2015-2016 Math League Contests, Grades 9 – 12
Second-Round, Jan - Feb 2016

Instructions:

1. This second-round contest consists of two parts. Part 1 is math questions. Part 2 is essay.
2. For all the questions below, login to your account at http://www.mathleague.cn/ , and enter your answers. Answers written on this document will NOT be credited.
3. In Part 1, you are asked to read one math subject, The Mathematics of Normal Distributions, and the supplementary materials if necessary, Descriptive Statistics. Then you have 28 questions to work on. You will need to give precise, unambiguous answers to Questions 1-19 (The Mathematics of Normal Distributions), and Questions 21-26 (Descriptive Statistics).
4. Question 20 (The Mathematics of Normal Distributions) and 27-28 (Descriptive Statistics) are Projects and Papers, which means you need to do your research and write a paper for each question. There is no word limit on each of your papers, but it doesn't necessary mean the more words the better. The best paper is precise and succinct. Please don't feel frustrated at all if you can't write a paper, as the topics, Confidence Intervals (Question 20); Lies, Damn Lies, and Statistics (Question 27); and Data in Your Daily Life (Question 28), are very hard for a high school student, even for an adult. Please don't feel frustrated even if you can't finish all of Questions 1-19, 21-26, as they are not trivial questions and it requires a lot reading and thinking. Students who can work out a few questions should be commended.
5. **For the subject of Normal Distributions, if you really understand what it is and how it works, then the questions are fairly easy to solve. So our recommendation is don't rush to solve the problems. Instead please take your time to read and understand the subject thoroughly. Once you understand how Normal Distributions works, you can solve most of the problems without much difficulty. So this is really a test of your research and analytical skill, your patience, and perseverance.**
6. **In order to understand Normal Distributions, you need to be familiar with basic statistics terms such as mean, median, standard deviation, percentile, quartile, and etc. It is a good idea to read the subject Descriptive Statistics, the supplementary materials, thoroughly to refresh your memory.**
7. The more questions you answered correctly, the more credit you will get. The total credit, or perfect score, of Part 1 is 180. The total credit, or perfect score, of Part 2, is 90. The problems are ordered by content, NOT DIFFICULTY. It is to your advantage to attempt problems from throughout the test.
8. You can seek help by reading books, searching the Internet, asking an expert, and etc. But you can't delegate this to someone else and turn in whatever he/she wrote for you. To make it clear, the purpose of the second-round contest is to test your ability to read and research. You need to be the one who understand the topics and solve the problems. You will be caught if it is not the case during the interview.
9. For Part 1, you can write in either English or Chinese.
10. In Part 2, you are asked to write an essay. You have to write in English in Part 2.
11. If you have any questions regarding the contest, please contact us at once at INFO@LTHOUGHTS.COM
12. This document contains 16 pages in total, including this page.
13. Submission of your answers:
    a) For all the questions below, login to your account at http://www.mathleague.cn/ , and enter your answers. Answers written on this document will NOT be credited.
    b) You need to submit your answers no later than 12:00AM, Feb 7, 2016, Beijing Time. Later submission will not be accepted.

Part 1 – The Mathematics of Normal Distribution

The following is an excerpt from some math book.

The Mathematics of Normal Distributions, (see separate document).

Understanding the above Chapter on "Normal Distributions" requires familiarity with basic statistics terms such as mean, median, standard deviation, percentile, quartile, and etc. It helps to read the following Chapter on "Descriptive Statistics", the supplementary materials, if you need to refresh your memory of these terms.

Descriptive Statistics, (the supplementary materials, see separate document).

For all the questions below, login to your account at http://www.mathleague.cn/ , and enter your answers. Answers written on this document will NOT be credited.

Question 1: (credit: 4)

Consider a normal distribution with $Q_1 = 432.5$ points and $Q_3 = 567.5$ points.

(a) Find the mean μ of the distribution.

(b) Find the standard deviation σ of the distribution rounded to the nearest point.

Hint: Q_1 is the first quartile. Q_3 is the third quartile. For the definition of Q_1 and Q_3, see Section 14.3, of Chapter 14, "Descriptive Statistics."

Answer:
(a) 500 points
(b) 100 points

Question 2: (credit: 4)

Estimate the value of the standard deviation (rounded to the nearest inch) of a normal distribution with $\mu = 81.2$ inch and $Q_3 = 94.7$ inch.

Hint: Q_3 is the third quartile. For the definition of Q_3, see Section 14.3, of Chapter 14, "Descriptive Statistics."

Answer:
20 inch

Question 3: (credit: 4)

Explain why a distribution with $\mu = 195$, $Q_1 = 180$, and $Q_3 = 220$ cannot be a normal distribution.

Note: Q_1 is the first quartile. Q_3 is the third quartile. For the definition of Q_1 and Q_3, see Section 14.3, of Chapter 14, "Descriptive Statistics."

Note: For this question, please write your answer on file "high-school-answersheet.doc", downloadable together with this document at www.mathleague.cn, and submit file "high-school-answersheet.doc" at www.mathleague.cn after you are done.

Answer:

In a normal distribution, the mean μ must be at the median of the quartiles.

Question 4: (credit: 4)

In a normal distribution with $\mu = 50$ lb, a weight of $x = 84$ lb has the standardized value $z = 2$. Find the standard deviation σ.

Answer:
17 lb.

Question 5: (credit: 4)

In a normal distribution with $\mu = 183.5$ ft and $\sigma = 31.2$ ft, find the data value corresponding to each of the following standardized values.

(a) -1 **(b)** 0.5

(c) -2.3 **(d)** 0

Answer:

(a) 152.3 ft **(b)** 199.1 ft **(c)** 111.74 ft **(d)** 183.5 ft

Question 6: (credit: 4)

In a normal distribution, the data value $x_1 = 20$ has the standardized value $z_1 = -2$ and the data value $x_2 = 100$ has the standardized value $z_2 = 3$. Find the mean μ and the standard deviation σ.

Answer:

$\mu = 52; \sigma = 16$

Question 7: (credit: 4)

A normal distribution has standard deviation $\sigma = 6.1$ cm, and 84% of the data fall above 50.2 cm. Find the mean μ.

Answer:

56.3 cm

Question 8: (credit: 4)

In a normal distribution with mean μ and standard deviation σ, what percent of the data fall

(a) below the value $\mu + 2\sigma$?

(b) between $\mu + \sigma$ and $\mu + 2\sigma$?

Answer:

(a) 97.5% **(b)** 13.5%

Question 9: (credit: 4)

A normal distribution has mean $\mu = 12.6$ and standard deviation $\sigma = 4.0$. Approximately what percent of the data fall between 9.9 and 16.6?

Answer:

59%

Questions 10 & 11 refer to the following:

The distribution of weights for children of a given age and sex is approximately normal. This fact allows a doctor or nurse to find from a child's weight the weight percentile of the population (all children of the same age and sex) to which the child belongs. Typically, this is done using special charts provided to the doctor or nurse, but these percentiles can also be computed using facts about approximately normal distributions, such as the ones we learned in this chapter. (Note: The numbers in these examples are 1997 figures taken from charts produced by the National Center for Health Statistics, U.S. Department of Health and Human Services.)

Note: For the definition of percentile, see Section 14.3, of Chapter 14, "Descriptive Statistics."

Question 10: (credit: 6)

The distribution of weights for six-month-old baby boys is approximately normal with mean $\mu = 17.25$ pounds and standard deviation $\sigma = 2$ pounds.

(a) Suppose that a six-month-old boy weighs 15.25 pounds. Approximately what weight percentile is he in?

(b) Suppose that a six-month-old boy weighs 21.25 pounds. Approximately what weight percentile is he in?

(c) Suppose that a six-month-old boy is in the 75th percentile in weight. Estimate his weight.

Answer:

(a) 16th percentile **(b)** 97.5th percentile **(c)** 18.6 lb.

Question 11: (credit: 6)

The distribution of weights for one-month-old baby girls is approximately normal with mean $\mu = 8.75$ pounds and standard deviation $\sigma = 1.1$ pounds.

(a) Suppose that a one-month-old girl weighs 11 pounds. Approximately what weight percentile is she in?

(b) Suppose that a one-month-old girl weighs 12 pounds. Approximately what weight percentile is she in?

(c) Suppose that a one-month-old girl is in the 25th percentile in weight. Estimate her weight.

Hint:
(c) Rounded to the nearest pound.

Answer:

(a) 97.5th percentile **(b)** 99.85th percentile **(c)** 8 lb.

Question 12: (credit: 6)

A dishonest coin with probability of heads $p = 0.4$ is tossed $n = 600$ times. Let the random variable X represent the number of times the coin comes up heads.

(a) Find the mean and standard deviation for the distribution of X.

(b) Find the first and third quartiles for the distribution of X.

(c) Find the probability that the number of heads will fall somewhere between 216 and 264.

Hint:
(b) Rounded to nearest integer.
(c) Enter your answer as a decimal between 0 and 1, rounded to the nearest hundredth.

Answer:

(a) $\mu = 240, \sigma = 12$ **(b)** $Q_1 \approx 232, Q_3 \approx 248$
(c) 0.95

Question 13: (credit: 6)

Suppose that an honest die is rolled $n = 180$ times. Let the random variable X represent the number of times the number 6 is rolled.

(a) Find the mean and standard deviation for the distribution of X.

(b) Find the probability that a 6 will be rolled more than 40 times.

(c) Find the probability that a 6 will be rolled somewhere between 30 and 35 times.

Hint:
(b) Rounded to nearest thousandth.
(c) Rounded to the nearest hundredth.

Answer:

(a) $\mu = 30, \sigma = 5$ **(b)** approximately 0.025
(c) approximately 0.34

Question 14: (credit: 4)

Each day a machine produces 1600 widgets. In 95 out of the last 100 days, the machine has produced somewhere between 117 and 139 defective widgets per day. What are the chances that a randomly selected widget produced by this machine is defective?

