Predicting the London Olympics Medal Count

and the Why's Behind It

By Dan Graettinger

Will the United States retain its position as the top medal-winning nation at this year's Olympic Games in London, or will up-and-coming China capture the crown? Is it possible to predict how many medals each nation will win? Why do some countries take home a bundle of medals while others take home none at all? And what is it about a nation that allows it to produce Olympic medal-winning athletes?

Rank	Nation	Olympic Medals 2004	Olympic Medals 2008
1	United States	103	110
2	China	63	100
3	Russia	92	72
4	United Kingdom	30	47
5	Australia	49	46
6	Germany	49	41
7	France	33	40
8	Korea, South	30	31
9	Italy	32	28
10	Ukraine	23	27
11	Japan	37	25
12	Cuba	27	24
13	Belarus	15	19
14	Canada	12	18
15	Spain	19	18
...	....		

Table 1

It was these latter two questions that intrigued me the most. If we look at the medal counts for the two most recent Olympic Games (see Table 1), we see that the top two nations are the U.S. and China, who happen to be the 3rd and 1st most populous nations in the world. So population seems be important. But where is India, the world's second most populous nation?[1] Maybe wealth is the key factor. That seems to fit. A lot of the nations at the top of the list are the wealthier nations of the world. But how did Cuba and Belarus rank so high? As we think more and more about it, it quickly becomes clear that the *why's* behind the medal counts at the Olympics are complex. Fortunately, I'm a data miner, and my job is to find patterns in data and use those patterns to predict future events. And trying to predict the 2012 Olympic medal counts using data mining methods was too tempting to pass up!

Since the puzzle I wanted to solve focused on the characteristics of nations that lead to their success at the Olympics, I took a top-down approach -- looking purely at national measures. Alternatively, there are various ways to project the medal counts. A bottom-up approach would look at the top athletes in each event, assess their recent results, and assign individual odds of winning a medal. Then you can sum those individual odds across all 29 sports to get national totals.[2] Since the nation-focused perspective would give

us more explanatory power and insight into the "why" questions that captured our imagination, we chose that approach.

To project the medal counts using the top-down method, I first needed to compile data on the nations of the world that might shed some light on what makes a difference in the medal count. On the one hand, I wanted to collect data that my intuition said was important, like population, wealth, and development level. On the other hand, I wanted to hold the door open for other categories of data that could have an impact, like geography, history, religion, political organization, and personal freedoms. By linking each nation's data with its Olympic outcomes, perhaps patterns would emerge that would allow for a mathematical model to be created that would be predictive, while simultaneously yielding insights to answer my questions. (See Table 2 at the end of this article for the full list of variables and their sources that went into the dataset.)

For statistical reasons, we decided to try to predict which nations would win two or more medals. This would help eliminate some statistical "noise" in the data where a nation might win a medal due to a single outstanding individual. After that, we compared each of the variables against the outcome of winning two or more medals. This allowed us to weed out those characteristics of a nation that do and do not connect strongly with their medal count. So let's take a look at some of the expected, the sensible, and the downright head-scratching characteristics of a nation that relate to the ability to produce world champion athletes.

What Does Matter

- The single characteristic most closely associated with winning Olympic medals is … ***number of internet users***. My initial reaction was, "What the heck??!!" This is a good time to point out that good predictors may not actually cause the outcome, but rather go together with (correlate to) the outcome.[3] After further thought, I realized that the number of internet users does tell us a lot about a country. The people are wealthy enough to afford computers and internet access. The population of the country is relatively large (since this piece of data measured the total number of users, not users *per capita*). Finally, the people have enough free time on their hands to engage in non-subsistence-related activities, like participating in sports or surfing the net!
- ***Total Gross Domestic Product*** - Here again we see an indication that a nation's wealth helps them to produce elite athletes. What's intriguing, though, is that the total GDP for the nation was far more predictive than GDP per capita. For example, in 2008, the nation of China had the second highest GDP in the world, as well as the second most medals at the Olympics. Yet their GDP per capita ranked them 134th in the world, behind nations like Thailand, Tunisia, and El Salvador. One possible explanation is that China's communist government, having access to the great combined wealth of the nation,

diverted enough funds to their government-sponsored athlete development program to overwhelm the relative poverty of that nation's individuals.

- ***Total Population*** - Now that makes sense! With all else being equal, the more individuals a nation has, the more outstanding individuals there ought to be. This is why high school athletics in the United States are divided by the size of the school. A high school with 2,000 students will likely have more high-caliber athletes than a high school with only 200 students.

