Tableau for Robotics: Creating Heat Maps

HEAT MAPS ARE AWESOME

Of all the analytics that a team can use, heat maps are some of the most impressive and utilitarian tools. Put simply, a heat map for scouting is way of graphically superimposing a robot's shooting locations onto a map of the field. If you show your alliance exactly where your opponents shoot from, even a drive team with no training in reading the visualization will play much better defense.

On paper, some alliances look amazing, with all three robots scoring huge points each match. But many times, these "super" alliances get tangled by shooting from the same location. An alliance captain that takes shooting location into account when picking partners can avoid these problems and create a much more efficient alliance.

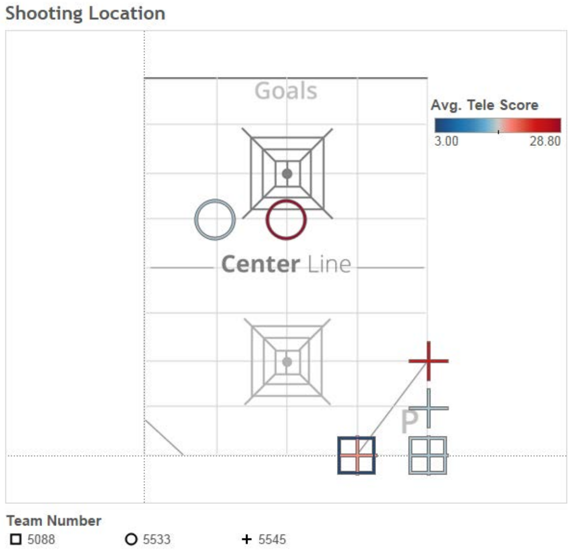
The previous Tableau whitepapers assumed a game that has a small number of goals with a lot of area to shoot from, but different game types require different graphs and different ways to collect the data. Therefore, we are going to look at the heatmaps and how to make them with each common type of game.

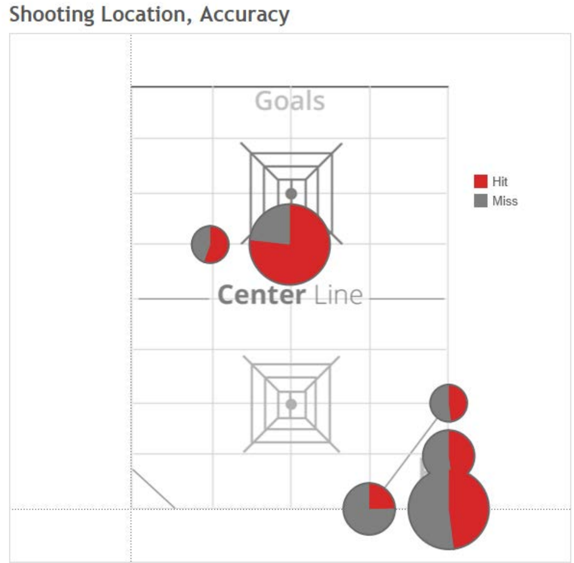
PREVIOUS GAME SCENARIO

Small number of goals with a protected area to shoot from (e.g., 2012, 2013)

These games have a location to shoot from where a defensive bot cannot physically touch a robot. This does not mean that defense is impossible, though. Instead of pushing a robot out of its favorite location, you can park a robot in front of it in the protected zone. Also, because robots are always guaranteed not to be disturbed during shooting, few drivers are used to shooting from different locations. Because of these factors, knowing which protected zone opponents shoot from should be the primary goal of your location collection.

