

## THE TRUTH ABOUT ASTROLOGY

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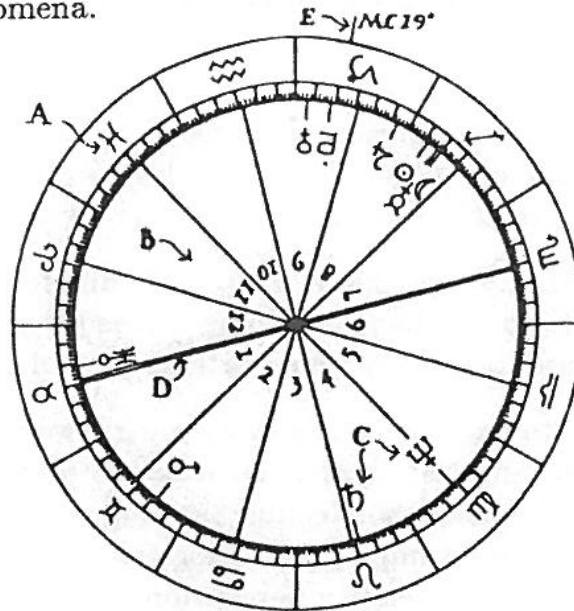
### Introduction:

- The aim of this article is to present an unusual application of an area of mathematics: assessing the validity of claims about astrology by using statistical techniques. By using statistics we are able to come closer to *'the truth about astrology'*.
- The statistical method represents a completely different way of looking at the world, and one that you probably have not come across yet. The 'statistics' that you do at school is only a small, relatively unimportant, part of the subject.
- If we use statistics to test the claims of astrology, we must be very careful to avoid a number of problems and pitfalls that have flawed previous attempts. However, there is no other practical method for testing astrology. The method used is applicable to other similar areas, for example, psychological personality tests like the Rorschach test, graphology and extra-sensory perception.

### Astrology:

- The basic premise of astrology is that there is a connection between events on earth and events in the heavens. The most important branch of astrology is **natal** astrology, which deals with the connection between an individual's character and fate and the positions of the 'planets' (including the sun and the moon) at the time of birth.
- This connection is shown by a **horoscope**, which is a geocentric map of the heavens at the time and place of birth. The **signs** of the zodiac are shown around the outside; the **houses** are thirty degree divisions counted from the **ascendant**, the point on the eastern horizon; the **midheaven** or zenith is marked; the positions of the **planets** are shown, as are various angular relationships or **aspects** between them. An example of a horoscope is shown below: for more details, you can consult any astrological text (e.g., Mayo [6] or Parker and Parker [7]).
- Modern astrological theory uses a psychological approach to the interpretation of a horoscope. Each planet represents a psychological drive, the sign it is in shows the manner of expression, the house shows the area of expression, and the aspects to other planets are modifiers. As an example, a horoscope with the sun in Virgo in the second house (*'activity show adaptively in the area of possessions'*) shows a person who has a lively, agile and argumentative nature which is particularly strongly shown in regard to possessions, personal security and money. The many individual indications are integrated into a complete profile of the person.
- Astrology has a long history going back to Babylonian times. It has been studied seriously by scholars for much of this time, including famous people such as Pythagoras, Plato, Aristotle, Paracelsus, Cardano and Kepler. Nowadays, we can distinguish three types of astrology: newspaper astrology is thought of as rubbish by almost everyone, traditional astrology is widely practiced and believed by many, scientific astrology

(sometimes called *cosmobiology*) examines the association between living organisms and extra-terrestrial phenomena.



- Key:
- A the signs of the zodiac
  - B the astrological houses
  - C the planets
  - D the ascendant
  - E the midheaven

### Testing Astrology:

- Astrology claims no deterministic rules: an often quoted saying is *'the stars incline, but do not compel'*. Hence, any laws of astrology must be of a statistical nature: something like *'with this particular positioning of planets, this sort of personality is likely'*. We can only discover and demonstrate such rules by using statistical methods.
- We must use statistical methods very carefully since there are many ways that the claims of astrology can be made convincing. These include people's basic gullibility (in an experiment, 94% of people claimed that the horoscope of a notorious murderer accurately described their own character), the universal validity of certain traits (90% of people claim to have an above average sense of humour), research errors (in the design, the analysis or the reporting), biased selection of data or experimenter bias (from subconscious to outright cheating). Lastly, there is the innate human desire to find a pattern even in situations where none exists.

