



Scouting Database

by

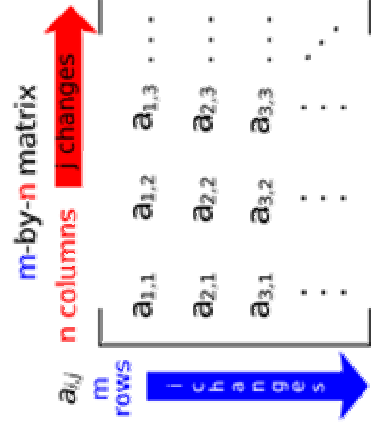
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Quick Tutorial in Matrices

In mathematics, a matrix (plural matrices) is a rectangular table of elements (or entries), which may be numbers or, more generally, any abstract quantities that can be added and multiplied. Matrices are commonly used to describe linear equations.



The horizontal lines in a matrix are called rows and the vertical lines are called columns. A matrix with m rows and n columns is called an m -by- n matrix (written $m \times n$) and m and n are called its dimensions. The dimensions of a matrix are always given with the number of rows first, then the number of columns.



Quick Tutorial in Matrices

Matrix addition

$$\begin{bmatrix} 1 & 3 & 1 \\ 1 & 0 & 0 \\ 1 & 2 & 2 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 5 \\ 7 & 5 & 0 \\ 2 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 1+0 & 3+0 & 1+5 \\ 1+7 & 0+5 & 0+0 \\ 1+2 & 2+1 & 2+1 \end{bmatrix} = \begin{bmatrix} 1 & 3 & 6 \\ 8 & 5 & 0 \\ 3 & 3 & 3 \end{bmatrix}.$$

Matrix multiplication

$$\begin{bmatrix} 1 & 0 & 2 \\ -1 & 3 & 1 \end{bmatrix} \times \begin{bmatrix} 3 & 1 \\ 2 & 1 \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} (1 \times 3 + 0 \times 2 + 2 \times 1) & (1 \times 1 + 0 \times 1 + 2 \times 0) \\ (-1 \times 3 + 3 \times 2 + 1 \times 1) & (-1 \times 1 + 3 \times 1 + 1 \times 0) \end{bmatrix} = \begin{bmatrix} 5 & 1 \\ 4 & 2 \end{bmatrix}.$$

 2×3
 3×2
 2×2

$$\begin{bmatrix} 1 & 0 & 2 \\ -1 & 3 & 1 \end{bmatrix} = \begin{bmatrix} (1 \times 3 + 0 \times 2 + 2 \times 1) & (1 \times 1 + 0 \times 1 + 2 \times 0) \\ (-1 \times 3 + 3 \times 2 + 1 \times 1) & (-1 \times 1 + 3 \times 1 + 1 \times 0) \end{bmatrix} \begin{bmatrix} 3 & 1 \\ 2 & 1 \\ 1 & 0 \end{bmatrix}$$



Quick Tutorial in Matrices

The following is a system of equations with two equations and two unknowns.

$$2x + 5y = 16$$

$$x + 3y = 9$$

This can be rewritten in matrix form

$$\begin{bmatrix} 2 & 5 \\ 1 & 3 \end{bmatrix} \begin{Bmatrix} x \\ y \end{Bmatrix} = \begin{Bmatrix} 16 \\ 9 \end{Bmatrix}$$
$$\begin{Bmatrix} x \\ y \end{Bmatrix} = \begin{bmatrix} 3 & -5 \\ -1 & 2 \end{bmatrix} \begin{Bmatrix} 16 \\ 9 \end{Bmatrix}$$
$$= \begin{Bmatrix} 3 \\ 2 \end{Bmatrix}$$



Offensive Power Rating

From the Chief Delphi forum, the earliest I found the use of the term Offensive Power Rating (OPR) was by Scott Weingart (“sw293”) in his April 2006 posting. I think he first coined this term OPR and explained how it is calculated in the Chief Delphi post: <http://www.chiefdelphi.com/forums/showpost.php?p=484220&postcount=19>

Karthik Kanagasabapathy from Team 1114 did the same calculation and called it Calculated Contribution. It seems that he had been using that number even before April 2006 but never published it until 2008.

“Bongle” from Team 1281 and Guy Davidson from Team 5 implemented the calculation of OPR from “sw293” and published a lot of results on Chief Delphi before the Championship in 2008.



How to Calculate OPR?