Answer:
0.08

Questions 15-18:

Percentiles. *The* ***pth percentile*** *of a sorted data set is a number x_p such that p% of the data fall at or below x_p and (100 − p)% of the data fall at or above x_p. (For details, see Chapter 14, Section 14.3.) For normally distributed data sets, there are detailed statistical tables that give the location of the pth percentile for every possible p between 1 and 99. The following table is an abbreviated version giving the approximate location of some of the more frequently used percentiles in a normal distribution with mean μ and standard deviation σ. For approximately normal distributions, Table 16-3 can be used to estimate these percentiles.*

TABLE 16-3

Percentile	Approximate location	Percentile	Approximate location
99th	$\mu + 2.33\sigma$	1st	$\mu - 2.33\sigma$
95th	$\mu + 1.65\sigma$	5th	$\mu - 1.65\sigma$
90th	$\mu + 1.28\sigma$	10th	$\mu - 1.28\sigma$
80th	$\mu + 0.84\sigma$	20th	$\mu - 0.84\sigma$
75th	$\mu + 0.675\sigma$	25th	$\mu - 0.675\sigma$
70th	$\mu + 0.52\sigma$	30th	$\mu - 0.52\sigma$
60th	$\mu + 0.25\sigma$	40th	$\mu - 0.25\sigma$
50th	μ		

In Questions 15-18, you should use the table above to make your estimates.
Note: For the definition of percentile, see Section 14.3, of Chapter 14, "Descriptive Statistics."

Question 15: (credit: 4)

The distribution of weights for six-month-old baby boys is approximately normal with mean $\mu = 17.25$ pounds and standard deviation $\sigma = 2$ pounds.

(a) Suppose that a six-month-old baby boy weighs in the 95th percentile of his age group. Estimate his weight in pounds approximated to two decimal places.

(b) Suppose that a six-month-old baby boy weighs in the 40th percentile of his age group. Estimate his weight in pounds approximated to two decimal places.

Answer:

(a) 20.55 lb **(b)** 16.75 lb

Question 16: (credit: 4)

Consider again the distribution of weights of six-month-old baby boys in Question 15.

(a) Jimmy is a six-month-old-baby who weighs 17.75 lb. Estimate the percentile corresponding to Jimmy's weight.

(b) David is a six-month-old baby who weighs 16.2 lb. Estimate the percentile corresponding to David's weight.

Answer:

(a) 60th percentile **(b)** 30th percentile

Question 17: (credit: 6)

In 2007, a total of 1,494,531 college-bound seniors took the SAT exam. The distribution of scores in the *Critical Reading* section of the SAT was approximately normal with mean $\mu = 502$ and standard deviation $\sigma = 113$. (Source: *www.collegeboard.org*.)

(a) Estimate the 75th percentile score on the exam. (*Note*: SAT scores come in multiples of 10.)

(b) Estimate the 70th percentile score on the exam.

(c) Estimate the percentile corresponding to a test score of 530.

Answer:

(a) 580 points **(b)** 560 points **(c)** 60th percentile

Question 18: (credit: 8)

The grade breakdown in Dr. Blackbeard's Stat 101 class is: 10% A's, 20% B's, 40% C's, 25% D's, and 5% F's. The numerical class scores had an approximately normal distribution with mean $\mu = 65.2$ and standard deviation $\sigma = 10$.

(a) What is the minimum numerical score needed to get an A?

(b) What is the minimum numerical score needed to get a B?

(c) What is the minimum numerical score needed to get a C?

(d) What is the minimum numerical score needed to get a D?

Answer:

(a) 78 points **(b)** 70.4 points **(c)** 60 points

(d) 48.7 points

Question 19: (credit: 4)

An honest coin is tossed n times. Let the random variable Y denote the number of tails tossed. Find the value of n so that there is a 16% chance that Y will be at least $(n/2) + 10$.

Answer:

400

Question 20: (credit: 20, note: paper with exceptional quality can get up to 40 credits)

Confidence Intervals

The concept of a *confidence interval* was introduced in Example 16.13 in this chapter. The two most frequently used levels of confidence intervals are 95% confidence intervals (sometimes described as intervals at a 95% *confidence level*) and 90% confidence intervals (intervals at a 90% *confidence level*).

In this project, you are to describe the process of constructing confidence intervals in general. Given a target confidence level 95% (or 90%, or x%), how do you construct the corresponding confidence interval? Conversely, given a specified interval, how do you find the confidence level that best fits that interval? Illustrate the relationship between confidence level and the size of the confidence interval using a real-life poll. Conclude with a discussion of some common misconceptions about confidence intervals. When no confidence interval is mentioned, how should we properly interpret the results of the poll?

Note: You can write in either Engish or Chinese.

Note: For this question, please write your answer on file “high-school-answersheet.doc”, downloadable together with this document at www.mathleague.cn, and submit file “high-school-answersheet.doc” at www.mathleague.cn after you are done.

以下试卷供大家参考。这份试卷并不代表是写得最好、最正确、最全面、得分最高的，只是给大家参考。

参考试卷：

The following essay includes five parts:
To construct a confidence interval
To find a confidence level
Illustration of the relationship
Common misconception
How to interpret a poll

To construct a confidence interval

After reading Example 16.13 in the textbook provided, I found out that the confidence interval is similar to the interval in normal distribution, where 68% of the data lies within one standard deviation above and below the mean. In the construction of confidence interval, the lower and upper limits are also obtained by subtracting certain number of standard deviation/standard error from the statistics of the sample.

However, Example 16.13 in the book is not a general example in finding a confidence interval, since it illustrates the conditions in a poll, where the results are expressed in percentage.

First I will illustrate the method of constructing a confidence interval generally, of which the results are shown in numbers instead of percentage.

When we are given a confidence level, we should look up the chart that tells us the critical value z. The interval should be determined as:

$$\mu_{sample} \pm z \times \sigma_{sample}$$

while assuming that the sampling distribution is normal. μ_{sample} means the mean of the sample. σ_{sample} means the standard deviation of the sample.

The mean of the sample is equal to the mean of the whole population.

The standard deviation of the sample can be calculated as:

$$\sigma_{sample} = \frac{\sigma_{pop}}{\sqrt{n_{sample}}}$$

In which σ_{pop} represents the standard deviation of the whole population; n denotes the size of the sample. σ_{sample} in the normal distribution can also be obtained by the dishonest-coin principle:

$$\sigma_{sample} = \sqrt{n_{sample} \times p \times (1-p)}$$

In which n denotes the size of the sample; p denotes the possibility of certain event.

Second, the method of constructing a confidence interval in which the results should be expressed in percentage such as a poll is the same intrinsically as the method illustrated above. We set the possibility of a certain event which we want to construct its confidence interval as p.

The interval can be obtained as:

$$p \pm z \times \frac{\sigma_{sample}}{n_{sample}} = p \pm z \times \frac{\sqrt{n_{sample} \times p \times (1-p)}}{n_{sample}} = p \pm z \times \frac{p \times (1-p)}{\sqrt{n_{sample}}}$$

In which n represents the size of the whole population.

We can set p as 0.5 to maximize $p \times (1-p)$ which maximize σ_{sample} and the interval.

Then we need to know the size of the sample and the possibility of a certain event p. After that, we look up the chart for the value of z.

After obtaining these values, we can construct a confidence interval.

To find a confidence level

Given a confidence interval, we know the upper and lower limit of the interval.

$$\text{Lower limit} = p - z \times \frac{p \times (1-p)}{\sqrt{n_{sample}}}$$

$$\text{Upper limit} = p + z \times \frac{p \times (1-p)}{\sqrt{n_{sample}}}$$

Subtract lower limit from the upper limit we can get:

$$U - L = 2 \times z \times \frac{p \times (1-p)}{\sqrt{n_{sample}}}$$

To find the confidence level, we need to obtain the value of z.

Therefore, we need to know the size of the sample and the possibility of the event.

Or to estimate, we can set p as 0.5 to maximize $p \times (1-p)$ which maximize σ_{sample} and the interval.

$$z = \frac{(U-L) \times \sqrt{n_{sample}}}{2 \times p \times (1-p)}$$

Then we look up the chart that tells us the confidence level that corresponds the nearest to z.

Illustration of the relationship

The bigger the confidence level is, the bigger the size of the confidence interval.

Before 2012 presidential election, 1000 registered voters were asked who they wanted to vote for in the 2012 presidential election. 50% of people planned to vote for Barack Obama and 44% of people planned to vote for Mitt Romney, while 6% of people were still undecided.

$$\sigma_{sampleobama} = \sqrt{1000 \times 0.5 \times (1-0.5)} = 15.8114$$

Therefore the respective standard error is:

$$SE_{obama} = \frac{15.811}{1000} \times 100\% = 1.58\%$$

Therefore, there is 68% of possibility that the percentage of vote for Obama will fall between:

$$50\% - 1 \times 1.58\% = 48.42\% \text{ and } 50 + 1 \times 1.58\% = 51.58\%$$

There is 95% of possibility that the percentage of vote for Obama will fall between:

$$50\% - 2 \times 1.58\% = 46.84\% \text{ and } 50 + 2 \times 1.58\% = 53.16\%$$

We can see that:

$$51.58\% - 48.42\% = 2 \times SE_{obama}$$

$$53.16\% - 46.84\% = 4 \times SE_{obama}$$

Therefore, the confidence interval with 95% confidence level is bigger than that with 68% confidence level.

Because the bigger confidence interval provides with more possibility that the result will fall in the interval, which means the bigger confidence level, the bigger the confidence level is, the bigger the size of the confidence interval. Besides, the confidence interval is calculated by:

$$p \pm z \times \frac{\sigma_{sample}}{n_{sample}}$$

The bigger the confidence interval, the bigger critical value z is.