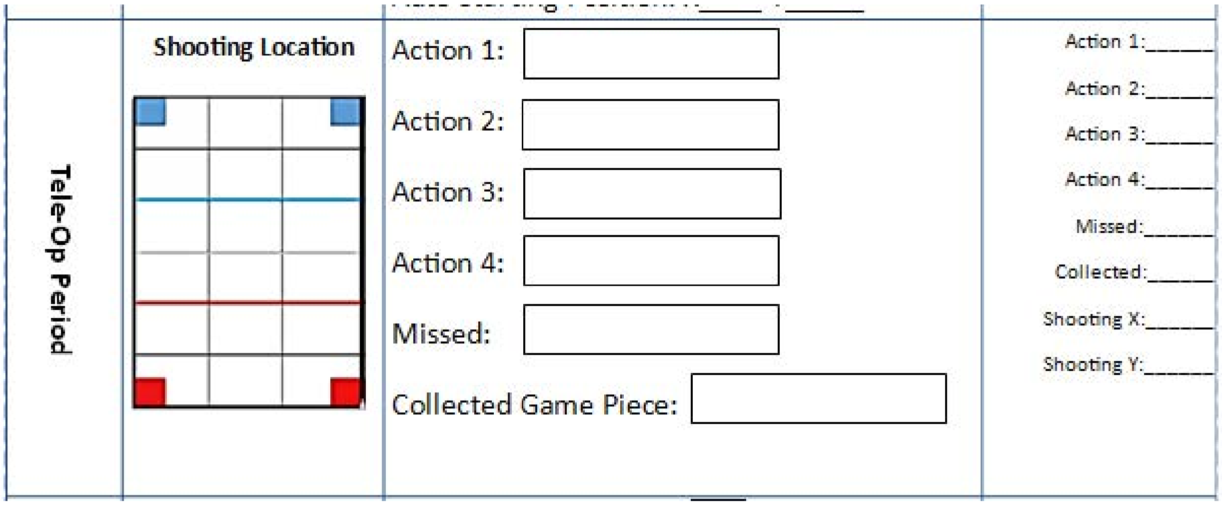
Analysis: The type of heat map that is most useful in this game can be called a "sticky" heat map. A sticky heat map rounds each shooting location to a point in a grid. This way, overlapping shooting locations can be seen easier. Additionally, it is possible to show accuracy directly on the heatmap when the data is rounded this way.





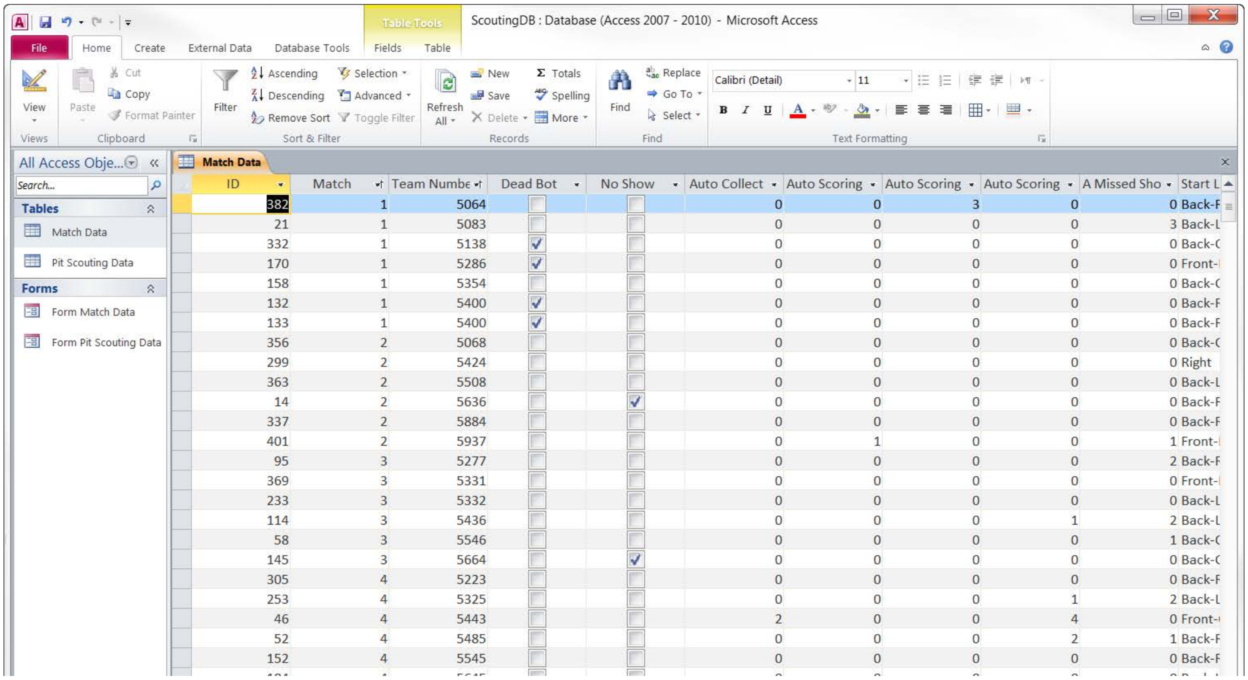
Here are two different heat map variants for this game type. On the left map, the locations are broken apart by team number so the overlapping positions can be easily seen. In this match, both 5533 and 5545 shoot from the same location, so by blocking that location you can shut down two teams. The right graph instead shows accuracy at each location. Knowing locations where teams are less accurate can be a good tie breaker for two locations with a similar number of points scored.