### Statistics:

- First, some definitions of the statistical method - the only possible way of testing the claims of astrology:

*Statistics is the science of collecting, classifying and using numerical facts.*

*Statistics is the art of drawing reasonable conclusions from numerical data.*

*Statistics is a set of methods for coping with uncertainty.*

*Statistics is a theory of information with inference as its goal.*

*Statistics is numerical detective work.*

- In this case, we are interested in **inferential statistics**, that is, in using data to draw conclusions and make decisions - in this case decisions about astrology. The other branch of statistics, **descriptive statistics**, (which you may have met at school) is not so important here.
- We will examine the logic of statistical inference in the context of testing astrology. Statistical testing is a formal way of using numerical information to make decisions. The formal nature is important to ensure a consistent approach to problems of inference in any field. We will illustrate the ideas with a particular test called the **chi-squared goodness of fit test** (sometimes just called the  $\chi^2$ -test). We will actually use this method to test a claim of astrology.

#### A Chi-Squared Test of Mathematical Ability:

- Your **sun sign** is the sign of the zodiac that the sun was in when you were born. It can be determined easily from your birthday, and I am sure that almost all of you will already know what your sun sign is. We are going to check the connection between sun signs and mathematical ability. Standard astrological theory would claim that some signs confer more mathematical ability than others.
- To check this claim, we can collect data on the sun signs of a group of people with mathematical talent (the readership of this article, for example!) If they show a concentration in some signs, and a dearth in other signs then this would be evidence for astrology. If they are spread fairly evenly over the twelve signs, this would be evidence against this particular astrological idea.
- The first formal step in this test is to set up a **null hypothesis** (labelled  $H_0$ ) and an **alternative hypothesis** (labelled  $H_1$ ). The null hypothesis always represents the conservative viewpoint, in this case that there is no connection between sun signs and mathematical ability. The alternative hypothesis is the one that requires evidence to prove it, in this case that there is such a connection.
- We can write the null and alternative hypotheses as follows:  
 $H_0$ : sun signs evenly distributed.  
 $H_1$ : sun signs unevenly distributed.

- We collect data to fill in the following table:

Sun Sign	Observed Frequencies ( $0_i$ )	Expected Frequencies ( $e_i$ )
Aries		
Taurus		
Gemini		
Cancer		
Leo		
Virgo		
Libra		
Scorpio		
Sagittarius		
Capricorn		
Aquarius		
Pisces		
Total		

- The 'observed frequencies' column is filled in with the actual numbers of mathematicians with the particular sun sign. The 'expected frequencies' column is filled in with the frequencies that we would expect **if the null hypothesis were true** ('under  $H_0$ '). In this case, each expected frequency would be one twelfth of the total.
- If the observed frequencies are close to the expected frequencies then we have support for the null hypothesis: if they are far from the expected frequencies, we have support for the alternative hypothesis. We can measure the degree of closeness by evaluating a **test statistic**. In this case, we calculate the 'chi-squared statistic':

$$\chi^2 = \sum_i \frac{(0_i - e_i)^2}{e_i}$$

Here,  $0_i - e_i$  measures the difference between each observed and expected frequency, squaring makes all the differences positive. Dividing by  $e_i$  implies that we are looking at differences as a proportion of expected frequencies: these are summed across the different groups to obtain the final value.

- If the value of  $\chi^2$  is small, the null hypothesis is more likely to be correct: if the value is large, the alternative hypothesis is more likely to be correct. The problem is that we could get a high value of the test statistic purely by chance, even if the null hypothesis were true! This is a dilemma that cannot be avoided: using a statistical test we can never be absolutely certain of which hypothesis is true, and we can never be absolutely certain that we will make the right choice.
- To carry out the test, we pick a **significance level** (5% is a commonly used value) and reject the null hypothesis in favour of the alternative if our value of the test statistic falls in the most extreme 5% of the possible values under  $H_0$ .