Common misconception

We take the confidence level 95% as an example.

A common misconception is: The final true result has 95% of possibility to fall in the confidence interval.

It results from the misconception of the concepts. The true result can only have two possibilities: fall in the confidence interval or not. It cannot have 95% or 68% or whatever of possibility to fall in the interval.

So what does the 95% confidence level mean? What's the use to define a concept of confidence interval and confidence level?

They are used to predict the true-result-interval (the interval where unknown true result lies) from the **sample**.

Therefore the correct understanding should be: When we obtain confidence intervals from repeatedly from different samples through the same way, there are confidence intervals from 95% samples that will include the true value.

According to the International Association of Statistical Education, 75% of undergraduates think that as the size of the sample increases, the width of confidence interval increases. On the contrary, the width decreases as the sample size increases. Because the confidence interval is obtained by

$$\mu_{sample} \pm z \times \sigma_{sample}$$

σ_{sample} is obtained as:

$$\sigma_{sample} = \frac{\sigma_{pop}}{\sqrt{n_{sample}}}$$

The bigger the size is, the smaller the standard deviation is, the smaller the confidence interval. Because the bigger the size is, each data will have less effect on the whole.

How to interpret a poll

The definition of a poll: poll is a sampling or collection of opinions on a subject, taken from either a selected or a random group of persons, as for the purpose of analysis.

The factors that will affect the results of a poll are as followings:

1. the group of people who vote --- if there is selection bias
2. the size of the group --- it will affect the standard deviation
3. big sampling error

To correctly interpret the result of a poll, the group of people who vote matters much. The sample can be scientifically selected or self selected. The place of a poll is held also matters. For example, the poll of a presidential election held by Times magazine will mainly receive the votes from readers of Times magazine, who have a certain kind a characteristics that cannot represent the whole population. The readers of a business magazine may favor a president whose policy will benefit themselves as businessmen.

The marginal error plays a very significant role in interpreting the result. For example, if Candidate A is reported to have 47% of support and Candidate B is reported to have 45% of support, however, the margin of error is reported to be ±3%. That means Candidate A may not be in the lead of Candidate B. Because with the margins of error, Candidate A's support could change from 44% to 50%; Candidate B's support could change from 42% to 48%.

We also need to compare the poll with other same polls conducted at the time to see if the poll has a big sampling error that cannot well reflect the whole population.

Question 21: (credit: 4)

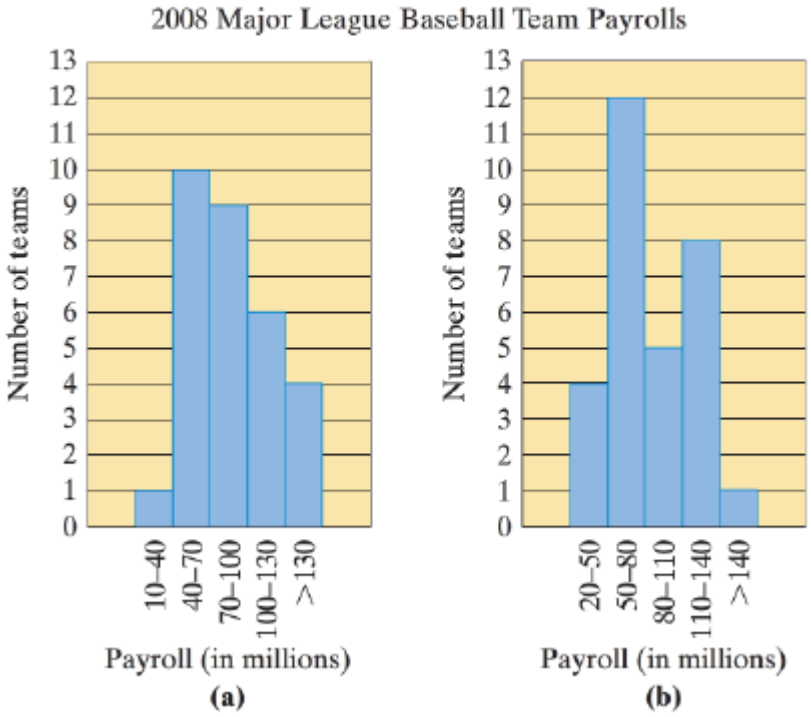
In 2006, the median SAT score was the average of $d_{732,872}$ and $d_{732,873}$, where $\{d_1, d_2, \ldots, d_N\}$ denotes the data set of all SAT scores ordered from lowest to highest. Determine the number of students N who took the SAT in 2006.

Answer:
1465744

Question 22: (credit: 4)

The two histograms below summarize the team payrolls in Major League Baseball (2008).

The two histograms are based on the same data set but use slightly different class intervals. (You can assume that no team had a payroll that was exactly equal to a whole number of millions of dollars.)



Using the information in the figure, where did the median payroll of 2008 baseball teams fall?
(a) Somewhere between $50 million and $80 million
(b) Somewhere between $70 million and $80 million
(c) Somewhere between $70 million and $100 million
(d) Somewhere between $80 million and $100 million

Answer:
(b)

Question 23: (credit: 6)

This question refers to histograms with unequal class intervals.

When sketching such histograms, the columns must be drawn so that the frequencies or percentages are proportional to the area of the column. Figure 14-25 illustrates this. If the column over class interval 1 represents 10% of the population, then the column over class interval 2, also representing 10% of the population, must be one-third as high, because the class interval is three times as large (Fig. 14-25).

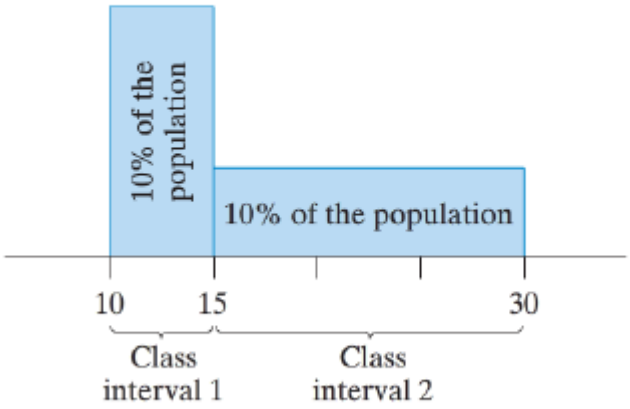


FIGURE 14-25

If the height of the column over the class interval 20–30 is one unit and the column represents 25% of the population, then

(a) how high should the column over the interval 30–35 be if 50% of the population falls into this class interval?

(b) how high should the column over the interval 35–45 be if 10% of the population falls into this class interval?

(c) how high should the column over the interval 45–60 be if 15% of the population falls into this class interval?

Answer:
(a) 4 **(b)** 0.4 **(c)** 0.4

Question 24: (credit: 8)

News media have accused Tasmania State University of discriminating against women in the admission policies in its schools of architecture and engineering. The *Tasmania Gazette* states that "68% of all male applicants to the schools of architecture or engineering are admitted, while only 51% of the female applicants to these same schools are admitted." The actual data are given in Table 14-23.

TABLE 14-23 Applications/admissions by gender

	School of Architecture		School of Engineering	
	Applied	Admitted	Applied	Admitted
Male	200	20	1000	800
Female	500	100	400	360

(a) What percent of the male applicants to the School of Architecture were admitted? What percent of the female applicants to this same school were admitted?

(b) What percent of the male applicants to the School of Engineering were admitted? What percent of the female applicants to this same school were admitted?

(c) How did the *Tasmania Gazette* come up with its figures?

(d) Explain how it is possible for the results in (a) and (b) and the *Tasmania Gazette* statement to all be true.

Note: For (c) and (d), please write your answer on file "high-school-answersheet.doc", downloadable together with this document at www.mathleague.cn, and submit file "high-school-answersheet.doc" at www.mathleague.cn after you are done.

Answer:

(a) Male: 10%; female: 20% **(b)** Male: 80%; female: 90%

(c) The figures for both schools were combined. Of a total of 1200 males who applied, 820 were admitted, an admission rate for males of approximately 68.3%. Similarly, of a total

of 900 females who applied, 460 were admitted, an admission rate for females of approximately 51.1%.

(d) In this example, females have a higher percentage $\left(\frac{100}{500} = 20\%\right)$ than males $\left(\frac{20}{200} = 10\%\right)$ for admissions to the School of Architecture and also a higher percentage $\left(\frac{360}{400} = 90\%\right)$ than males $\left(\frac{800}{1000} = 80\%\right)$ for the School of Engineering. When the numbers are combined, however, females have a lower percentage $\left(\frac{100 + 360}{500 + 400} \approx 51.1\%\right)$ than males $\left(\frac{20 + 800}{200 + 1000} \approx 68.3\%\right)$ in total admissions. The reason this apparent paradox can occur is purely a matter of arithmetic: Just because $\frac{a_1}{a_2} > \frac{b_1}{b_2}$ and $\frac{c_1}{c_2} > \frac{d_1}{d_2}$, it does not necessarily follow that $\frac{a_1 + c_1}{a_2 + c_2} > \frac{b_1 + d_1}{b_2 + d_2}$.

Question 25: (credit: 4)

Let A denote the mean of data set $\{x_1, x_2, ..., x_N\}$. Let B denote the mean of data set $\{x_1 + c, x_2 + c, ..., x_N + c\}$.

(a) Find the relationship between A and B.

a) $A < B$
b) $A = B - c$
c) $A = B + c$
d) Nondeterministic

(b) Find the mean of $\{x_1 - A, x_2 - A, ..., x_N - A\}$.

Answer:
(a) 答案是 (b)
(b) 答案是 0

Question 26: (credit: 4)

Let R_1 and σ_1 denote the range and standard deviation of data set $\{x_1, x_2, ..., x_N\}$, respectively.

Let R_2 and σ_2 denote the range and standard deviation of data set $\{x_1 + c, x_2 + c, ..., x_N + c\}$, respectively.

