Is it possible to beat the lottery system?

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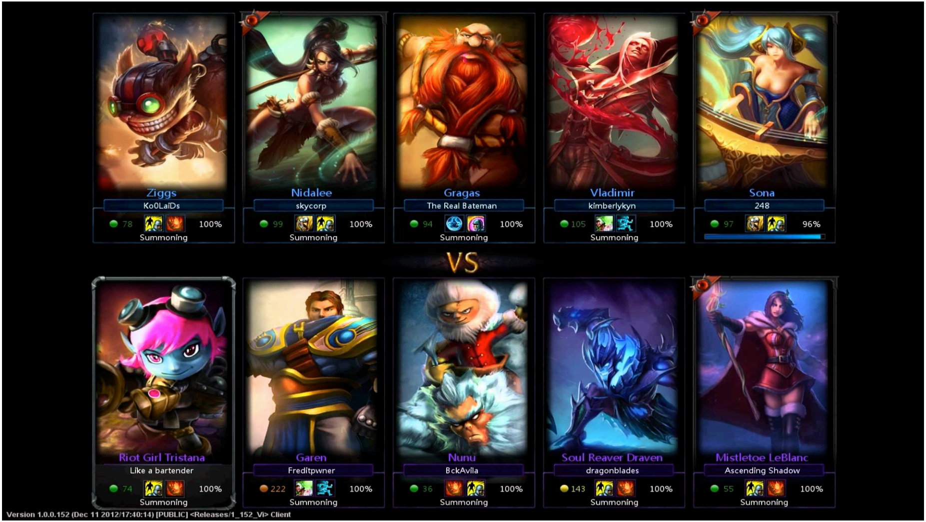
The University of Adelaide

Postgraduate Seminar, 2014

The story

One day, while sitting at home (working hard)...

The story



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The story

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on the results of the
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lion prize is one in 2,036,265.

Forecasting or predicting the winning numbers is, inevitably, pure guesswork. But it is possible to arrange a set of numbers in such a way that if the set should chance to include four of the numbers actually drawn, the player can ensure that they fall together. A consolation prize is surely better than no prize!

To see how it works, study the diagram showing a method for reducing a System 12 entry. Each number is used exactly 21 times. I developed the plan in 1980 and published it in Monash University's mathematics magazine 'Function'.

Within each System 12 entry, there are 924 combinations of six numbers. My reduced entry system covers 12 numbers with just 42 different combinations of six. A player obtaining four of the numbers actually drawn would be assured of winning at least one minor prize.

Whether a player invests in a full System 12 or the reduced System 12 as shown, the probability of obtaining any return is identical.

A player investing in a full system 12 stands to win more — four winning numbers will ensure 28 minor prizes — but he or she also stands to lose more, since the full system 12 requires an outlay of

with 0.0012125.

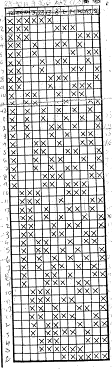
Readers wishing to try their luck with a reduced System 12 should write their 12 numbers in the 12 spaces at the top of the diagram, then transfer them to the entry forms by matching the corresponding Xs as set out in the diagram.

The positive aspects of the reduced System 12 are as follows:

a. Four main numbers, or three main numbers plus a supplementary, ensures the player of at least one fourth division or a fifth division, respectively.

b. Five main numbers will ensure either one third division prize or five fourth division prizes.

c. Six main numbers will ensure at least one third division plus several smaller prizes.



red. Dr Bush's evidence
m sediment cores taken
ador's Lake Ayauch.
of preserved pollen
l characteristic, tiny
lusters called
, that are deposited in
ng leaves of maize.
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ery different and much
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, since they are much
y to be preserved than

plant macrofossils such as leaves, twigs and seed structures.

What is the evidence that the pollen and phytoliths are not simply from wild teosinte, rather than from cultivated maize? Dr Bush's group found that pollen spectra between 7100 and 5300 years ago are dominated by pollen from mature rainforest, with low, sporadic occurrences of pollen from maize and another herbaceous species, *Cecropia*, a common weed of disturbed ground. Neither teosinte nor *Cecropia* would be expected to be present in a lowland tropical rainforest, so the conclusion must be that their presence reflects human disturbance of the environment.

The evidence that maize was cultivated some 7000 years ago in South America — and presumably somewhat earlier in central and North America, attests to a much longer history of agriculture in the Americas than would have been suspected a mere decade ago.

The story

The article had a simple problem:

- Playing in the lottery is expensive, chances of winning are small
- Tickets with high chances are expensive
- So here is a better scheme!