- ***Latitude*** - Here's another entry in the "What the heck??" category. The only reason I included this piece of data in the dataset was that I originally envisioned this project after watching the 2010 Winter Olympics. I had a hunch -- and I'm going way out on a limb here! --- that nations further from the equator just might perform better and snow-related sports than countries like Western Sahara and Malaysia. Yet latitude also showed up as a significant predictor of Summer Olympics medals! Here's the map (Figure 1), with green dots indicating nations that won two or more medals in both 2004 and 2008[4], grey dots indicating winning two or more only one of those times, and red dots indicating no medals at either Olympiad.

Figure 1

- ***Overall Economic Freedom*** - Each year the Heritage Foundation publishes a chart ranking nations on various aspects of freedom. The higher the scores, the greater the freedom the people enjoy. As Figure 2 indicates, the higher the freedom score, the more likely a nation was to win 2 or more medals in the last two Games. Nations whose freedom scores measured in the 80's had a 75% likelihood of winning medals in 2004 and 2008. So freedom is a factor.

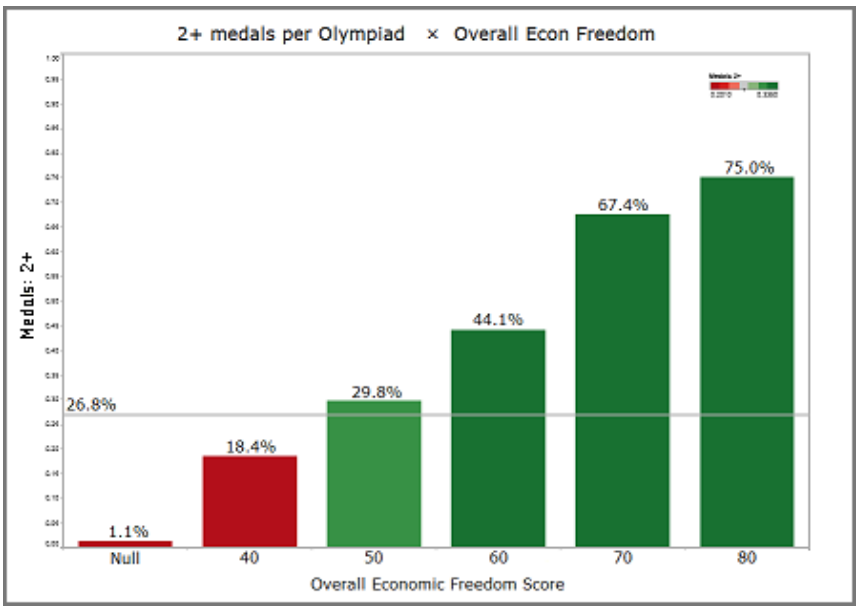


Figure 2

Enough Wonkiness - How Did the Predictions Turn Out

Considering that we took a top-down approach and used only high-level, national statistics as predictors, the results turned out pretty well. When we tested the predictive model against the actual '04 and '08 medal counts, we got the scatter plot diagram in Figure 3.