Assume team i , j and k are three teams in an alliance and they scored p points in that match. Then we can write

$$x_i + x_j + x_k = p, \text{ where } x_i \text{ is the score contributed by team } i$$

Assume team i played with team m and n in another alliance and they score q points in that match. Then we can write

$$x_i + x_m + x_n = q$$

If we add all the matches that team i was involved in, we get

$$2x_i + x_j + x_k + x_m + x_n = p + q = B_i$$

If we put them in row i of an $N \times N$ matrix A , where N is the total number of teams in that regional, and repeat that for each team, we get



How to Calculate OPR?

$$2x_i + x_j + x_k + x_m + x_n = p + q = B_i$$

$$\begin{array}{c}
 \begin{matrix} i & j & k & l & m & n \end{matrix} \\
 \begin{bmatrix} 2 & 1 & 1 & 0 & 1 & 1 \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 1 & 1 \end{bmatrix}
 \end{array}
 \begin{Bmatrix} x_i \\ x_j \\ x_k \\ x_l \\ x_m \\ x_n \end{Bmatrix}
 =
 \begin{Bmatrix} B_i \\ B_j \\ B_k \\ B_l \\ B_m \\ B_n \end{Bmatrix}$$

$$[A]\{x\} = \{B\}$$



How to Calculate OPR?

Since the matrix A is symmetric and positive definite, we can use Cholesky decomposition to solve for x . The result x is the contribution of each team to each of their alliance. The number is known as the Offensive Power Rating of each team.



A Proposed New Method

The drawback of the Offensive Power Rating is that it completely ignores the contribution of defense. Jay Lundy from Team 254 has proposed another method that takes into account both defense and offense. Please refer to Chief Delphi post <http://www.chiefdelphi.com/forums/showpost.php?p=733759&postcount=160>

However it will result in a rectangular matrix which is harder to solve. Also the offense and defense numbers may be hard to interpret.

Hence I am proposing a new method that takes into account both offense and defense directly and still have a symmetric and positive definite matrix.



A Proposed New Method

Once you understand how to calculate OPR, it is fairly simple to calculate this new rating. It is based on the winning margin of each match rather than the points scored. So instead of adding up all the points of all the matches and put into B_i , you add up all the winning margins and put into B_i . I call this new rating CCWM which simply stands for Calculated Contribution to Winning Margin.

Notice that some teams have negative CCWM and if you add up all the CCWM of all the teams in the regional, you will get zero.



A Proposed New Method

This CCWM gives credit to teams that play good defense. In games where your team's Match Ranking Points is based on your opposing alliance's score, this should still be valid since you want to score as many points as possible. The only time it does not work is if your team is allowed to intentionally score points for your opponents' alliance. Even so, this does not occur very often unless there is a very big lead and you know you will win for sure. However in a two minutes game, after establishing a big lead, the amount of time left to intentionally score points for your opponent is limited.



Comparison between OPR and CCWM

Using 2008 Regional data, I found that CCWM is as good as OPR in terms of predicting the outcome of the elimination matches.

CCWM seems to correlate better than OPR in terms of actual teams selected as alliances even though there are many factors that affect how teams are selected.

For a game like the one in 2008 where there are only two balls to hurdle and the third team can either run laps to score points or play defense, the first pick should probably be one who can score as many points as possible. Hence OPR can be a good criteria. For the second pick, I think that using CCWM will have a better chance than using OPR to unearth a gem that is overlooked by other teams.

My conclusion is OPR and CCWM both have advantages and disadvantages. It depends on the game and how the match ranking points are scored.



Scouting Database

The user interface of the database I developed looks similar in format with Karthik's database from Team 1114. I chose to make it look and feel similar not just because Karthik did a good job in designing it. I did it because a lot of people are already using it and familiar with that format. Underneath that skin, everything was developed independently. Here are a number of differences.

- 1) The color scheme is changed to blue because it is our school color.
- 2) The pick order in the alliance selection is calculated instead of relying on information from teams who were there to minimize error.
- 3) Each team can have only one world ranking based on their best performance instead of multiple world ranking based on multiple regional events.
- 4) A picture is added instead of information on other awards.
- 5) Both CCWM and OPR are reported.
- 6) Also contains sortable table of results of all teams that can be filtered.



Scouting Database

Karthik Kanagasabapathy (Team 1114)