Data collection: Collecting shooting location in these games can be most efficiently done with a grid with coordinates.



If a bot shoots from the same location, only one area per match needs to be collected.

Data storage: Because there is only one shooting location per record, all of the information can be stored on a single table. Along with the normal scouting data, we simply add two columns, one for each coordinate of the shooting location.



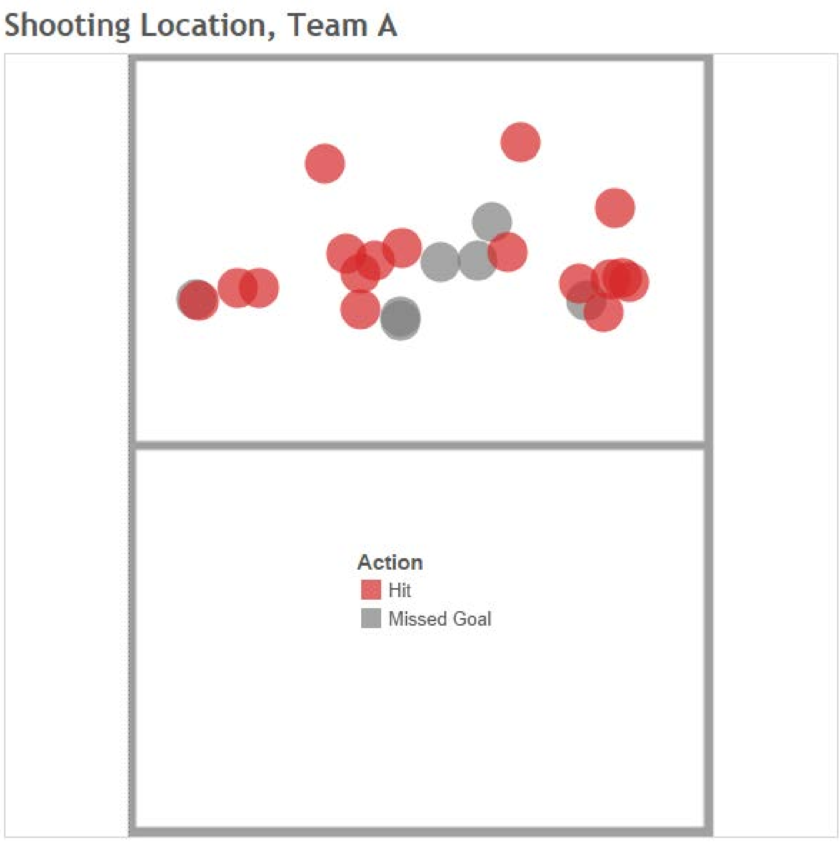
ID	Match	Team Numbe	Dead Bot	No Show	Auto Collect	Auto Scoring	Auto Scoring	Auto Scoring	A Missed Sho	Start L
382	1	5064	☐	☐	0	0	3	0	0	Back-F
21	1	5083	☐	☐	0	0	0	0	3	Back-L
332	1	5138	☑	☐	0	0	0	0	0	Back-C
170	1	5286	☑	☐	0	0	0	0	0	Front-
158	1	5354	☐	☐	0	0	0	0	0	Back-C
132	1	5400	☑	☐	0	0	0	0	0	Back-F
133	1	5400	☑	☐	0	0	0	0	0	Back-F
356	2	5068	☐	☐	0	0	0	0	0	Back-C
299	2	5424	☐	☐	0	0	0	0	0	Right
363	2	5508	☐	☐	0	0	0	0	0	Back-L
14	2	5636	☐	☑	0	0	0	0	0	Back-F
337	2	5884	☐	☐	0	0	0	0	0	Back-F
401	2	5937	☐	☐	0	1	0	0	1	Front-
95	3	5277	☐	☐	0	0	0	0	2	Back-F
369	3	5331	☐	☐	0	0	0	0	0	Front-
233	3	5332	☐	☐	0	0	0	0	0	Back-L
114	3	5436	☐	☐	0	0	0	1	2	Back-L
58	3	5546	☐	☐	0	0	0	0	1	Back-C
145	3	5664	☐	☑	0	0	0	0	0	Back-C
305	4	5223	☐	☐	0	0	0	0	0	Back-F
253	4	5325	☐	☐	0	0	0	1	2	Back-L
46	4	5443	☐	☐	2	0	0	4	0	Front-
52	4	5485	☐	☐	0	0	0	2	1	Back-F
152	4	5545	☐	☐	0	0	0	0	0	Back-F