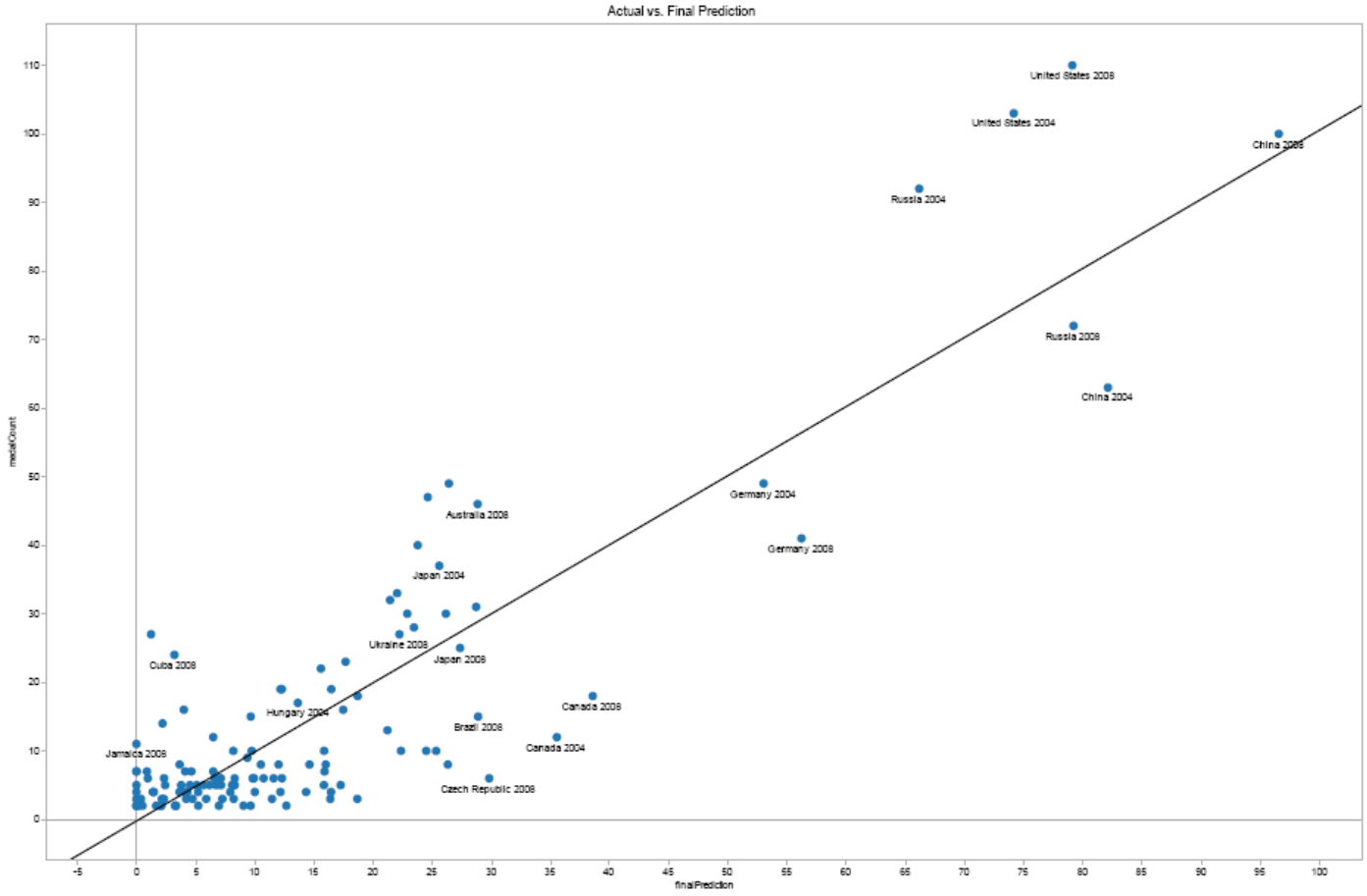


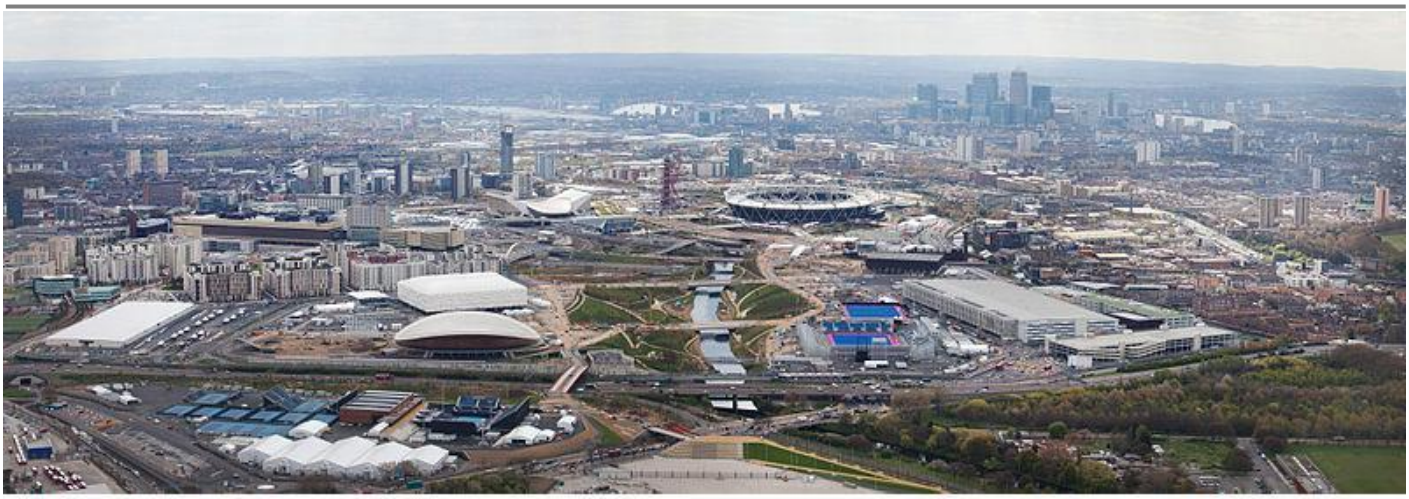
Figure 3

If the model had been able to predict perfectly, all of the dots would have fallen directly on the diagonal line. As you can see, the results do generally follow the line, so that tells us that our model really is on to something. Another thing we immediately notice is that a number of nations stand out as overperforming and underperforming against the model. Perhaps the most important reasons for this are …

- An athlete is not a national average. The drive and determination of an individual athlete is something that can't be seen from 30,000 feet.
- There are factors that influence the winning of medals for which data was not available.

