

HYPOTHESIS TESTING

Is one zodiac more likely to be a billionaire?

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SUMMARY

Some people consult astrology and horoscopes for predictions in their life, love, and fortune. This project aims to tackle the relationship between zodiac signs and “luck” in money by investigating if one of the twelve zodiac signs is more likely to be a billionaire than others. This project makes use of a billionaire count per zodiac from a study published digitally by the CEOWorld Magazine in 2020. The data was obtained by the study from a random sample of 194 billionaires from the official Forbes’ billionaires list as of 2020. A one-way chi-squared test was then implemented to determine if there is preference for one zodiac. At the 0.05 level of significance, this project is able to conclude that one of the twelve zodiacs is more likely to be a billionaire.

NULL AND ALTERNATIVE HYPOTHESIS

Ho: All zodiacs are equally likely to be a billionaire (equally distributed).

Ha: One zodiac is more likely to be a billionaire (not equally distributed).

EXPERIMENT DESCRIPTION

Anna Papadopoulos from the CEOWorld magazine compiled a billionaire count per zodiac from a study conducted by UK Domain. The study analyzed the zodiac of 250 billionaires randomly selected from the top billionaires in the official Forbes’ list as of 2020 (CEOWorld Magazine, 2020). However, the actual sample of the study is only 194 ($n=194$) since not all of the 250 billionaires have their zodiacs/birthdays disclosed publicly (“Forbes Billionaires 2020,” 2020).

To obtain data for this project, I manually tabulated the observed frequency of Billionaires vs. the twelve zodiac signs — namely Aries, Taurus, Gemini, Cancer, Leo, Virgo,

Libra, Scorpio, Sagittarius, Capricorn, Aquarius, and Pisces. The data is shown as Table 1 in this paper.

I then decided on a test for the data and checked for assumptions. Since n is large and all expected frequencies are greater than 5, then χ^2 has approximately a chi-squared distribution. The data also fits the assumptions for a chi-squared test, namely:

- 1) The information was obtained from a random sample, and
- 2) Each observation is categorized according to the categorical variables involved.

Since this project involves an experimental design with one independent variable (Observed frequency of Billionaires) and a nominal dependent variable (Zodiac), I decided to implement a one-way chi-squared test to determine if there is preference for one zodiac at the 0.05 level of significance ($\alpha = 0.05$).

The data consists of 194 independent trials and each outcome of the trial fits into exactly one of the twelve possible cells. The Observed frequency of Billionaires accurately totals to 194 ($O_1 + O_2 + \dots + O_{12} = 194$). If no preference among the zodiacs was shown, we expect the 194 billionaires to be equally distributed among the twelve zodiacs. Thus, the expected proportion for each zodiac must be $\frac{1}{12}$ or 8.33% ($p_1 + p_2 + \dots + p_{12} = 1$). I tabulated the Observed frequency of Billionaires and the Expected frequency for each (shown in Table 2) to calculate the chi-squared test statistic given by $\chi^2 = \sum \frac{(O-E)^2}{E}$.

I used both the p-Value and Classical Approach for this project. For the p-Value Approach, I obtained a p-value from the value of the chi-squared test statistic ($\chi^2 = 23.2371$) I calculated. I got $0.01 < P < 0.025$ from Table 8 and $P = 0.0164$ from a chi-squared test calculator by GraphPad (GraphPad QuickCalcs: chi square calculator, 2018), which are both less than the level $\alpha = 0.05$. For the Classical Approach, I obtained the critical value $\chi^2 = 19.7$ given $df = 12 - 1 = 11$ and $\alpha = 0.05$. The value was inside the critical region. Both approaches suggested the rejection of my null hypothesis and accordingly, supports the statement that one zodiac is more likely to be a billionaire.