PREVIOUS GAME SCENARIO

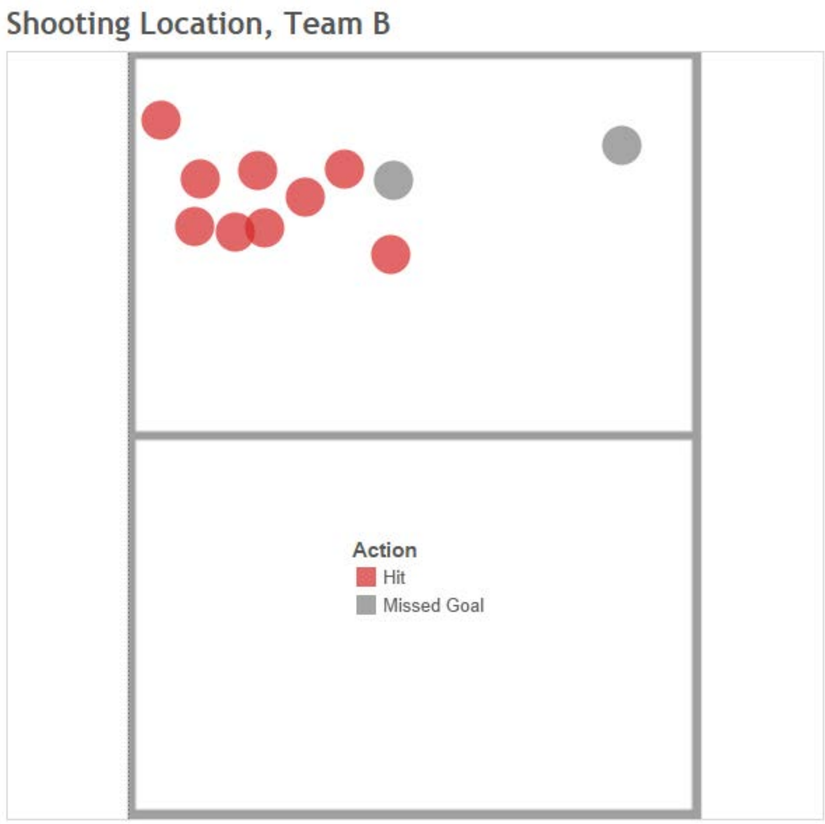
Small number of goals with a large area to shoot from (e.g., 2006, 2010, 2014)

Because these games have no safe zones, robots have to be able to shoot from different locations to adjust for potential defense. Defending in this game mode is possible by pushing other robots around and out of their comfortable shooting locations. Because teams should anticipate defense, effective teams usually have several spots they can shoot from. These spots can be a certain distance from the goal, one side of the field, or even a field feature they line up with. To figure out which locations a team prefers, you can collect data on each shot a team makes.