(a) Find the relationship between R_1 and R_2.

a) Nondeterministic

b) $R_1 = R_2$

c) $R_1 = R_2 + c$

d) $R_1 = R_2 - c$

(b) Find the relationship between σ_1 and σ_2.

a) Nondeterministic

b) $\sigma_1 = \sigma_2$

c) $\sigma_1 = \sigma_2 + c$

d) $\sigma_1 = \sigma_2 - c$

Answer:

(a) 答案是(b)

(b) 答案是(b)

Question 27: (credit: 20, note: paper with exceptional quality can get up to 40 credits)

Lies, Damn Lies, and Statistics

Statistics are often used to exaggerate, distort, and misinform, and this is most commonly done by the misuse of graphs and charts. In this project you are to discuss the different graphical "tricks" that can be used to mislead or slant the information presented in a picture. Attempt to include items from recent newspapers, magazines, and other media.

Note: You can write in either Engish or Chinese.

Note: For this question, please write your answer on file "high-school-answersheet.doc", downloadable together with this document at www.mathleague.cn, and submit file "high-school-answersheet.doc" at www.mathleague.cn after you are done.

以下是一些同学提交的试卷，供大家参考。这些试卷并不代表是写得最好、最正确、最全面、得分最高的，只是给大家参考，因为这道题目本身就是 open question，没有标准答案或者最佳答案。

试卷一(节选)：

在信息大爆炸的时代，处理信息最方便的方法就是绘制图表。但是一旦处理不得当就容易误导他人。引入歧途的统计图表往往是绘图者故意或无意地采取花招来迷惑群众的双眼，也可能是群众本身就不知道如何正确解读这些图表，从而造成一种误解。一般来讲，"蒙骗式"的图表一般有以下几种类型：

一、样本不具有普遍性

统计学抽样中最重要的原则就是平均分配，各个层次的人群都要考虑到，如果我们所选取的代表只是某一个特殊的群体，那么就会影响样本的代表性，最终的结果一定是不准确的，这种逻辑错误在英文中有一个术语叫做"Hasty Generalization". 比如1936年的美国大选前期，著名的《文学摘要》杂志一如既往地进行了总统选举的预测。该杂志信心满满，因为前4次它都预测准确。《文学摘要》发出了1000万封问卷，收回了230万封。结果显示共和党候选人兰登将以57.1%投票率获胜。可事实是，民主党候选人，也就是当时在任的总统罗斯福以60.8%的普选优势继续当选。这场预测的失败让《文学摘要》颜面扫地。那为什么预测和真实结果会如此大相径庭呢?《文学摘要》给杂志订阅者，拥有汽车和电话的消费者以及俱乐部成员发放了它的调查问卷。而杂志的受众在大萧条时期仍然有时间看，并且是看新闻分析类杂志的，本身就是闲的蛋疼不用为生计奔波的，自然往偏向资本的共和党靠近(共和党当时的政策是高关税和维护商业团体的利益)，而能够买得起汽车和拥有电话的人都是有钱人，可能都是资方，与罗斯福支持的工人阶级本就是冤家对头，自然更多地支持共和党，最后俱乐部成员——物以类聚嘛，都是有钱的主，同时保持了一致的政治倾向。《文学摘要》没有意识到总统选举预测信息的来源实际上是有失偏颇的，忽略了占人口比例大多数的工人阶级的人群，从而酿成了惨剧。

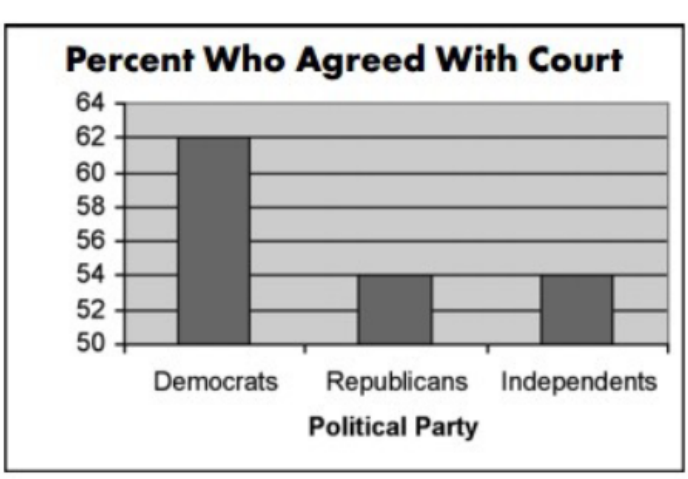
二、数据不具有时效性

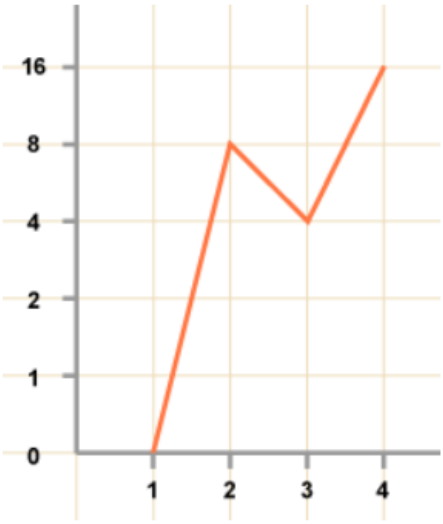
时代在变，人也在变。如果我们统计过程中采用的数据是很久以前的，那么这组数据肯定是不足以用来说明现在的某种特征，除非我们是历史学家，考古学家之类的。

三、统计数据有重叠

比如以下这个图，高露洁宣传说百分之八十的医生都推荐用高露洁牙膏。但实际上在做统计调查的时候医生是可以做多种选择的，不是单项选择，也就是说其他品牌的牙膏也同样可以和高露洁牙膏一样达到这么高的支持率。因为统计数据有重叠，不代表着80%的医生只认为高露洁牙膏最好。因此这张图表具有一定的误导性。

四、没有按照正确比例绘制，或者纵坐标没有从零开始（图表被截断）



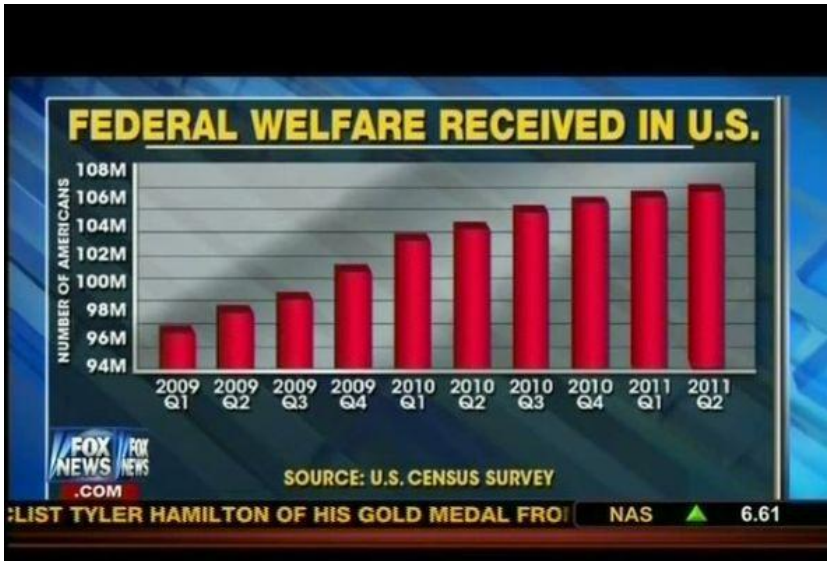


乍一看左边这个图，似乎民主党对法院的支持率要远远高于共和党和无党派，但仔细看一下会发现也不过只有8%的差别，这就是因为纵坐标是从50起始的而不是0，差点就要上当了啊！而右边这个图就是典型的绘制比例错误，我们在分析图表的时候一定要做到仔细，仔细再仔细。

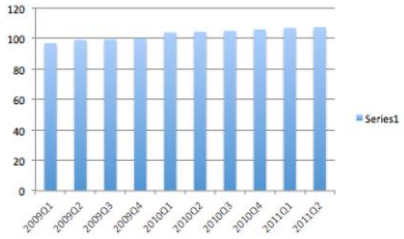
综上所述可以发现，生活中各类的图表都可以被广告商或其他人士为了各种目的巧妙的处理，以达到某种目的。比如：饼状图可以扩大或缩小实际数据的百分比；线性图可通过改变Y轴范围，强化图形的高峰和低谷；堆积图则可以利用下层数据的波动来改变上层数据的起伏。因此，在这样在信息大爆炸的时代，我们要时刻保持警惕，读懂这些小伎俩，识破骗人的把戏，才可以避免造成一定的损失。

试卷二(节选)：

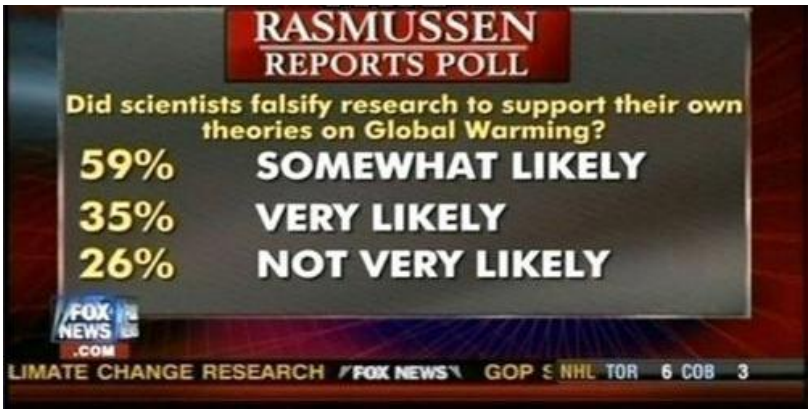
In a statistical graph, some news reporters will exaggerate the difference between two different times through adjusting the minimum and maximum number in y-axis. Here I extract some statistics from FOX NEWS.