- In this case, we know from theoretical considerations that the spread of possible values for  $\chi^2$  when  $H_0$  is true follows a **chi-squared distribution with eleven degrees of freedom** (written as  $\chi_{11}^2$ ). Exactly where this comes from does not matter. The important point is that we can look in tables to find that values of  $\chi^2$  greater than 19.68 form the most extreme 5%.
- We can now make a decision on the basis of our value of the test statistic. If  $\chi^2$  is less than 19.68, we will **accept** the null hypothesis, and conclude that the test has shown no support for astrology. If  $\chi^2$  is greater than 19.68, we **reject** the null hypothesis and conclude that the test has supported the astrological theory. This is referred to as a **statistically significant** result at the 5% level: that is, it has less than 5% probability of arising purely by chance.
- A value of  $\chi^2$  greater than 19.68 can arise in two different situations. Either the null hypothesis is correct, and a high value has arisen by chance (this happens 5% of the time), or the null hypothesis is not correct. If we reject the null hypothesis, there is a 5% probability that we have made the wrong decision. If you feel that 5% is too high a value, you may use a smaller level of significance - 1% is another commonly used value - and then you will only reject the null hypothesis if  $\chi^2$  is greater than 24.73.
- It is important to realise that, whatever decision you make, you may be wrong! The situation is analogous to a court of law during a murder trial. The null hypothesis is that the person is innocent (in this country, at least), and the alternative hypothesis is that they are guilty. On the basis of the evidence, you make a decision to acquit or convict the person. A wrong decision in either direction can have serious consequences.

### Some Problems with Testing Astrology:

- The general theory of statistical testing has been outlined in the above example. However, there are many problems and pitfalls in applying this theory: some of these will be outlined here. They range from very obvious and straightforward problems to very subtle and unexpected ones.
- The first problem is that any statistical irregularity found may in fact be true for all people - that is, it may be the result of a demographic or astronomical law. If more people were born with their sun in Scorpio then it would not be surprising that more mathematicians appeared in this category. This is in fact the case - there is an excess of births in the spring, for humans as well as lambs!  
 Earlier this century, an astrologer named Krafft examined the sun signs of almost 3000 musicians and found that more of them were born under Taurus than chance would lead us to expect. He concluded that the signs do exert an influence on musical ability. However, since Taurus is a (northern hemisphere) spring sign, the excess of births is the result of a demographic law.  
 Krafft also fell foul of an astronomical law. He looked at those of his musicians who had their moon in conjunction with Uranus (i.e., within about  $8^\circ$  of each other). This conjunction was very common in some signs, but completely absent in others. Krafft's conclusion failed to notice that, since Uranus moves very slowly through the zodiac, it had not reached many of the signs for the group of musicians he considered.



- The solution to this problem is to use what statisticians call a **control**. When we look at the sun signs of a group of famous mathematicians to check whether there are any unusual irregularities, we should also look at the sun signs of a similar sized group of ordinary people of about the same age as the mathematicians. Any irregularities caused by demographic or astronomical laws will be evident in both groups.
- The second problem is caused by the very logic of statistical testing. If you carry out a large number of statistical tests, about 1 in 20 of them will show a significant result (at the 5% level) **by chance alone**. If we had been examining the connection between sun signs and various occupations, it would not be surprising that one group (maybe the mathematicians) did show a significant result.  
This is probably what caused another astrologer, Choisnard, to find a significant excess of ascendants in the intellectually inclined 'air' signs of Gemini, Libra and Aquarius for a group of more than 100 talented people.  
The same problem occurred when the psychologist Jung was studying the relationship between the horoscopes of 180 happily married couples. He found that the moon in the woman's horoscope was very likely to be in the same position as the sun in the man's horoscope. However, with 10 'planets' in each horoscope, there are 100 possible pairs, of which Jung studied 50. It is hardly surprising that one of these yielded a significant result.
- The solution to this problem is to use what statisticians refer to as **replication**. If you obtain a significant result in an experiment like those discussed above, you must repeat the experiment with another sample of people, this time concentrating your attention only on the particular anomaly that you discovered. If it arose by chance in the first case, it is only likely to arise by chance in the repeat experiment. If it is a real irregularity, then it should be evident in repetitions.
- There are other problems of a more subtle nature in testing astrological claims. For instance, an experiment by Mayo *et al.* found that astrology could predict a major dimension of personality - extraversion and introversion. The result was statistically significant, and held up in replication. However, it was shown that people with some knowledge of astrology modify their ideas about their personality on the basis of the known characteristics of their sun sign. If you have your sun in Leo, you might start to see yourself as generous, magnanimous and a good leader, and, who knows, you may even become a good leader! Almost everyone knows a bit about astrology, and Mayo's results could be explained even if only a few people had identified with the traits of their sun sign.
- One solution to this problem is to use people with no knowledge of astrology (children, for example), or people with much more knowledge of astrology (who realise that the sun sign is only one factor among many). Alternatively, the assessment of personality could be made by some means other than a questionnaire.
- A final example, although there are many more! People can be divided into two classes: 'confirmers' and 'disconfirmers'. Confirmers are those people who have a personality and fate similar to what astrological theory would predict. Disconfirmers have a

personality and fate in conflict with what astrological theory would predict. Notice that this is irrespective of the truth of astrology – confirmers might occur just by chance. If you run an astrological test using confirmers, you will get generally positive results. This has in fact been demonstrated to have happened several times, in one case in an experiment by Clark in which astrologers matched personality descriptions of people with their horoscopes.