Analysis: This visualization is probably the closest to a true heat map. With every shooting location a team has made put onto a single map, the locations where the hits cluster show a robot's favorite shooting locations. Here is the heat map of two different teams and trends that could be exploited.

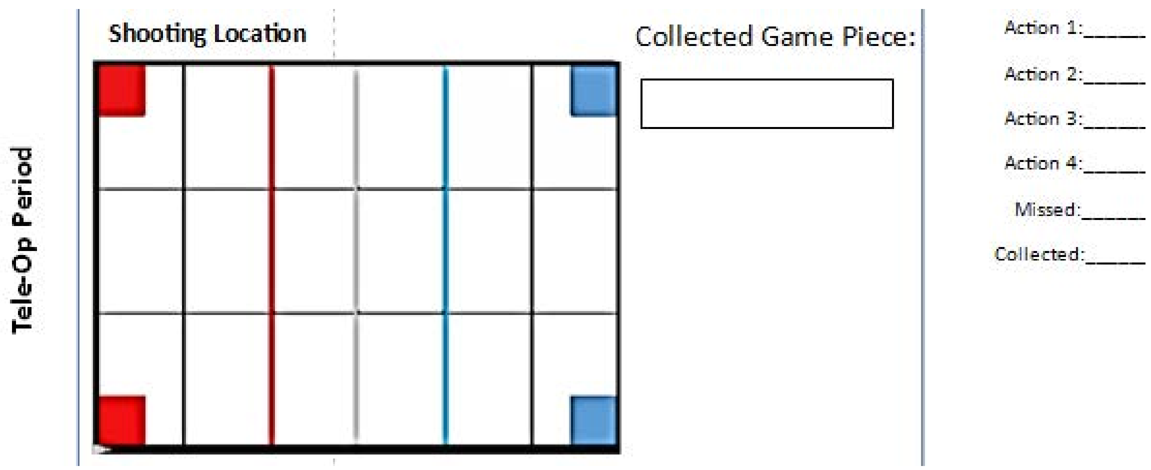


To find accuracy in visualizations like this, look for clusters of hits or misses. While this isn't a precise science, it can give you a good idea of how accurate a team is from that position. For instance, the team above is more accurate on the left side of the field and is least accurate in the middle. This team also likes to shoot from roughly the same distance. To play defense against them, your team could work to push them forward or backward to put the shooter out of their comfort zone.



On this second heat map, the team is shown to shoot at a variety of ranges, but always from the same side of the field. To play defense against them, a bot should defend that side of the field, either blocking the bot or forcing them onto the left side of the field..

Data collection: Although these heat maps are very powerful, it can be hard for scouts to collect the shooting location of every shot a team makes with a paper scouting system. However, there are some tricks that make it easier. Instead of having an area to tally hits and misses, you can insert a large picture of the field. Whenever a robot takes a shot, put an "H" or "M" symbol. It should look something like this.



On the right side, you can still total up the number of hits and misses for your normal data collection. However, for your shooting location, it helps to have a separate sheet to copy over the data. For each hit or miss recorded on the sheet, transcribe it onto a separate sheet that would look something like this.

Team Number		
Match Number		
X	Y	Result

In games where the robots shoot more than one game piece at a time, it may be easier to just record the hits and misses as usual, and record the location of each volley instead. You will lose the ability to graph accuracy, but you will get more accurate data overall.

Data storage: Because this method uses two scouting sheets for each match, you will need two tables to hold the data. The first table is for the actual scouting sheet and holds all of your non-location data. The second table is for the location data. Unlike the table for the scouting data where each record was one robot in one match, the location data will have a record for each shot or volley. The table will end up looking like the table on the next page.