EXPERIMENT RATIONALE

Astrology ascribes meaning to the placement of the sun, moon, and planets within 12 sections of the sky — the signs of the zodiac — on the day you were born. Zodiacs date back to 500BC as a religious/ritual tradition in Mesopotamia (Whitaker, 2011). It then lived on as a culture seen as horoscopes in a newspaper and paid astrologists. Today, in the internet age, zodiac signs are booming once again to be a trend especially amongst millennials and Gen X. Horoscopes have also grown to be part of mobile applications, online discussions, and internet humor such as memes.

Some people follow astrology only for humor and believe it to have no scientific ground. However, a lot of people still religiously turn to astrological zodiacs for personality assessments, phenomena explanations, and life decisions especially during times of stress. Additionally, a lot of people, including myself, turn to horoscopes for advice on life, love, and fortune (Beck, 2018).

In this project, I decided to focus on one of the usual aspects tackled by horoscopes: fortune. By investigating whether or not one zodiac sign is more likely to be a billionaire, I intend to confirm if one of the zodiacs actually have more “luck” with money compared to others, as astrologists suggest. I believe that this will be an interesting topic for everyone interested in money, horoscopes, or both. This project can also add to the discussion on the credibility of zodiacs and its impact on fortune.

DATA

Table 1

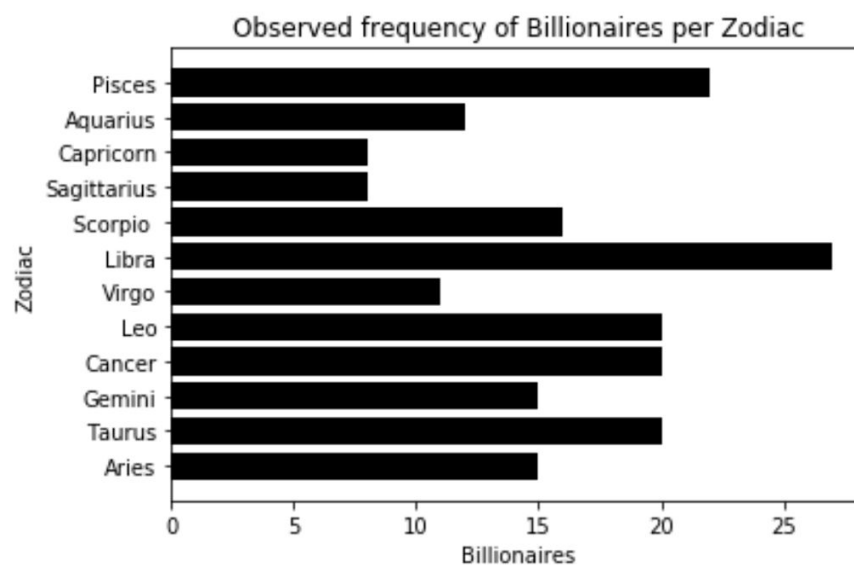
Observed frequency of billionaires per zodiac sign

Zodiac	Observed frequency of Billionaires
Aries	15
Taurus	20
Gemini	15
Cancer	20
Leo	20
Virgo	11
Libra	27
Scorpio	16
Sagittarius	8
Capricorn	8
Aquarius	12
Pisces	22
TOTAL	194

Note. Data is from CEOWorld Magazine (2020)

Figure 1

A bar graph of the Zodiac signs vs. the Observed frequency of billionaires for each