Section 1

Counting and Probability Background

Counting and Probability Background

We denote the number of ways to choose k objects from n as

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

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Odds:
1 : 800 implies that you will win once, and not win 800 times.

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$$\text{Prob.} = \frac{\frac{1}{odds}}{1 + \frac{1}{odds}}$$

Section 2

Lottery basics

Lottery basics

Each person has a game (or some number of games) which have 6 numbers on them.

Every week, lottery is drawn.

6 numbers are chosen randomly, followed by 2 'supplementaries'.

In order to win, you need a certain combination...

Lottery basics

Division	Main numbers	'Supps'
1	6	-
2	5	2
	5	1
3	5	0
4	4	2
	4	1
	4	0
5	3	2
	3	1
6	2	2
	1	2

And here's why you never win...

To win division 1, you need all 6 numbers correct.

There are $\binom{45}{6}$ different tickets. Only one of them is a winner.

Thus, your odds of winning are 1 in $8,145,060$.

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Or the probability of winning is 1.22×10^{-7}

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To win division 2, you need 5 numbers and 1 supplementary.

There are still $\binom{45}{6}$ different tickets but now the probability of having a winner is

$$\binom{6}{5}\binom{2}{1} = 12,$$

So, your odds of winning are 1 in 678, 755.

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Or the probability of winning is 1.47×10^{-6}

And it continues...

Division	Odds	Prob.
1	$8,145,060$	1.22×10^{-7}
2	$678,755$	1.47×10^{-6}
3	$36,689$	2.72×10^{-5}
4	733	0.0014
5	297	0.0034
6	144	0.0069

And it continues...

Division	Odds	Prob.
1	8, 145, 060	1.22×10^{-7}
2	678, 755	1.47×10^{-6}
3	36, 689	2.72×10^{-5}
4	733	0.0014
5	297	0.0034
6	144	0.0069

Roughly 1 of my Facebook friends will win division 5 if we all bought a ticket, while 1 of Kelli's Facebook friends would win division 4 if they all bought a ticket.

The winnings

Higher divisions give a higher payout:

Division	Payout
1	1, 013, 557.14
2	8, 871.65
3	1, 014.45
4	30.95
5	20.65
6	12.25

(Taken from 08/03/2014 X Lotto Draw)

Different ticket styles

In order to improve your chances of winning (or their profits) you can buy different types of tickets.

System 12: Choose 12 numbers, receive all combinations of those 12 numbers.

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System 12: Choose 12 numbers, receive all combinations of those 12 numbers.

How many games?

$$\binom{12}{6} = 924 \text{ games}$$

Which means more probability...

Division	Odds	Prob.
1	8, 813	1.14×10^{-4}
2	734	0.0014
3	39.71	0.0246
4	0.79	0.5587
5	0.32	0.7576
6	0.16	0.8621

You can also win multiple times!

For example, should you get all 6 primary numbers and 2 supps, you win

Division	Amount
1	1
2	12
3	24
4	225
5	320
6	114

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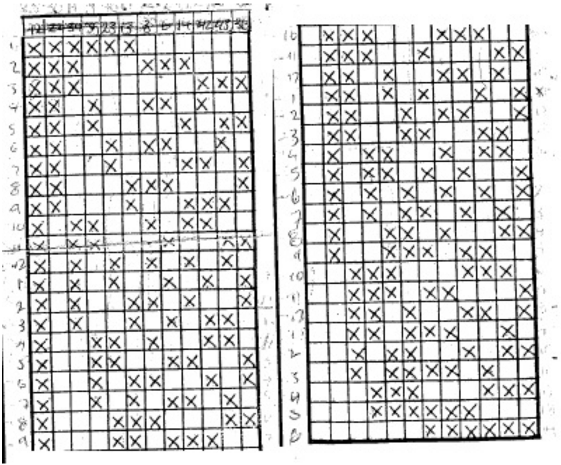
But, a System 12 ticket costs \$596.15...

Section 3

The Problem Itself

The Problem Itself

The article suggests instead of spending all your hard-earned money on a System 12, you should use an alternative scheme.



The Problem Itself

Consider winning division 1. In a System 12 our probability is 1.14×10^{-4}. For the alternative, our odds are

$$42 \text{ in } \binom{45}{6} = 1 : 1.81 \times 10^5$$

and so the probability is 5.53×10^{-6}.

So we lose a lot of the coverage, but the reduced System 12 costs only \$27.10.

So how does it work?