ID	Match Numb	Team Numbe	Action	X	Y	Click t
10454	1	4500	upperGoal	82	28	
10455	1	4500	missedGoal	83	30	
10456	1	4500	missedGoal	78	29	
10457	1	4500	missedGoal	79	27	
10458	1	4500	missedGoal	79	25	
10459	1	4500	upperGoal	63	24	
10460	1	3256	upperGoal	56	76	
10461	1	3256	upperGoal	57	74	
10462	1	3256	upperGoal	97	26	
10463	1	3256	upperGoal	96	21	
10464	1	3256	upperGoal	96	53	
10465	1	3256	missedGoal	91	7	
10466	1	3256	upperGoal	91	7	
10467	1	3256	missedGoal	91	7	
10468	1	3256	upperGoal	80	8	
10469	1	3256	upperGoal	80	8	
10470	1	3256	missedGoal	100	0	
10471	1	3256	missedGoal	63	71	
10472	1	3256	upperGoal	91	7	
10473	1	3256	upperGoal	85	46	
10474	1	120	missedGoal	91	87	
10475	1	120	missedGoal	31	59	
10476	1	120	upperGoal	13	11	
10477	1	120	upperGoal	42	51	
10478	1	120	upperGoal	14	13	
10479	1	120	upperGoal	17	36	
10480	1	120	missedGoal	21	15	
10481	1	120	missedGoal	39	46	
10482	1	120	upperGoal	20	15	
10483	1	120	upperGoal	81	18	
10484	1	120	upperGoal	82	19	
10485	1	120	missedGoal	81	18	

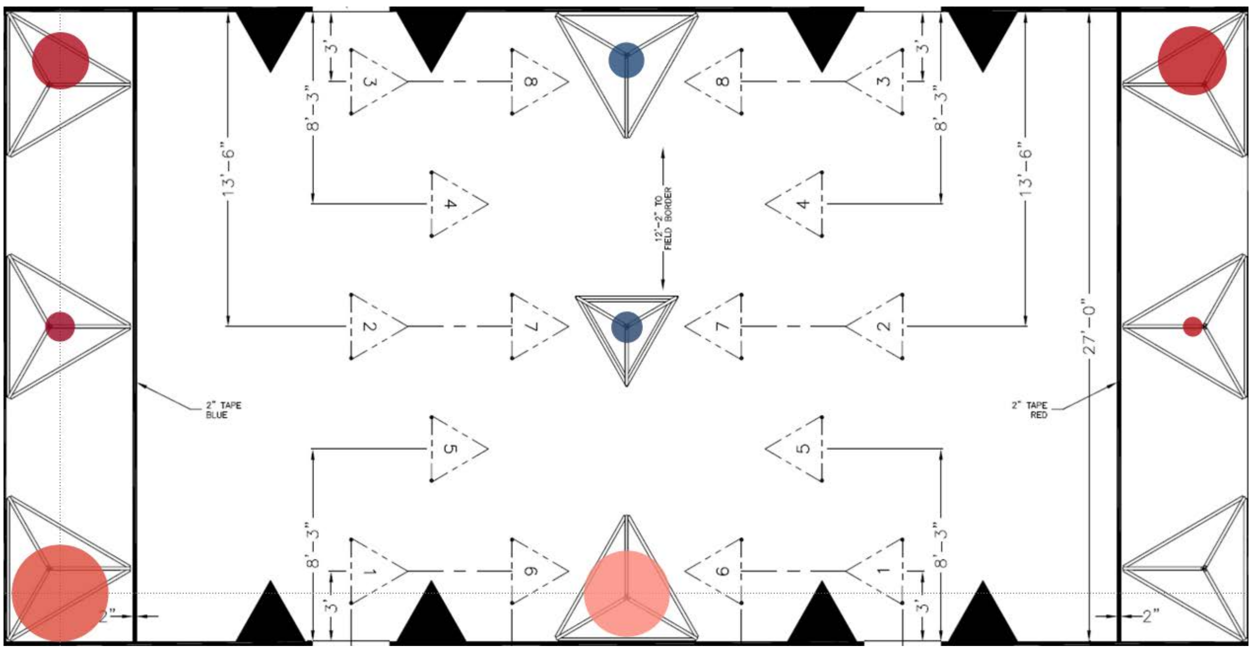
The reason we do this is so we can have a variable number of shots per match and still visualize them all on the same axis.

