Scouting Database

by

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Outline

Background

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Proposed new method of ranking teams

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Enhancements since last year

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Background

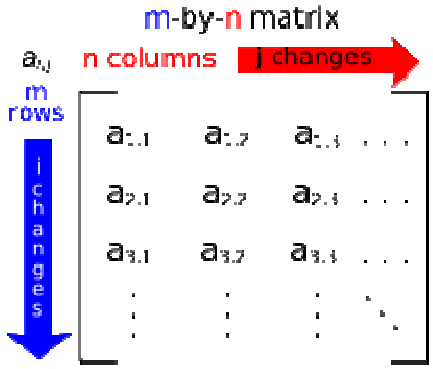
Purpose of the scouting database

Software platform used

Improve how teams are ranked to help in alliance selection

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 × 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

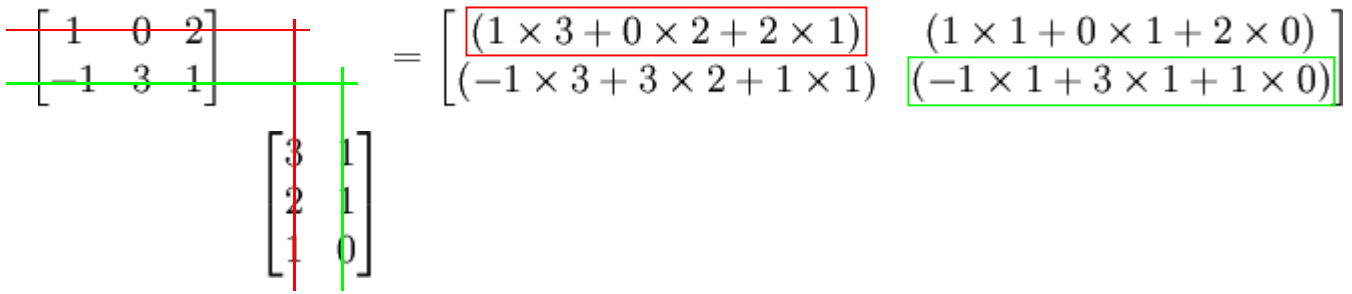
Matrix addition

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

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 x 3 3 x 2 2 x 2



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. He first published it in 2008.

"Bongle" from Team 2702 and Guy Davidson from Team 8 implemented the calculation of OPR from "sw293" and published a lot of results on Chief Delphi before the Championship in 2008.

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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

$$x_i + x_j + x_k = p$$, where x_i 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 x 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?

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

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

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

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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.

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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.

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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.

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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.

A Note on DPR and PMR

At around the same time that I developed CCWM, other people have proposed calculating DPR which stands for Defensive Power Rating and PMR which stands for Plus/Minus Rating. These were proposed by a number of people but made popular by “Bongle”.

DPR is calculated similar to OPR except the vector B is the sum of all the opposing alliances’ scores instead of your alliances’ scores. PMR can be calculated by subtracting DPR from OPR.

Jesse Knight of Team 1885 was the first to notice that CCWM and PMR are numerically identical and he verified it with his program. Subsequently, I published a proof why they are numerically the same at
http://www.chiefdelphi.com/forums/showpost.php?p=835222&postcount=48

Hence DPR = OPR - CCWM

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The Interpretation of OPR

OPR does not predict what a team (robot and human player) can score. It is the calculated contribution by that team on average to all the matches they were involved in to their alliance partners. A team that has high OPR score means that every time they are on the field, good things happen to that alliance meaning high score. Some of the possibilities are:

1) their robot score a lot of points
2) their human player score a lot of points
3) their presence allow their alliance partners to score a lot of points which they don't normally do as well.
4) they have on average stronger partners and weaker opponents by the luck of the draw than other teams.

A low OPR is just the opposite.

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The Interpretation of CCWM

CCWM is the calculated contribution to the winning margins of the matches the team was involved in. A negative CCWM means the team is a liability to their partners. A team with negative CCWM should not be picked as alliance partners.