Obviously, such graphs only concerned about the potential increase for some affairs that are pleasing. But in fact, these increase are relatively small if we make an actual graph:



And for some polls, the sum of percentage of different options is not equal to 100%. The consequence will be rigorous, since reporters exaggerate or demolish the differences among options.



Some reporters even craft the potential for using some values that show the general potential increase through previous data shown below:

But they neglect what's happening during certain time intervals. If the data **fluctuate** very rapidly, it is not reliable for these data to show this obvious potential. (Turn to the next page)

Here is another graph shown by a famous website about statistics.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number of people who died by becoming tangled in their bedsheets Deaths (US) (CDC)	327	456	509	497	596	573	661	741	809	717
Total revenue generated by skiing facilities (US) Dollars in millions (US Census)	1,551	1,635	1,801	1,827	1,956	1,989	2,178	2,257	2,476	2,438

Correlation: 0.969724

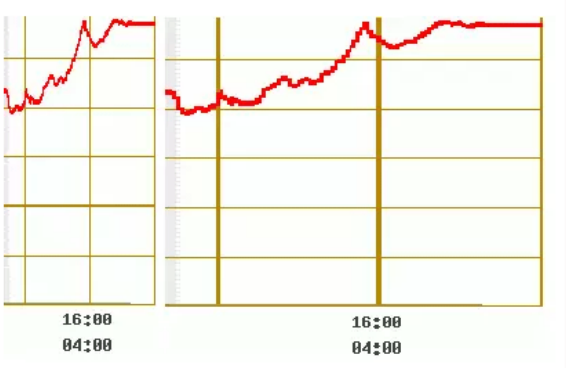
Permalink - Mark as interesting (556) - Not interesting (276)

If we directly look at the potential of both curves, it is true that they have strong correlation statistically. However, the number of people who died by becoming tangled in their bedsheets and the total revenue generated by skiing facilities have even no relationships if considered objectively. Some reporters even use this method to exaggerate the relationship between two unrelated stuffs, since neither of them will become a factor that influences another one.

试卷三(节选):

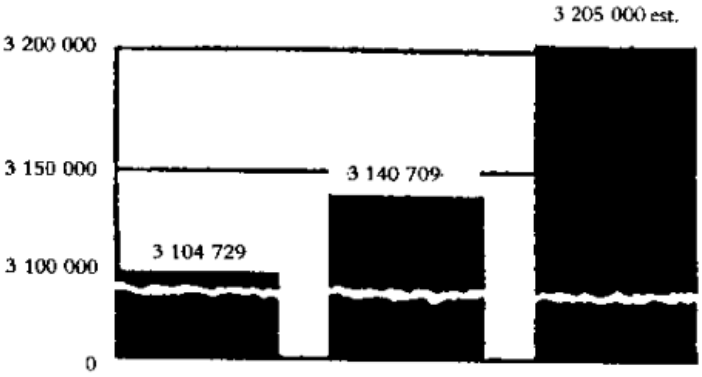
Darrell Huff once wrote in his famous book *How to Lie with Statistics "statistics is as much an art as it is a science."* Ironically, that art actually refers to tricks, which is frequently used nowadays to serve certain purposes such as exaggeration and misleading. Among statistical traps, graphical tricks are one of the most impressive and effective means.

There are several ways to trick on a graph. The most famous and frequent one is the trick on x and y axis.

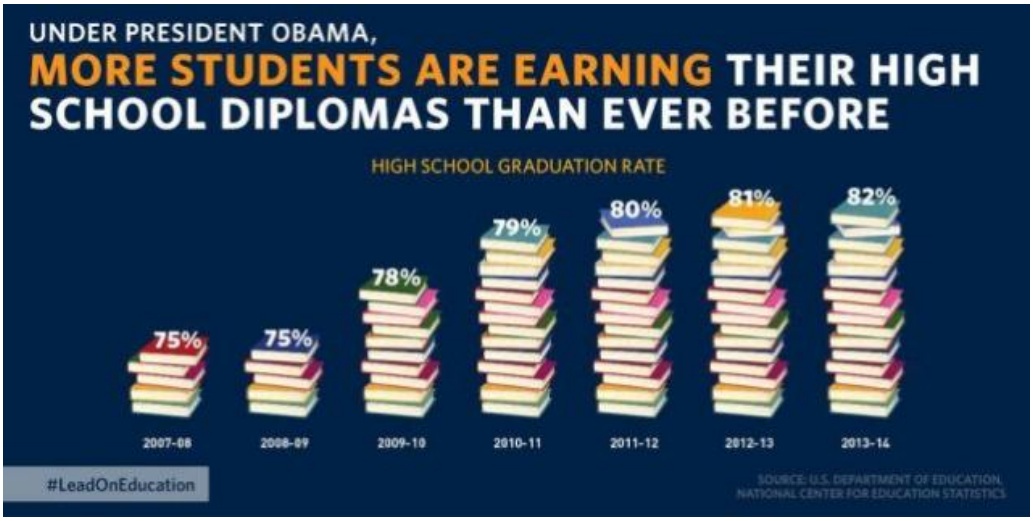


Assume above is the change of gold price on market, the left one will be far more exciting than the right one, won't it? Change of ratio of x and y sometimes significantly changes the graph's impression, in this case, the right one seems a lot "faster".

Besides changing the ratio, sometimes you will see a gap of number on the y axis like showed below.

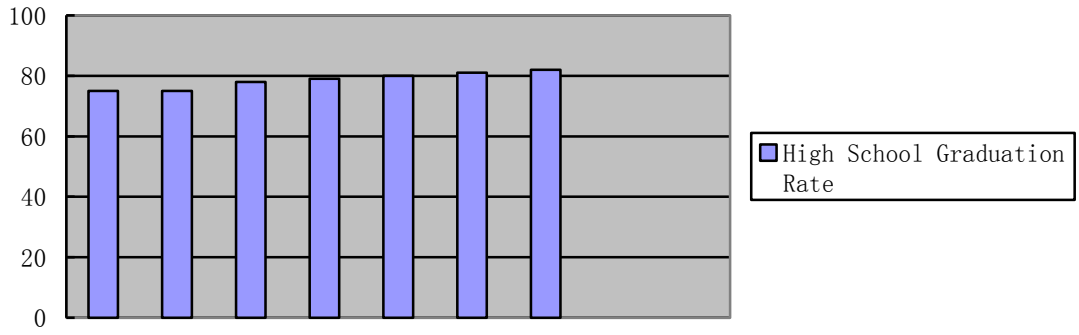


It looks like a tremendous growth, but you will find it wrong by the numbers upon the bars. The total change is actually about 3%, but it attains an impression a far cry from the reality. And this technique has been widely used throughout the history since there was media. Below is a recent typical example.

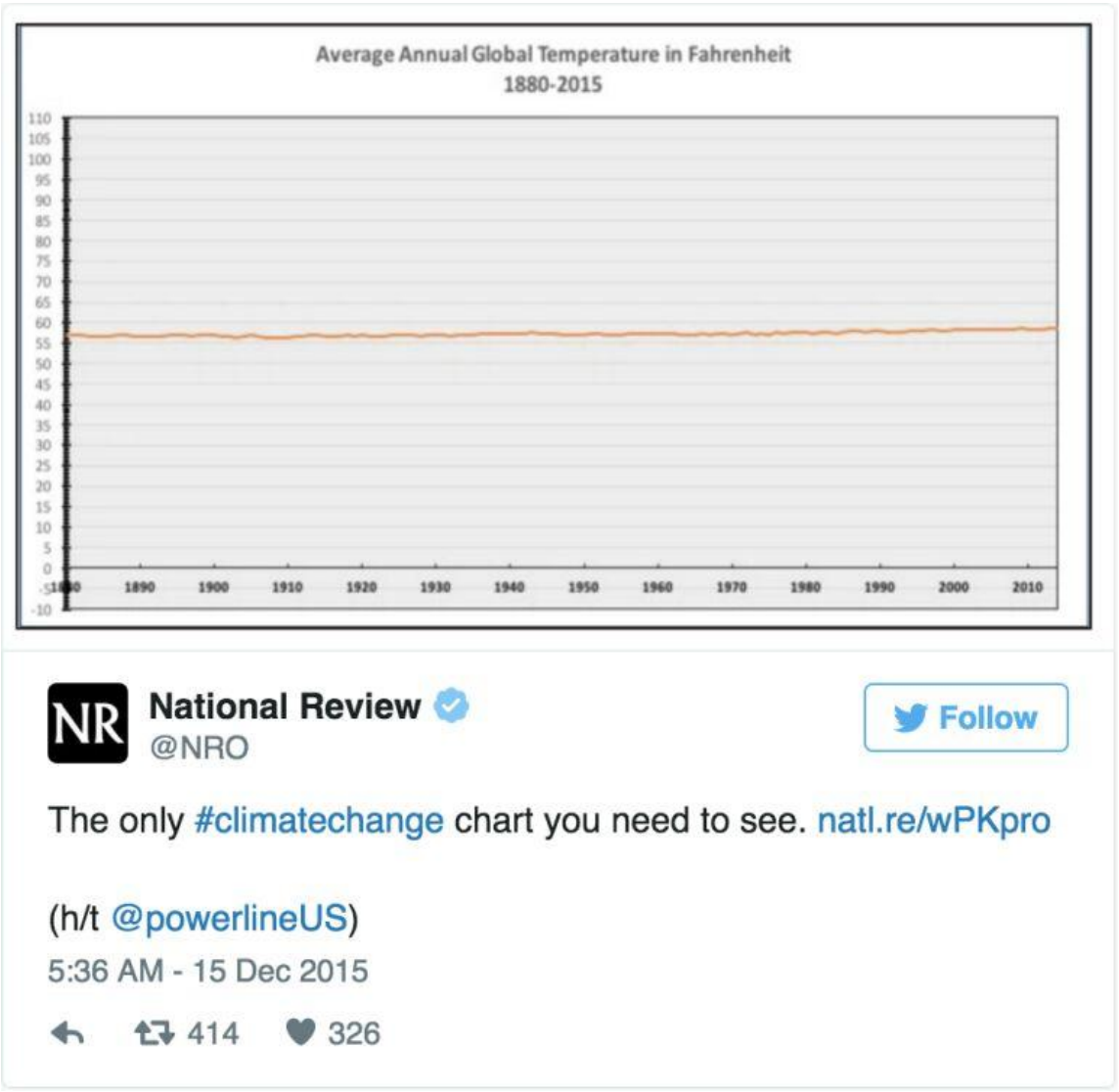


There are only 5 books representing 75%, but 16 representing 82%. That creates the impression of