PREVIOUS GAME SCENARIO

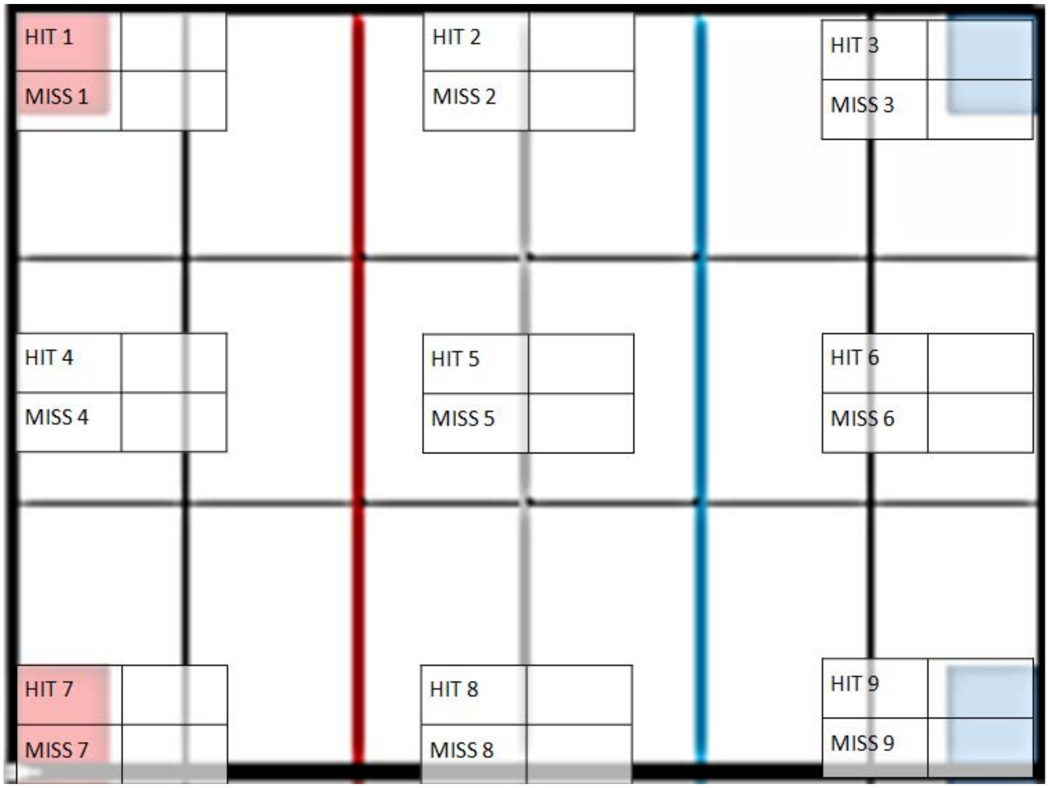
Large number of goals or racks (2005, 2007, 2011)

In games with a large number of goals, it is less important to know exactly where they shoot from and more important to know which goal is their favorite to score at. This is because in games like this, the high number of goals makes defending a shooting location harder. However, knowing which goal a team favors will let you block access to that goal, and force a robot into less familiar territory.

Analysis: Heat maps in this type of game require more complicated calculations, but are equally as powerful as the other two types. Once you have your data, a heat map like this can be created by with a calculation similar to the one discussed starting at 5:40 at www.tableausoftware.com/first-robotics/advanced.