Team Number	217	Full Name	Ford Motor Company/FANUC Robotics America/B&K Corporation & Utica Community Schools
		Nick Name	ThunderChickens
		Location	MI, USA
		Division	Galileo
		Regional 1	St. Louis Regional
		Regional 2	Detroit Regional
		Regional 3	Great Lakes Regional
		Finish 1	Regional Winner
		Finish 2	Regional Winner
		Finish 3	Finalist
		Record 1	6-2-1
		Record 2	8-2-0
		Record 3	5-3-0
		Seed 1	6 88.9%
		Seed 2	3 93.8%
		Seed 3	16 76.2%
		Draft Position 1	1st pick
		Draft Position 2	1st pick
		Draft Position 3	1st pick
		Average Offensive Score 1	57.1
		Average Offensive Score 2	70.0
		Average Offensive Score 3	77.8
		Calculated Contribution 1	31.6
		Calculated Contribution 2	44.0
		Calculated Contribution 3	50.7
		Team	
		Regional Rank	6
		Regional Percentile	88.9%
		Champs Rank	96
		Champs Percentile	81.9%
		World Rank	127
		World Percentile	93.5%
		Regional Rank	1
		Regional Percentile	100.0%
		Champs Rank	28
		Champs Percentile	94.9%
		World Rank	29
		World Percentile	98.5%
		Regional Rank	5
		Regional Percentile	93.7%
		Champs Rank	11
		Champs Percentile	98.1%
		World Rank	11
		World Percentile	99.5%
		Regional Rank	3
		Regional Percentile	95.6%
		Champs Rank	82
		Champs Percentile	84.6%
		World Rank	103
		World Percentile	94.7%
		Regional Rank	1
		Regional Percentile	100.0%
		Champs Rank	23
		Champs Percentile	95.8%
		World Rank	24
		World Percentile	98.8%
		Regional Rank	1
		Regional Percentile	100.0%
		Champs Rank	9
		Champs Percentile	98.5%
		World Rank	9
		World Percentile	99.6%

Enter the team number here. Do not modify any other cells.

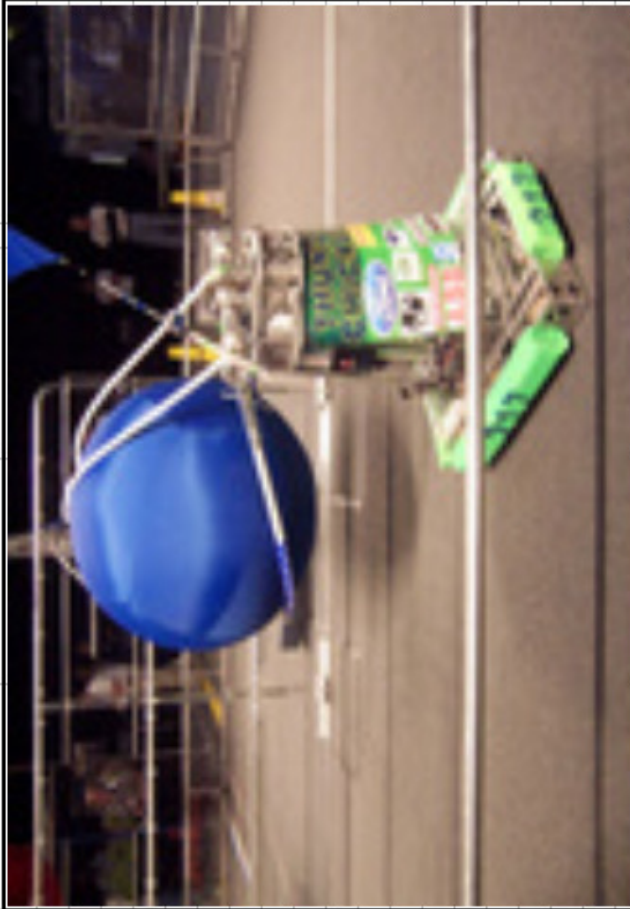


Team 2834



Bloomfield Hills
Andover High School

Scouting Database

Team Number	Ford Motor Company/FANUC Robotics America/B&K Corporation & Utica Community Schools													
217	Nick Name		ThunderChickens		Location		Sterling Heights, MI, USA		Division					
Enter the team number here.	Regional 1		StLouis											
	Regional 2		Detroit											
	Regional 3		GreatLakes											
	Regional 4		Galileo											
	Finish 1		Regional Winner											
	Finish 2		Regional Winner											
	Finish 3		Finalist											
	Finish 4		Regional Winner											
	Record 1		(6-2-1)											
	Record 2		(8-2-0)											
	Record 3		(5-3-0)											
	Record 4		(5-2-0)											
	Seed 1		6 of 45											
	Seed 2		3 of 32											
	Seed 3		16 of 63											
	Seed 4		12 of 86											
Alliance 1		# 1 pick												
Alliance 2		# 1 pick												
Alliance 3		# 1 or 16 pick												
Alliance 4		# 1 or 16 pick												
														
CCWM World Rank	Average Winning Margin Per Match		Calculated Contribution to Winning Margin		CCWM Regional Rank		Average Score Per Match		Offensive Power Rating		OPR Regional Rank		OPR World Rank	
23	7.3		26.7		3		19.0		31.6		3		14	
out of	10.8		37.1		1		23.3		44.0		1			
1498	7.9		23.6		4		25.9		50.7		1		out of	
	4.7		6.3		33		27.0		32.8		17		1498	

Enter the team number here.

[illegible]