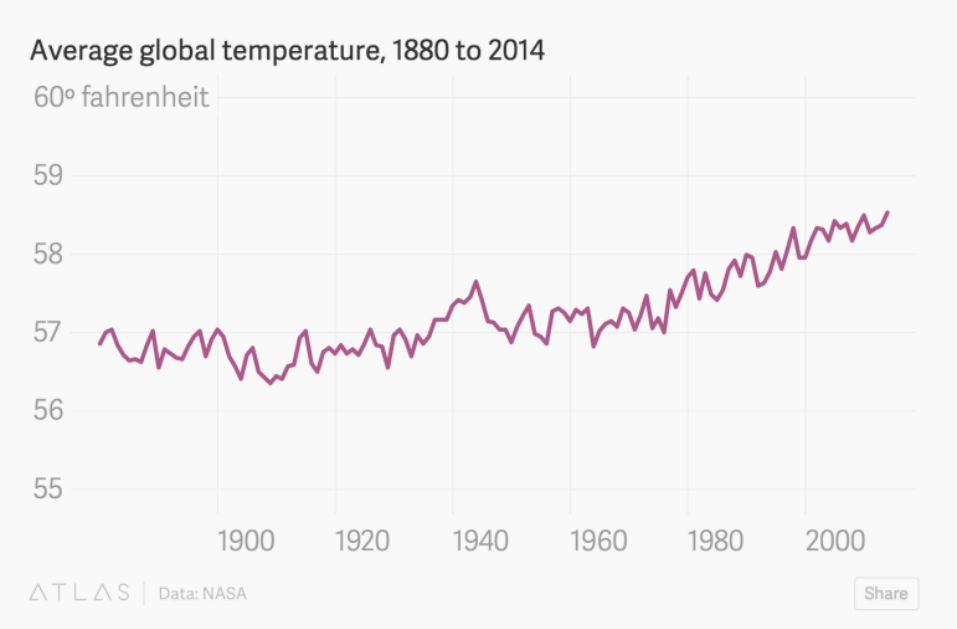
considerable increase. However, let's make a real bar graph of it.



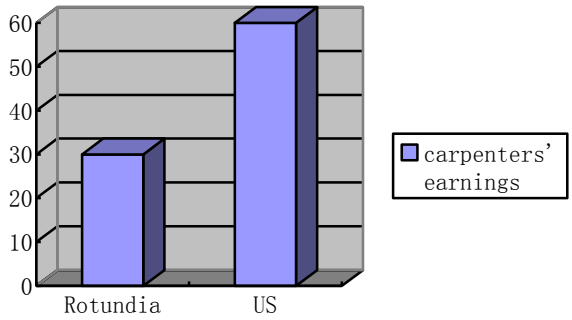
The increase is actually not that magnificent, is it? This kind of trick is quite popular, to have a clear overview of the truth, looking at the numbers is usually a good way.
However, sometimes adjustment on x and y axis is necessary, otherwise it will become a trick. Yes, sometimes showing the original graph is a trick!



This is a graph about change of global temperature released by National Review. The change looks so unnoticeable. However, people should really be a little more concerned. Increase of even 1 degree actually has serious consequence. Below should be the appropriate graph.



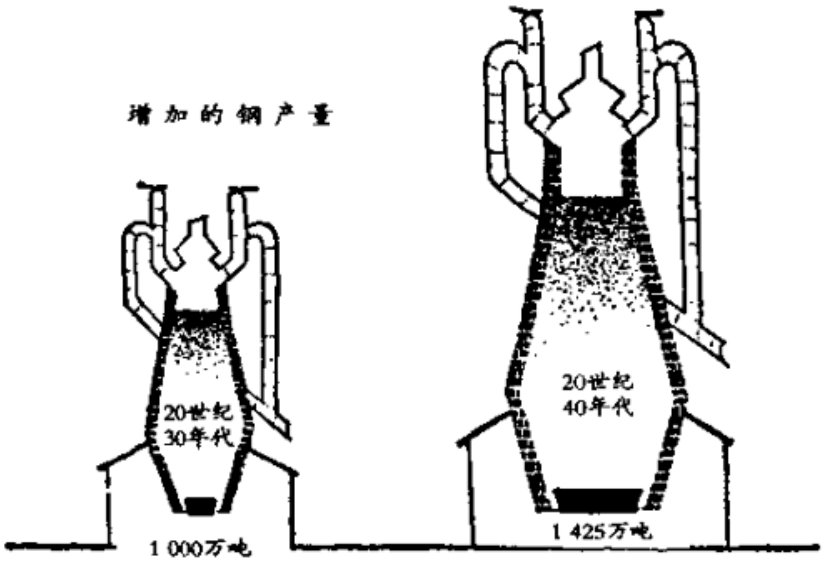
In such case, adjustment on y axis has to be made.
Besides these direct tricks on x and y axis, there are some interesting tricks that indirectly take advantages of x and y axis. Here is a typical example cited in numerous articles.
Assume carpenters in US have average earnings twice as much as carpenters in Rotundia. Below is a bar graph of it.



This bar graph sends information pretty directly, but now that vividly. How about using pictogram? Can we use moneybag to represent earnings? That is exactly the key of this type of trick. If we, following the rule of bar graph, make US carpenters' moneybag twice as high as that of Rotundian carpenters, it will look like this.

The thing is, the difference looks far more different than twice. Since a moneybag is a geometry on the graph, which means it is two-dimension, the difference in area is a lot bigger. Specifically, the moneybag of US carpenters is 4 times bigger than that of luomatiya. Moreover, readers often consider moneybag a 3-dimension object in their mind, which makes the volume of the US one 8 times bigger than the luomatiya one!

Usually, it's unable to express the information accurately through size, thus it's often tricks when you see graph using size to represent numbers, except for using height. Using different quantity sometimes is a suitable option. In this case, using 1 moneybag to represent average earnings of luomatiya carpenters, and 2 moneybags of the same size to represent average earnings of US carpenters is accurate. Or, using coins is also a proper option. However, some people covertly use the inaccurate quantity to provide a wrong impression. Below is an instance of iron production, in which the purpose is to show their increase from 10 million to 14.25 million in production without the interference of government.



Besides the common trick of enlarge the size, it is easy to notice the black bar at the bottom, which should represent the production through quantity. However, the latter one is about 2.5 times bigger than the former one, which is significantly different from the actual increase ratio 1.425. But it looks pretty convincing because the bar's increase goes along with the furnace' increase.

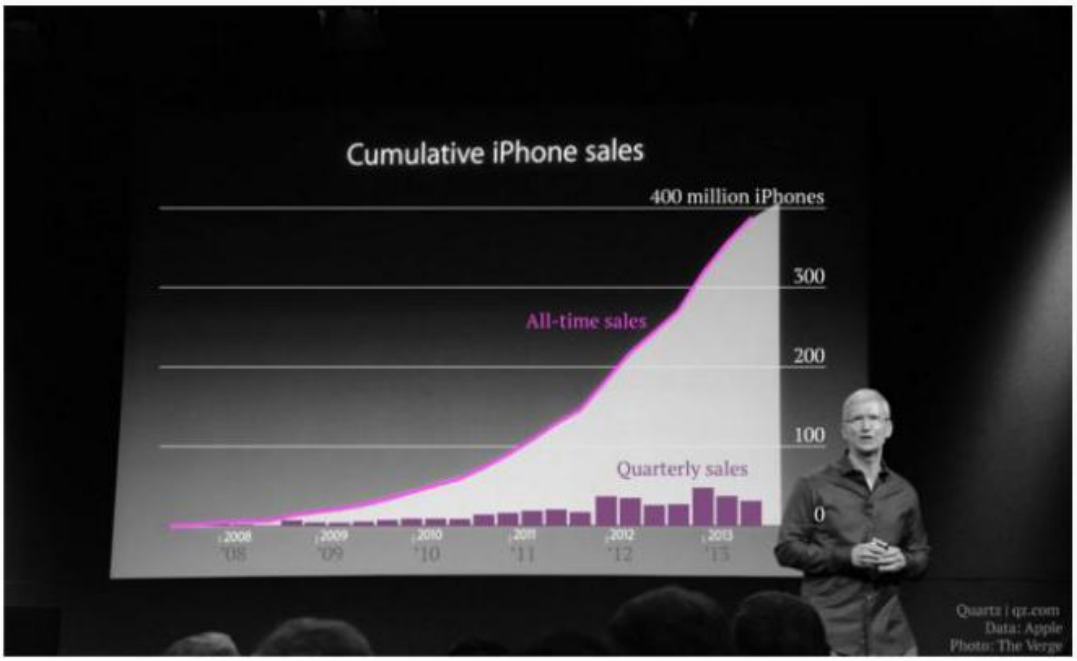
These means discussed in this essay are only some typical ones. In conclusion, there is numerous methods of trick in a graph, and each has its own characteristic. In order not to be tricked, it's better to focus on numbers, because they never lie.