To test which scheme is better, we could look at the probability and calculated expected winnings.

$$
\begin{aligned}
\mathbb{E}[W_{12}] &= P(\text{Div 1})\text{Payout}_1 + ... + P(\text{Div 6})\text{Payout}_6 - \text{ cost} \\
&= 196.4182 - 596.15 \\
&= -399.71 \\
\mathbb{E}[W_a] &= 14.27 - 27.10 \\
&= -12.83
\end{aligned}
$$

So, the alternative scheme is better... but not great.

The thing is...

There are many examples of people buying a ticket for the first time and immediately winning the big prize.

- The system is inherently stochastic
- Is it necessarily fair to look at the average case situation?

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There are many examples of people buying a ticket for the first time and immediately winning the big prize.

- The system is inherently stochastic
- Is it necessarily fair to look at the average case situation?

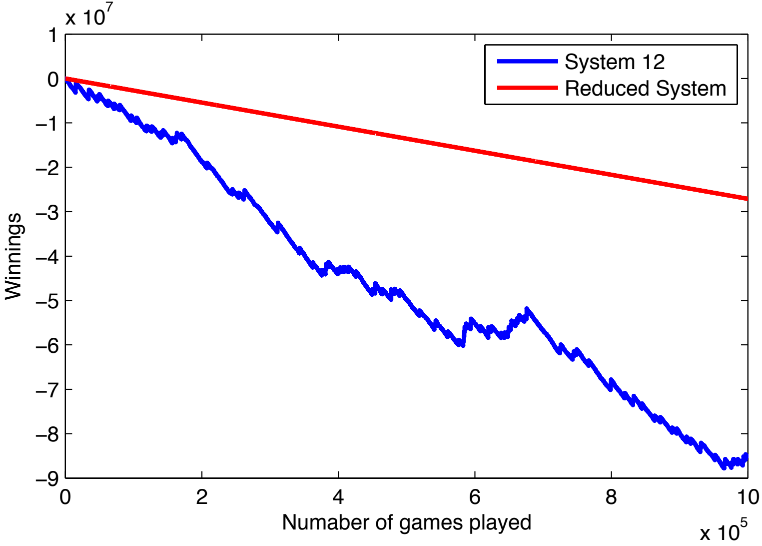
Let's instead use some simulation to make sure.

Simulating

Relatively simple algorithm:

1. Choose a set of 12 numbers, set up the 42 games in the alternative scheme.
2. For each lottery game:
    1. Pick 6 numbers and 2 supplementaries,
    2. Check how many fall in the system 12,
    3. Check how many fall in each alternative game.
    4. Update winnings vector, including cost.
    5. Go to 2.

And this is the result...



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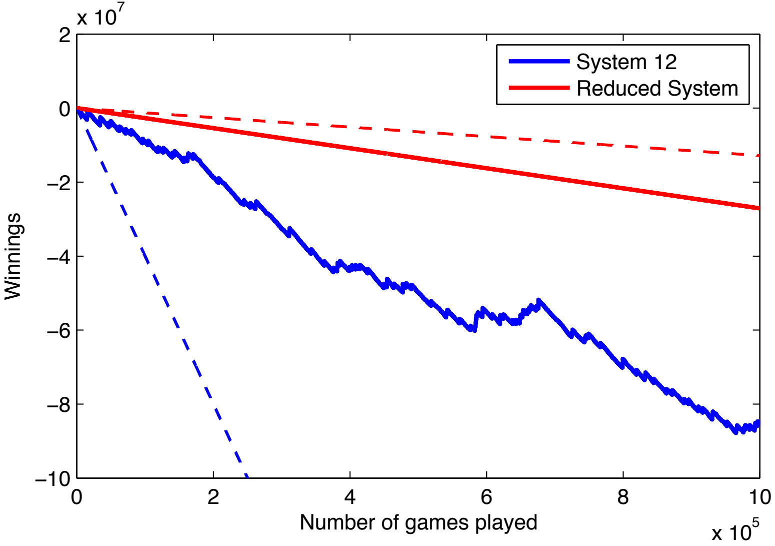

Possible Extensions / Future Work

Need to think more about why the prediction doesn't match the simulation.

But, simulation has shown us that the best scheme out of these two is...

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Neither!

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The 0 scheme (where we don't bet) is better!

Conclusion

We have seen:

- The basics of counting,
- The basics of a lottery,
- Two alternative schemes for betting on lotteries,
- Validating results via a simulation,

Importantly, we saw that the better way to win on the lottery is to, in fact, not bet at all.