This second fact still tantalizes me. If only I could've gotten some data on the extent to which each country subsidizes its athletes. Would that explain Cuba's overperforming in 2004 and 2008? And how can you measure a nation's affinity for sports? Whether it's table tennis in China or gymnastics in Russia and Romania, a nation's love of a specific sport or of sports in general is something we can't factor in for now.

Finally, how are those small nations like Jamaica, Kenya, and Ethiopia able to consistently produce winners in track and field? I guess we'll just have to watch the broadcasts and see if we can find out!



Olympic Park, London, UK — *by Anthony Charlton for LOCOG*

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Table #	Description	Category of data	Source
2002	Population Growth Rate	Population	CIA World Factbook
2102	Life Expectancy At Birth	Population	CIA World Factbook
2112	Net Migration Rate -Immigration	Population	CIA World Factbook
2119	Population	Population	CIA World Factbook
2177	Median Age	Population	CIA World Factbook
2001	GDP - Total	Economics	CIA World Factbook
2003	GDP Growth Rate	Economics	CIA World Factbook
2004	GDP Per Capita	Economics	CIA World Factbook
2034	Military Expenditures As A Pct Of GDP	Economics	CIA World Factbook
2046	Pct Of Pop Below Pov Line - By Nations' Own Stndrds	Economics	CIA World Factbook
2078	Exports (Value Of)	Economics	CIA World Factbook
2092	Inflation Rate	Economics	CIA World Factbook
2129	Unemployment Rate	Economics	CIA World Factbook
2175	Oil Imports	Economics	CIA World Factbook
2042	Electricity Consumption	Development Level	CIA World Factbook
2103	Literacy Rate	Development Level	CIA World Factbook
2153	Internet Users	Development Level	CIA World Factbook
2206	Pub Exp On Edu - Pct Of GDP	Development Level	CIA World Factbook
2226	Physicians Per 1000 Pop	Development Level	CIA World Factbook
2147	Geographic Area	Geographical	CIA World Factbook
3010	Rndd Latitude Of Capital City	Geographical	Wikipedia
3020a	Highest Point - Elevation In Meters	Geographical	CIA Wfb + Wikipedia
3020b	Lowest Point - Elevation In Meters	Geographical	CIA Wfb + Wikipedia
3030	Maximum Elevation Change	Geographical	Calculation
3040	Continent	Geographical	Other Sources + Wikipedia
4010	Part Of British Empire (Ever)	Historical	Wikipedia + Other Sources
4020	Member Of British Commonwealth & Former Colony	Historical	Wikipedia
4050	Part Of French Empire (Cntrlld After 1800)	Historical	Wikipedia
4100	Part Of Spanish Empire (Cntrlld After 1700)	Historical	Wikipedia
4200	Part Of Eastern Bloc (Ever)	Historical	Wikipedia
4800	Overall Freedom Ranking (Average Rating From Frdm House	Political	Freedom House
4810	Electoral Democracy	Political	Freedom House
4820	Freedom House - Freedom Group	Political	Freedom House
4850	Overall Economic Freedom	Political	Heritage Foundation
4860	Trade Freedom	Political	Heritage Foundation
4870	Property Rights Status	Political	Heritage Foundation
4880	Freedom From Corruption	Political	Heritage Foundation
4500	Majority Religion	Religion	Wikipedia & worldfactsandfigures.com
4520	Percent Christian	Religion	Wikipedia & worldfactsandfigures.com
4540	Percent Muslim	Religion	Wikipedia & worldfactsandfigures.com
4560	Percent Buddhist	Religion	Wikipedia & worldfactsandfigures.com
4580	Percent Hindu	Religion	Wikipedia & worldfactsandfigures.com
4600	Percent Other Affirmative Religion	Religion	Wikipedia & worldfactsandfigures.com
4620	Percent Non-Religious	Religion	Wikipedia & worldfactsandfigures.com
5030	Olympic Mdls (Summer) Given Yr	Olympics	RealClearSports.com / Wikipedia / DatabaseOlympics.com

Table 2

[1] India won one medal in Athens in 2004 and three medals in Beijing in 2008.

[2] Both USA Today and the Wall Street Journal Online have written interesting articles and generated predictions from the bottom-up point of view.

[3] For example, suppose you were trying to predict whether a person would be a fan of the Chicago Bears football team. I would imagine that, if you could get your hands on it, the piece of data most strongly correlated with "Chicago Bears fan" would be "Chicago Bulls fan." Being a Bulls fan doesn't cause a person to be a Bears fan. But being a Chicago Bulls fan encapsulates many of the same elements that would contribute to being a Bears fan: living in or near Chicago, liking sports, etc.

[4] In Figure 3, you'll see a benchmark line at 26.8%. That is the percentage of nations who participated in the 2004 & 2008 Games and won two or more medals.