DATA SUMMARY

Mean: $\bar{x} = 16.1\bar{6}$

Median: $Md = 15.5$

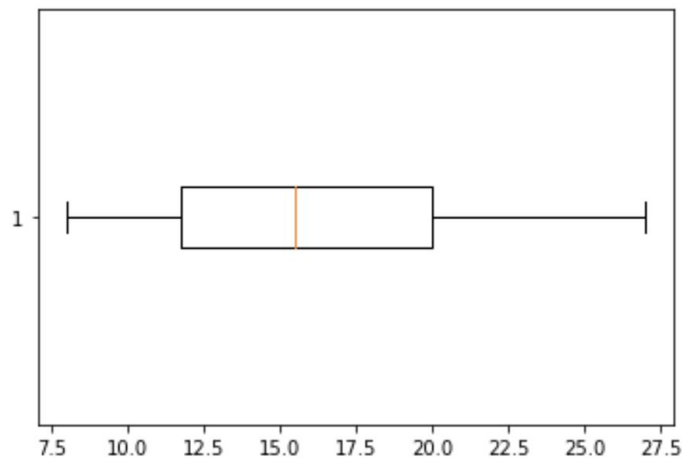
Mode: $Mo = 20$

Range: $R = 19$

Variance: $s^2 = 34.1\bar{5}$

Standard Deviation: $s = 5.84392977$

Figure 2



HYPOTHESIS TESTING:

1. The Set-up

a) Population parameters of concern

- Preference for each zodiac,
- the probability that a particular zodiac is a billionaire

b) The null and alternative hypotheses:

Ho: All zodiacs are equally likely to be a billionaire (equally distributed).

Ha: One zodiac is more likely to be a billionaire (not equally distributed).

2. The Hypothesis Test Criteria

a) Assumptions:

- The 194 billionaires represent a random sample from the world's top billionaires in Forbes' official list.
- Each observation is categorized according to the categorical variables involved in the test.

b) Test statistic: χ^2* with $df = k - 1 = 12 - 1 = 11$

c) Level of Significance: $\alpha = 0.05$

3. The Sample Evidence

a) Sample Information: Table given in Table 1

b) Calculate the value of the test statistic:

$$[\text{Manual}] \chi^2* = 23.2371$$

- If no preference among the zodiacs was shown, we expect the 194 billionaires to be equally distributed among the twelve zodiacs.
- The expected proportion for each zodiac must be $\frac{1}{12}$ or $8.\overline{33}\%$ ($p_1 + p_2 + \dots + p_{12} = 1$)
- The expected frequency for each zodiac must be $\frac{194}{12}$ or $16.\overline{16}$
- $\chi^2* = \sum \frac{(O-E)^2}{E}$

Table 2

Table for manual calculation of χ^2 through Observed and Expected Values of data.*

Zodiac	Observed (O)	Expected (E)	O - E	(O-E) ² / E
Libra	27	16.17	10.83	7.259450172
Pisces	22	16.17	5.83	2.104810997
Taurus	20	16.17	3.83	0.9089347079
Cancer	20	16.17	3.83	0.9089347079
Leo	20	16.17	3.83	0.9089347079

Scorpio	16	16.17	-0.17	0.001718213058
Aries	15	16.17	-1.17	0.08419243986
Gemini	15	16.17	-1.17	0.08419243986
Aquarius	12	16.17	-4.17	1.073883162
Virgo	11	16.17	-5.17	1.651202749
Sagittarius	8	16.17	-8.17	4.125429553
Capricorn	8	16.17	-8.17	4.125429553
TOTAL	194	194.00	0.00	23.2371134

[Using Python] $\chi^2* = 23.23711$

4. The Probability Distribution (p-Value Approach, Classical Approach)

[p-Value Approach]

a) The p-value: $P = P(\chi^2* > 23.2371 \mid df = 11)$

From software (shown in Figure 3): $P = 0.0164$

From Table 8: $0.01 < P < 0.025$

b) $0.0164 < 0.05$; The p-value is smaller than the level of significance.

[Classical Approach]

a) Critical value from Table 8: $\chi^2(df, \alpha) = \chi^2(11, 0.05) = 19.7$

b) $\chi^2* = 23.2371$ which is in the critical region $\chi^2 > 19.7$.

5. The Results

a) Decision: Reject H_0 .

b) Conclusion: **At the 0.05 level of significance, there is sufficient evidence to suggest that one zodiac is more likely to be a billionaire.**

REFERENCES

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