试卷四(节选):

2. The graph does not have a scale

(source: http://qz.com/122921/the-chart-tim-cook-doesnt-want-you-to-see/)

The graph shows the iPhone sales were increasing greatly overtime. However, the y-coordinate does not have a scale. Then a person made another chart based on other data of the quarterly sale:

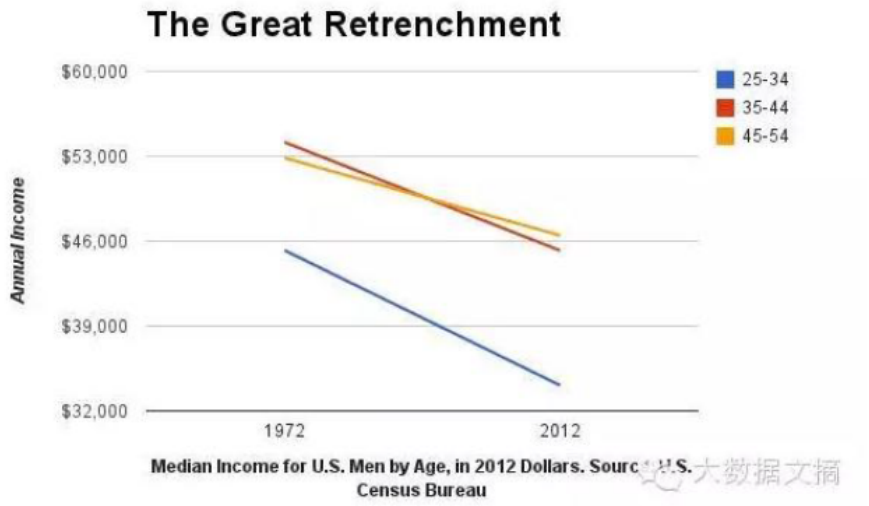


(source: http://qz.com/122921/the-chart-tim-cook-doesnt-want-you-to-see/)

As presented, quarterly sales are actually decreasing. The trick also includes ignoring other information.

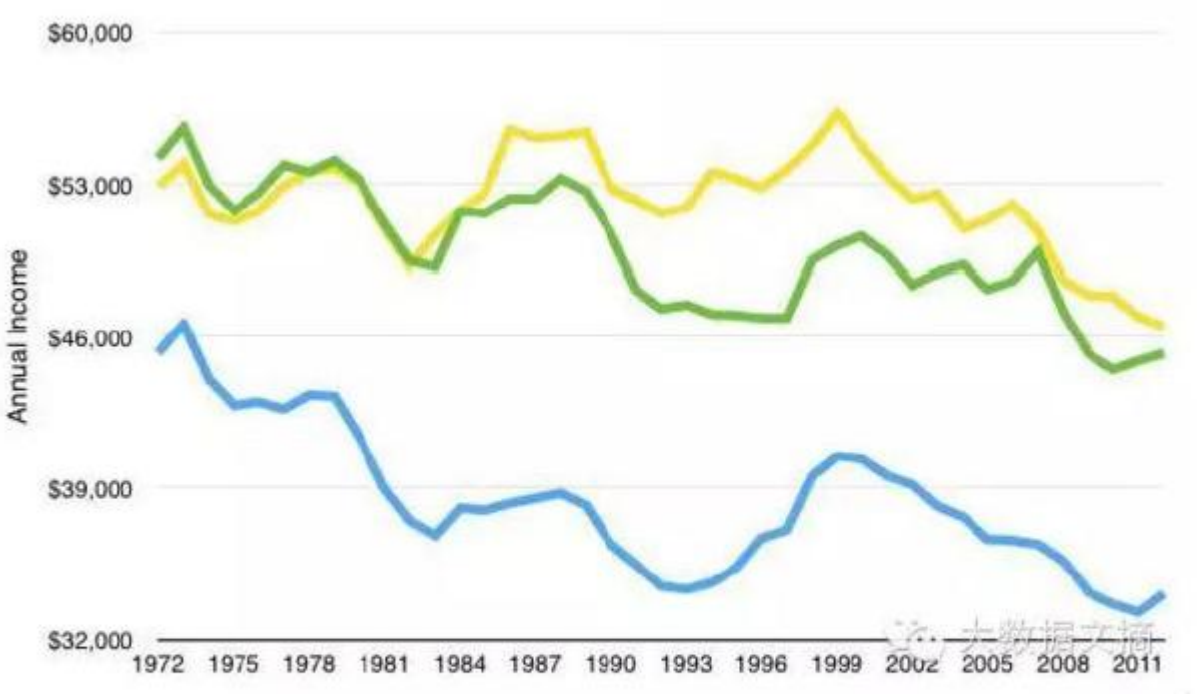
4. **The number of units is small.**

Just several points cannot reflect the situation properly.



(source: http://www.dataguru.cn/article-6676-1.html)

This graph shows a continuous decrease of income for U.S. Men by age. However, there are only two points on x-coordinate in this graph: 1972 and 2012. The graph with data every year is shown below:



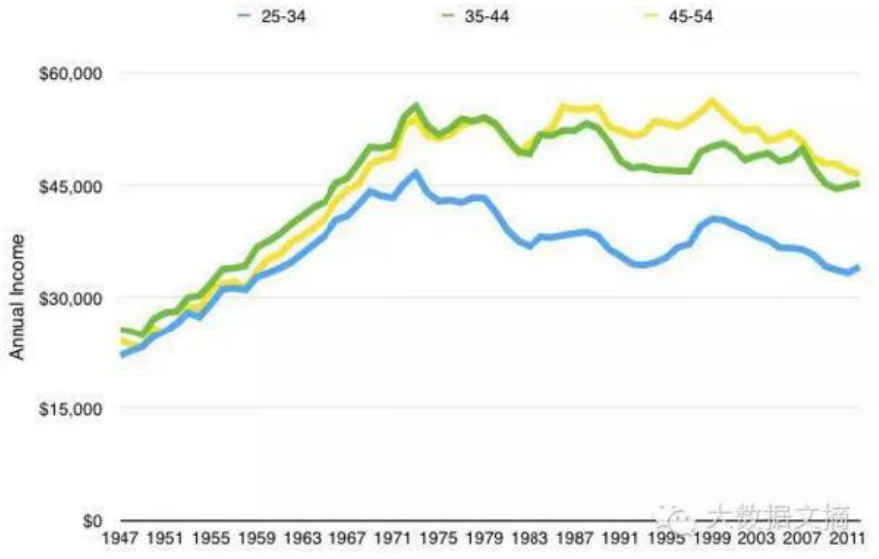
(source: http://www.dataguru.cn/article-6676-1.html)

This graph is not that terrifying.

Besides, another problem in the graph is that the y-coordinate does not begin with 0.

5. Ignore the background and other information

The example is still the graph that shows the steep declining in men's income in U.S. While the data before 1972 is shown, the graph becomes like this:



(source: http://www.dataguru.cn/article-6676-1.html)

It shows that actually the high income in 1972 was the highest point in men's income in U.S. Therefore, the decline of men's income after 1972 was normal.

Question 28: (credit: 20, note: paper with exceptional quality can get up to 40 credits)

Data in Your Daily Life

Which month is the best one to invest in the stock market? During which day of the week are you most likely to get into an automobile accident? Which airline is the safest to travel with? Who is the best place-kicker in the National Football League?

In this project, you are to formulate a question from everyday life (similar to one of the aforementioned questions) that is amenable to a statistical analysis. Then you will need to find relevant data that attempt to answer this question and summarize these data using the methods discussed in this chapter. Present your final conclusions and defend them using appropriate charts and graphs.

Note: You can write in either Engish or Chinese.

Note: For this question, please write your answer on file "high-school-answersheet.doc", downloadable together with this document at www.mathleague.cn, and submit file "high-school-answersheet.doc" at www.mathleague.cn after you are done.

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试卷一：

提出问题：哪一种近视治疗方法最适合青少年采用?

研究背景：现如今，青少年近视发病率已经高居世界第一位，总患病人群中高中生和大学生的近视发病率都超过70%，近视的总患病人数超过4.5亿。近视会导致学生看不清黑板和其他一些远处的物体，对学习和生活都有不小的影响。

研究目的：我希望能够给同学们提供关于矫正近视方法选择的合理化建议，避免同学们因为自身认知不足而造成一些不必要的损失。现如今很多学生单凭配镜师或其他非专业人士的一面之词就选择一种矫正近视的方式，而这种方式不一定适合自己。还有一些同学对各矫正方式的注意事项不甚了解，我也希望能对同学们进行科普。