A team that has high CCWM means that every time they are on the field, good things happen to that alliance and in this case it means winning by a big margin. Some of the possibilities are:

1) they score more points on others than others score on them
2) their presence allow their alliance to score more points on others than others score on them. This could be from playing defense or help pin an opposing robot so their alliance partner can score more.
3) they do not incur much penalties.
4) they have on average stronger partners and weaker opponents by the luck of the draw than other teams.

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) – 2008 version

Team Number	217

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

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		

Awards 1	GM Industrial Design Award
Awards 2	GM Industrial Design Award
Awards 3	GM Industrial Design Award

	Team	Regional	Regional Rank	Regional Percentile	Champs Rank	Champs Percentile	World Rank	World Percentile
Average Offensive Score 1	57.1	41.4	6	88.9%	96	81.9%	127	93.5%
Average Offensive Score 2	70.0	44.3	1	100.0%	28	94.9%	29	98.5%
Average Offensive Score 3	77.8	47.4	5	93.7%	11	98.1%	11	99.5%
Calculated Contribution 1	31.6	13.8	3	95.6%	82	84.6%	103	94.7%
Calculated Contribution 2	44.0	14.8	1	100.0%	23	95.8%	24	98.8%
Calculated Contribution 3	50.7	15.8	1	100.0%	9	98.5%	9	99.6%

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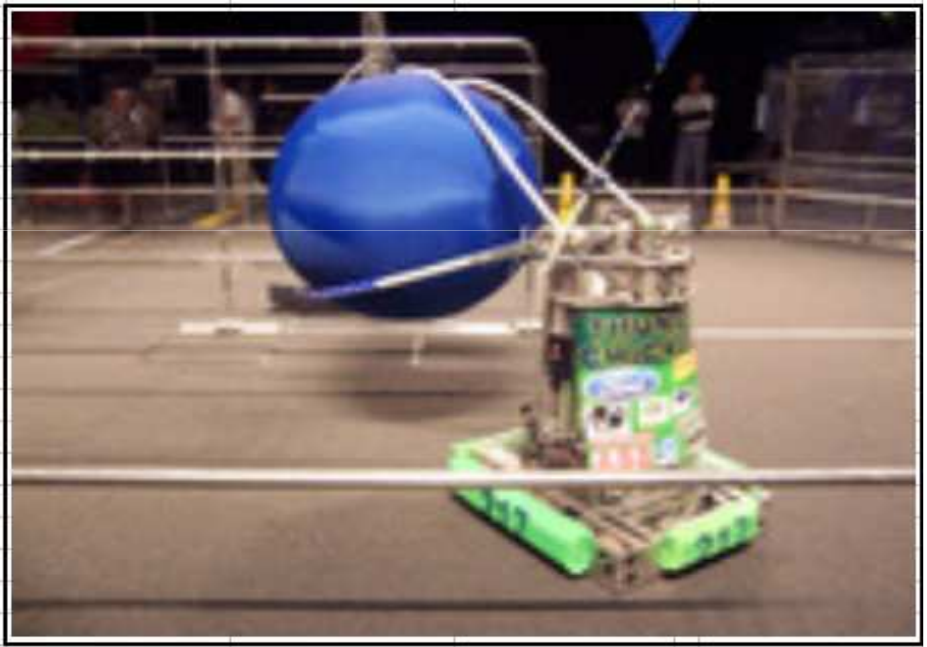
Scouting Database

Team Number	Full Name	Ford Motor Company/FANUC Robotics America/B&K Corporation & Utica Community Schools		
217	Nickname	ThunderChickens		
	Location	Sterling Heights, MI, USA	Division	Galileo

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	Regional 1	7.3	26.7	3	19.0	31.6	3	14
	Regional 2	10.8	37.1	1	23.3	44.0	1	
out of	Regional 3	7.9	23.6	4	25.9	50.7	1	out of
1498	Regional 4	4.7	6.3	33	27.0	32.8	17	1498

