construct $D(m)$ use the scores of each fixture **up to round** m **and including round** m (but NOT only round m) described in the article by Roger Walter on page 9. If you choose the win-loss records dominance matrices then use the win-loose points of each team **up to round** m **and including round** m (but NOT only round m) giving **4 points for a win, 0 point for a loss and 2 points for a draw**.
  When creating the dominance matrix, use the same order of teams as in the actual AFL ladder in Fig. 1. In other words, Geelong Cats is team 1, Melbourne Demons is team 2, Sydney Swans is team 3, etc. In this way, for example for $m = 11$, for **ratio-scores matrix** $D(11)$ you will have $D(11)_{1,14} = 97/55$ and $D(11)_{14,1} = 55/97$, because Geelong Cats defeated Adelaide Crows $97-55$ in round 11. Besides this $D(11)_{1,15} = 138/72$ and $D(11)_{15,1} = 72/138$, because Geelong Cats defeated Essendon Bombers $138-72$ in round 1. On the other hand, $D(11)_{1,8} = 0$ and $D(11)_{8,1} = 0$, because Geelong Cats played against Western Bulldogs (team 8) only in round 12, and, therefore, this result was not available after round 11, when the dominance matrix is constructed. In case when for some m two teams played with each other twice, think about what score ratio or win-lose points would be the best to be used in the matrix D(m) (you may experiment with a few options, for example consider only the first result, only the second result, the average between two results. Alternately you are welcome to use your own ideas).
- After the dominance matrix $D(m)$ is constructed for the chosen values of m, calculate the predicted team rankings using the formulae

$$\boldsymbol{r} = \boldsymbol{r}_1 + 0.5\boldsymbol{r}_2,$$

  where the first order ranking $\boldsymbol{r}_1$ is

$$\boldsymbol{r}_1 = \boldsymbol{D}(m)\mathbf{1} - (\boldsymbol{D}(m))^T\mathbf{1}$$

  and the second-order ranking $\boldsymbol{r}_2$ is

$$\boldsymbol{r}_2 = (\boldsymbol{D}(m))^2\mathbf{1} - ((\boldsymbol{D}(m))^2)^T\mathbf{1}.$$

  Explain in your own words the meaning of $\boldsymbol{r}_1$, $\boldsymbol{D}(m)^2$, $\boldsymbol{r}_2$.

- Compare the predicted team rankings $\boldsymbol{r}$ with the actual AFL ladder after 23 rounds in Fig. 1. Which teams have been ranked correctly? Discuss the results. Can the results be logically explained?
- What is in you case the smallest value of m such that the dominance matrix method gives the correct prediction for the most number of teams.
- Based on your results comment on the reliability of the considered dominance matrix method. Would you trust this method early in the season?
- Attempt to determine the best possible formula for predicting the true ranking for the end of the season. In doing so consider experimenting with the following parameters:
  - changing the weights for the first and the second order rankings r_1 and r_2;
  - extending the formula by adding higher order rankings;

  You are also welcome to use your owns ideas for finding the best possible formula for predicting the true ranking.
- **If you work in a team** of two or three, conduct the analysis **for both methods** described above of constructing dominance matrices. Compare and discuss the obtained results.

Your report is to be prepared and presented as if you are a consultant. This means that you must present your findings in as persuasive a way as possible, explaining the reasons for every technical choice you made. There may be some choices that are good under different circumstances, but bad for this circumstance (or vice versa). You should choose between them and explain your choice. At the start of your presentation you must explain the idea of the method including the meaning and purpose of $r_1, D(m)^2$, r_2 and all related concepts. A dominance matrix D(m) needed to be included in the presentation for a least one value of m.

There are two parts to the assessment submission:

Part A: You can work individually or in group of either two or three to prepare a "PowerPoint" style report. This should be submitted as a pdf of up to 6 pages/slides (1 person)+title page, 8 pages/slides (2 people)+title page or 10 pages/slides (3 people)+title page. An overall higher standard will be expected from larger groups than individuals. **The title page must include the names of group members**.

Part B: You must work individually to prepare a video in which you explain your (or your group's) predictions and choices. You should record yourself talking over the screen share of your report using zoom or a similar tool. The video recording must show you. This recording must be **no longer than 6 minutes**. The report you screen share must match your submitted pdf.
The video recording must show you at the start. You have to introduce yourself and show your id card to the camera (Student Id or Driving license or similar), so that it will be possible to recognise your photo and your Name on the card.
If you do the analysis and slides in a group, each group member is required to submit a presentation and a video individually, presenting and discussing the results. You must mention the names of all group members at the beginning of the video. The project will be graded individually.

All other detailed instructions for presentation and video including the marking guide can be found here: `https://lms.latrobe.edu.au/mod/page/view.php?id=7876161`.