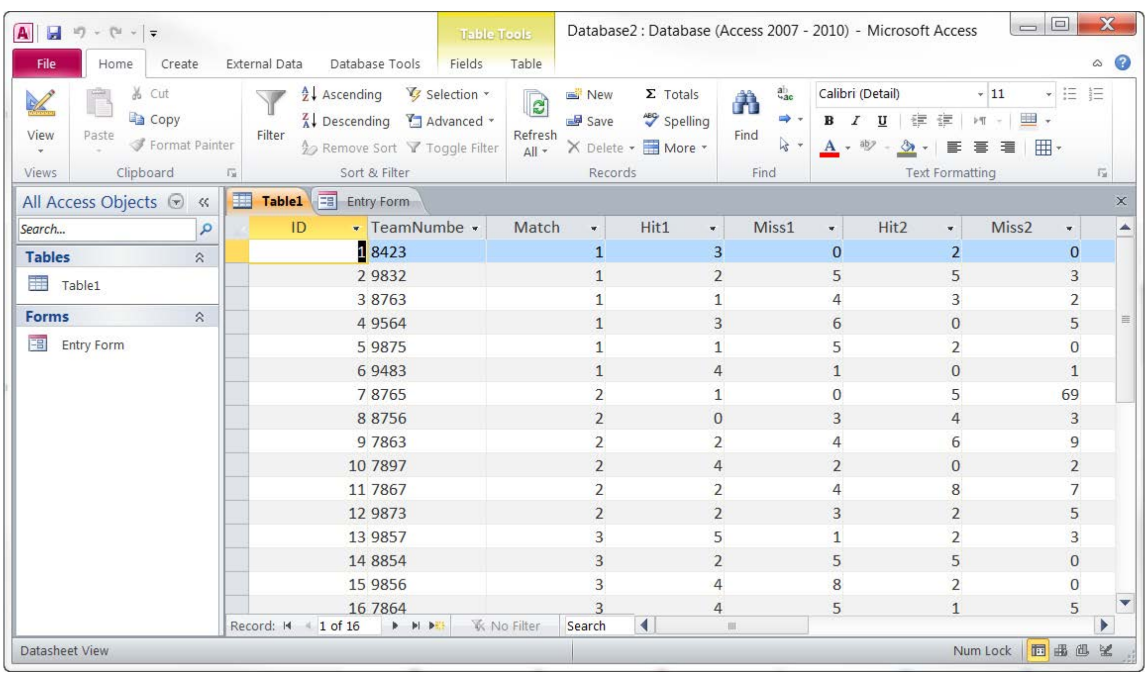


Data collection: One way to collect location data in a game like this is to tally the number of shots at each goal separately to find a team's shooting preference. To help your scouts remember the shooting location more easily, you can out the tally boxes over a picture of the game field, as shown on the following page.



Note that it is helpful to leave space on the right side of the sheet for hits and misses at each goal.

Data storage: While the table may be large, remember to make a column for hits and misses at each goal, just like the scouting sheet. You don't actually have to sum up all of the hit and misses when you are storing the data, as that calculation can be easily made in Tableau.



ID	TeamNumbe	Match	Hit1	Miss1	Hit2	Miss2
1	8423	1	3	0	2	0
2	9832	1	2	5	5	3
3	8763	1	1	4	3	2
4	9564	1	3	6	0	5
5	9875	1	1	5	2	0
6	9483	1	4	1	0	1
7	8765	2	1	0	5	69
8	8756	2	0	3	4	3
9	7863	2	2	4	6	9
10	7897	2	4	2	0	2
11	7867	2	2	4	8	7
12	9873	2	2	3	2	5
13	9857	3	5	1	2	3
14	8854	3	2	5	5	0
15	9856	3	4	8	2	0
16	7864	3	4	5	1	5

PREVIOUS GAME SCENARIO

Mobile or no goals (e.g., 2004, 2008, 2009)

In mobile or no goal games, heat maps are impractical. In games with a mobile goal, a heat map doesn't make sense. Mostly, this is because the mobile nature of the goals means that it is unlikely that an exploitable pattern in robot performance will emerge. For example, 2008's game (Overdrive), the goal was nearly the entire field. Knowing where the opponent threw the ball over the overpass was less important than the number of times they threw the ball because few robots had a strong enough preference for a specific location to exploit with a heat map.

NEXT STEPS: ASSESSING FUTURE GAMES

While there is no guarantee that future games will fall into existing categories, the same principles can likely be applied to future games from a perspective of how to analyze, collect, and store the data. The examples from previous games should be helpful in assessing how to best construct effective visualizations, including heat maps, which will provide insight into other team's strategies and methods of playing the game.