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Scouting Database

# of Events	# of Wins	Location	Team Name	Nickname	Team #	OPR Rank	Best OPR	Championship Division	BAE	Midwest	NewJersey	Oregon	StLouis	Pheonix	FingerLakes	Kansas	VCU	SanDiego	Boilermaker	Brazil	Chesapeake	Connecticut	Detroit	Florida	Peachtree	Pittsburg	SiliconValley	Wisconsin	Buckeye	Lonestar	LosAngeles	Microsoft	Oklahoma	Sacramental	Waterloo	WestMI	Israel	Bayou	Boston	Colorado	GreatLakes	Toronto	Hawaii	LasVegas	Minnesota	Palmetto	Philadelphia	LongIsland	NewYork	Archimedes	Curie	Galileo	Newton
					sort	sort			48	42	63	55	45	52	40	55	64	49	40	13	60	62	32	61	45	36	48	60	46	46	51	31	39	37	30	53	36	46	51	42	63	66	37	42	54	36	44	46	64	85	84	86	85
2	0	Por	The	The	1	161	27.7	Archim					14										28																												11			
2	0	Lak	Mill	Tea	4	1242	2.9	Curie																							-6												3							1		
1	0	Mel	For	Rot	5	197	25.0	Newto															4																														25
1		Bal	Loc	Tea	7	1208	3.7														4																																
3	0	Pal	TIB	The	8	635	13.1	Galilec				9															7																	13							4	
1		Chi	Roc	Roc	9	243	23.3			23																																										
2	1	Fla	Giv	MO	11	41	41.1	Archim			3										23																														41			
2	1	Mo	Bax	Bor	16	45	39.7	Curie		28																												38													40		
2	2	Cliff	Hos	The	20	28	44.9	Newto							40																								35														45
1		Titu	ASI	Cor	21	474	16.2																	16																														
2	1	Nor	Bris	Rai	25	18	48.8	Galilec			35																																	42								49	
2	0	Cla	The	Tea	27	24	46.3	Archim															12																			42								46		
1		Sag	PIE	Mis	28	1261	2.5																																								2					
1		Jen	AEI	Prir	31	725	11.5																										12																			
3	0	Aut	The	Kill	33	51	38.6	Curie		24																										37					39								18		
2		Ath	Cor	Roc	34	659	12.8																		13													13														
2	2	Gilt	Ger	The	39	13	52.7	Newto						34																													53									47
2	2	Mai	inte	Che	40	16	49.7	Galilec	25																														50												36	
2	1	Wa	AN/	Wa	41	107	31.3	Archim			24																																						31	22			
1		Hud	Dar	P.A	42	593	13.9		14																																											
2	0	Kok	Del	Tec	45	80	34.5	Curie					20						27																																35		
2	0	Por	Del	Chi	47	55	38.4	Newto															27																			37										38
3	0	Wa	Del	Del	48	263	22.5	Galilec		20																14			23																						11	
2	0	Sag	Dow	Rot	49	852	9.5	Archim															10															8												6		
1		Gre	Ele	Are	53	801	10.3														10																																
2		Bou	Eth	Rot	56	297	20.9																	21																										15			
2	1	Hou	Exx	Leo	57	303	20.7	Curie						9																21																					18		
1		Sou	Fail	Rio	58	110	31.0		31																																												
1		Mia	Mia	Rar	59	1280	2.1																	2																														
2	1	Kin	Lar	Bio	60	267	22.1	Newto						22																													10										22
2		Upt	EM	Shi	61	135	29.2															27																		29													
2		Erie	GE	The	63	1142	4.9																			-5															5											
2	0	Por	GM	The	65	127	29.7	Galilec							15																											30										8	
2	0	Yps	Ger	The	66	246	23.1	Archim																												13					20								23			
2	1	Milf	Ger	The	67	3	64.2	Curie							43																											41									64		
3	0	Por	Ger	T3	68	250	23.0	Newto							16																				18							23										21
2		Qui	P&(	Tea	69	40	41.1																	26															41													
3	0	Goo	Ger	Mor	70	172	27.2	Galilec					27																							26				24										15	
2	1	Har	Bea	Tea	71	31	44.0	Archim		22																										35														44			

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Enhancements

- Different ways to report rank data (available)
- Match Query with customized fields (beta test)
- Alliance Selection (beta test)
- Scouting List (available if there is interest)