- The solution in this case is to use as many people as possible in your experiments, and to select them randomly. In this case, you can expect to get about the same proportion of confirmers as there are in the general population.

### The Results of Astrological Testing:

- Although our main aim here has been to look at the statistical methods used in testing astrology, it is nevertheless interesting to see what results have been obtained to date. The first point to note is that *'no law of classical astrology has been demonstrated statistically by astrologers or scientists'* (Gauquelin [3]). In other words, the scientific verdict is that traditional astrology is rubbish!
- However, some positive results have been obtained by Gauquelin and his co-workers who have been researching in this area since the 1950's. These results are fascinating and quite unexpected. Although they have been established by what seems to be careful, thorough and controlled testing, and have been confirmed many times in replications, they are vehemently opposed by most members of the scientific establishment.
- Gauquelin has discovered that there seems to be a connection between the positions of certain planets at the time of birth and preeminence in certain professions. In the horoscopes of successful people in various occupations, certain planets occur significantly more often than chance in the sectors just past the ascendant and the midheaven (roughly corresponding to the astrological houses 12 and 9). These sectors are occupied by a planet that has just risen over the eastern horizon, or has just passed its zenith. This work was first published around 1960.  
Gauquelin found that Mars appears in those positions for many famous scientists, doctors and athletes. Jupiter appears there for famous military men, politicians and actors, Saturn for famous scientists and doctors, and the moon for famous politicians and writers. No results have been found for the other planets.  
For example, for 1553 sports champions, the following numbers were found to have Mars in each of 12 sectors (roughly corresponding to the 12 astrological houses):

134, 118, 114, 133, 124, 124,

104, 116, 158, 128, 125, 175.

The highest values are underlined: you can see that they fall in the ninth and twelfth sectors. You may care to show that, for this set of data,  $\chi^2$  is equal to 32.5, which is greater than the value of 24.73 required to achieve a significant result at the 1% level.

- Following on from this, personality descriptions of over 7000 famous people were related to the planets that appeared in the critical sectors. A coherent list of traits

were obtained for each planet:

Mars – active, eager, reckless, quarrelsome

Jupiter – ambitious, authoritarian, opportunistic

Saturn – formal, reserved, conscientious

Moon – amiable, imaginative, superficial.

Less definite results were obtained for Venus, and nothing for the other planets. These results were obtained in the late 1970's.

- By looking at the horoscopes of 15000 couples and their children (ordinary people, not necessarily eminent), Gauquelin established a form of planetary heredity. If one parent had Mars, Jupiter, Saturn or the moon in the critical sectors, their children were more likely to have the planet in the same positions. If both parents had planets in the critical sectors, their children were twice as likely to follow suit.
- The mechanism for these effects is still under investigation. Latest theories (for example, by Seymour [8]) talk about magnetic influences from the nearest and largest planets attenuating the magnetic field around the earth, and somehow being picked up by the still unborn child. The fact that the effect is only found for the nearest and largest planets implies that some sort of distance-mass law is at work. Response to magnetic influences is postulated to be determined genetically, therefore the planets at birth become indicators of the type of personality. It has been shown, for example, that Gauquelin's effects are more marked on days of heightened magnetic activity. Interestingly, the effects are only seen for natural births, and disappear completely for induced births.

### Conclusions:

- Most of traditional astrology has been proved to be rubbish using sound statistical principles. The results of Gauquelin represent a challenge to science: they seem to indicate evidence for the basic premise of astrology (though in a different way to traditional theory).
- This may sound far fetched, but the critics of Gauquelin have not been able to come up with anything better than *ad hominem* arguments, or the possibility of subconscious bias in the selection of many tens of thousands of birth data over several decades by several researchers. The scientific establishment has a lot of explaining to do!
- This chapter in the history of science is still being written, so we don't know '*the truth about astrology*'. It is important from our point of view to notice the essential part played in this investigation by statistics and the statistical method.

### References:

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[2] *Astrology and Science* (Davies 1970)

[3] *The Cosmic Clocks* (Paladin 1973)

[4] *The Spheres of Destiny* (Dent 1980)



[5] *The Truth about Astrology* (1984)

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[6] *Teach Yourself Astrology* (Teach Yourself 1964)

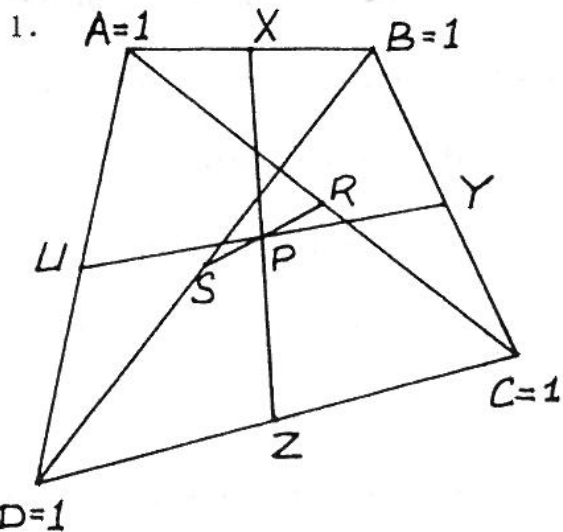
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[7] *The Compleat Astrologer* (Beazley 1975)

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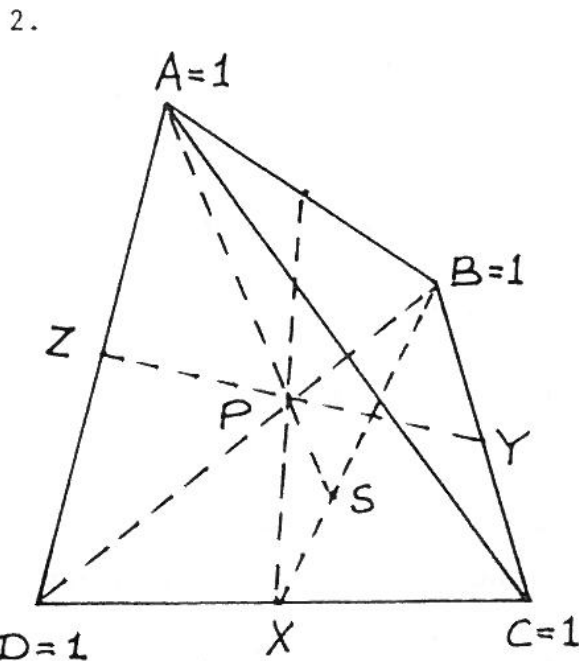
[8] *Astrology: The Evidence of Science* (Lennard 1988)

### Solutions to Problems on Page 10



Place a mass of  $1g$  into each vertex and find the centre of mass in 3 different ways:

a) The centre of mass on the rod  $AB$  is at  $X$  the midpoint of  $AB$ , with mass = 2, similarly the centre of mass for  $CD$  is at  $Z$  the midpoint of  $CD$ . Therefore the centre of mass is halfway between  $XZ$ , at point  $P$ . But we could have considered  $A, D$ , and  $B, C$ , or  $B, D$  and  $A, C$ , every time getting the centre of mass being halfway on the lines  $UY$ , resp.  $SR$ , (see figure) therefore these 3 lines must meet each other in a common point  $P$  which bisects each of these lines.



Place a mass of  $1g$  at each vertex of the tetrahedron and find the centre of mass in several different ways.

a) The masses at  $D, B, C$  can be replaced by a mass of  $3g$ 's at  $S$ , the centroid of  $\triangle DBC$ . Join  $S$  to  $A$ , then the centre of mass has to be on the line  $SA$ , at  $P$ , such that  $AP \div PS = 3 \div 1$ . But we could have started with any one of the 3 other triangles, so all 4 of these lines have to pass through  $P$  and be divided in the ratio  $3 \div 1$ .

b) Alternately we can take the centre of mass of the two masses at  $B$  and  $C$ , this will be at point  $Y$ , midpoint of  $BC$ , and represents  $2g$ 's. The remaining masses at  $A$  and  $D$  can be replaced by a mass of  $2g$ 's at  $Z$ , the midpoint of  $AD$ . So the centre of mass is at the midpoint of  $YZ$  which therefore is the same point  $P$  that we found in part a).