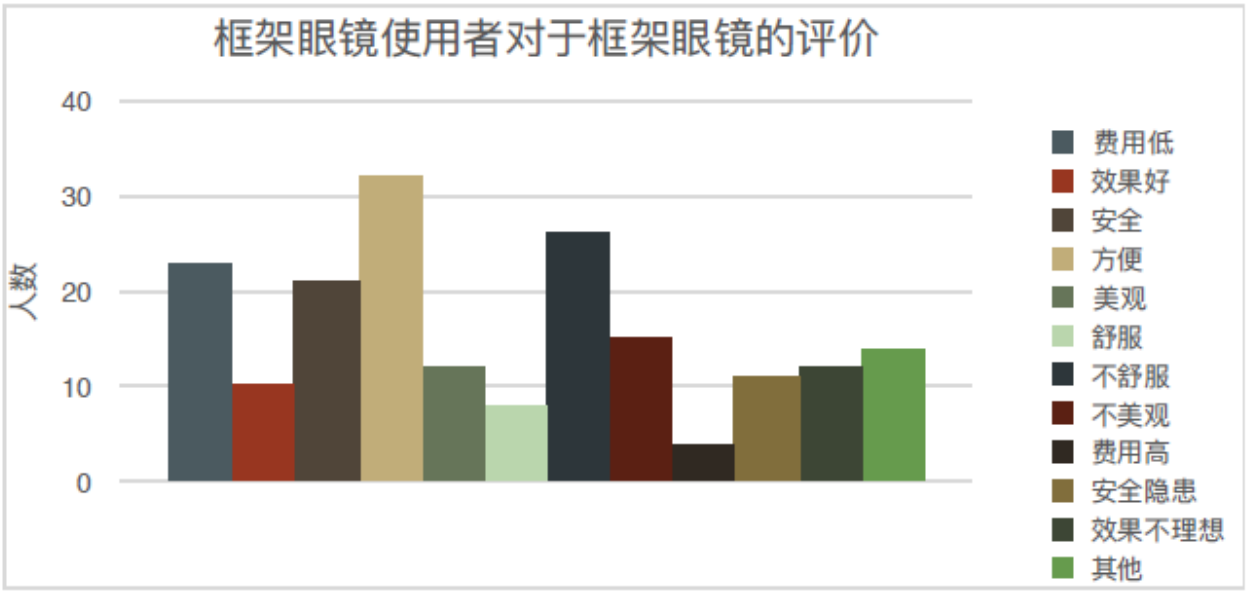
研究方法：从自己的学校做起，我通过问卷以及采访了解深圳中学近视学生的对各类矫正方法的看法，无论是他们使用过的还是没有使用过的。再对比通过网上查找的资料和对专业人士的采访所得到的关于各矫正方法的信息来发现同学们自身认知的误区，起到纠正作用。最后总结出推荐的方法并介绍给其他的同学，让更多的同学找到适合自己的矫正方式、更清楚各方式的利弊，同时也明晰各种注意事项以及更多的小细节。

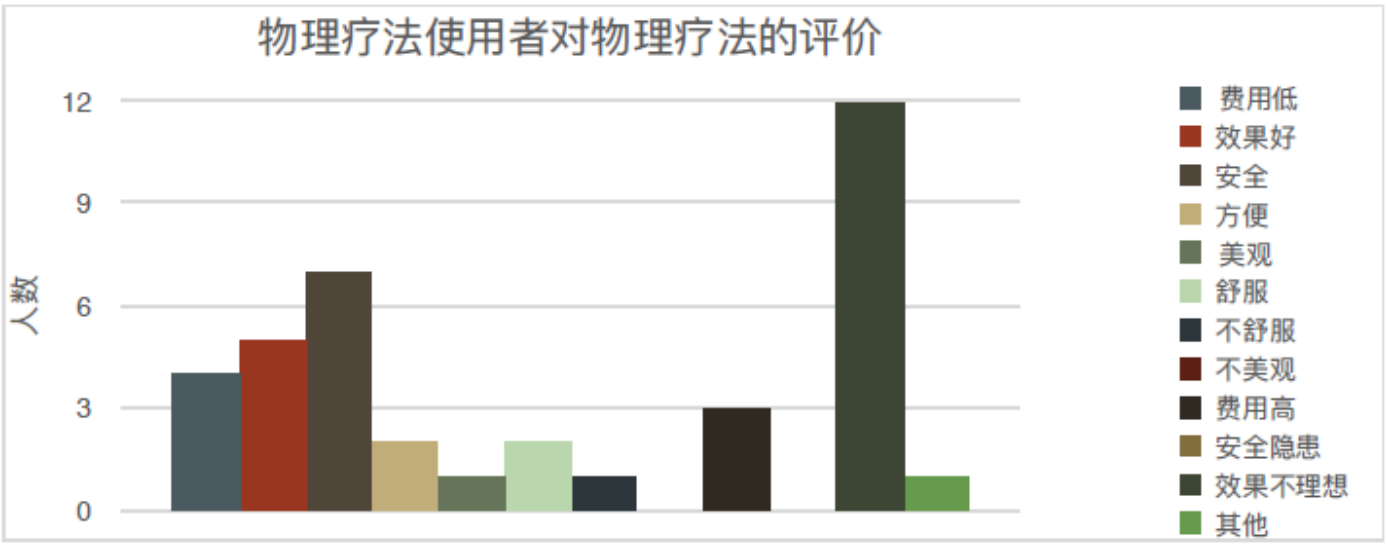
评判指标：综合便捷度，安全性，度数控制效果，价格，美观，专家建议等各项考量因素来给出最终建议

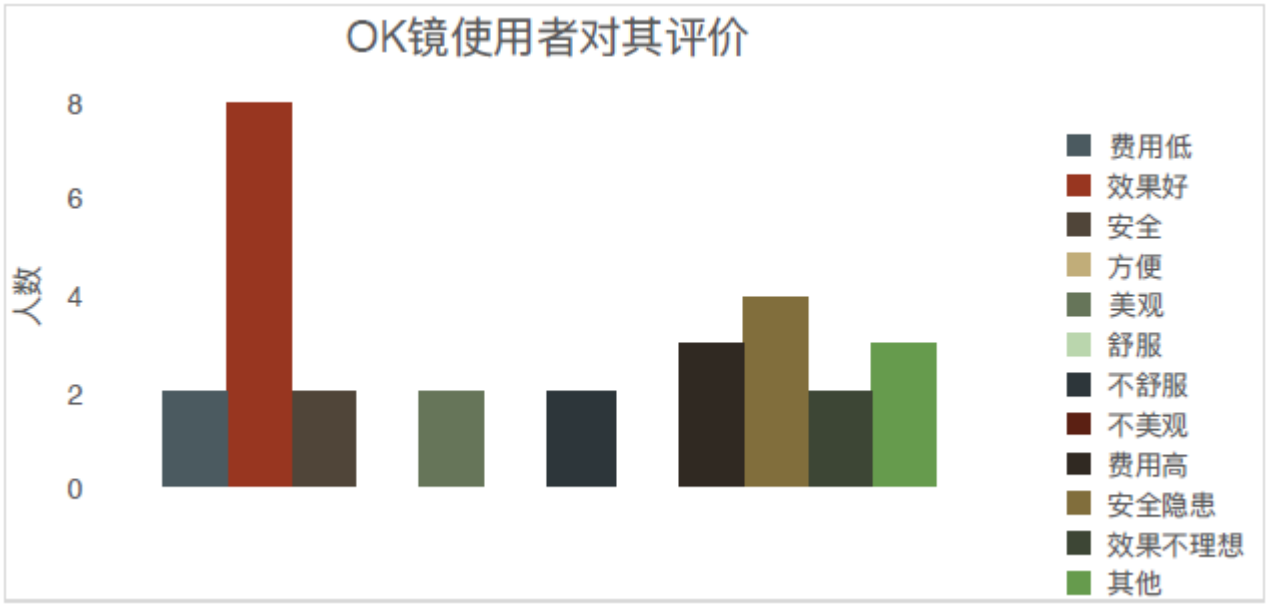
现阶段常用近视治疗方法：框架眼镜，角膜塑形镜（俗称ok镜），物理疗法（包括眼保健操），矫正手术

问卷调查结果

本次随机调查了150位近视的深中同学，回收的有效问卷为141份，其中使用框架眼镜的有106位，ok镜14位，隐形眼镜0位，物理疗法21位。各种治疗方式的使用者对于这种治疗方式的看法（前面6项是优点，后面6项是对应的缺点，其中每一个同学都只能勾选一个优点和一个缺点。数字代表的是勾选的人数，比如有23位同学认为框架眼镜最大的优点是费用低）

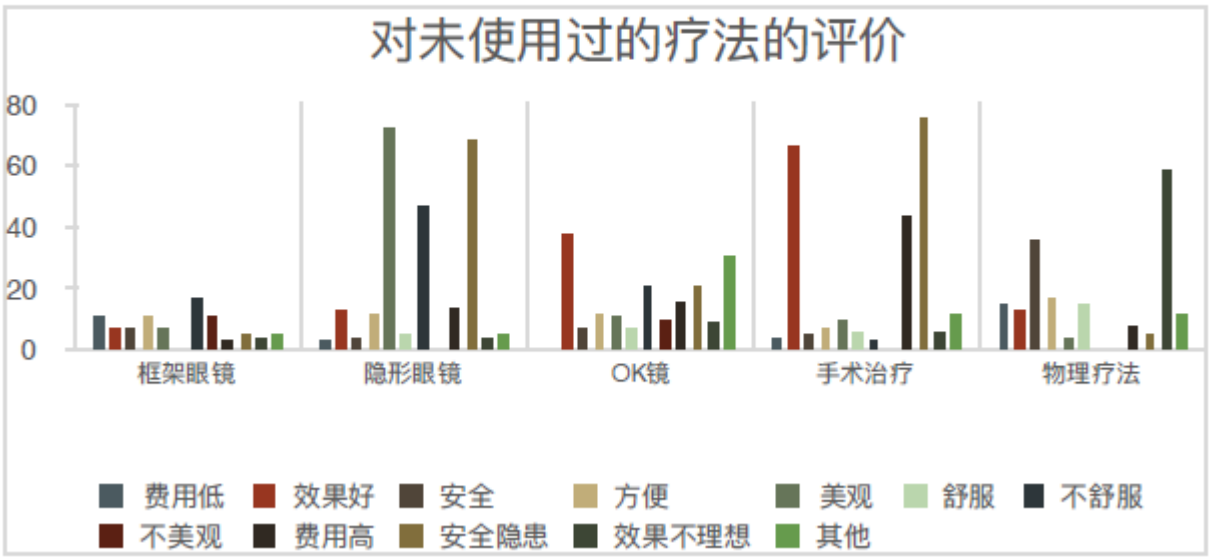






分析：取每种治疗方法最多人认为的优缺点我们可以看出，框架眼镜使用者对于框架眼镜的评价一般是方便，但是不舒服。ok镜使用者对于ok镜的评价是效果好，但是有一定安全隐患。物理疗法使用者对于物理疗法的评价是安全，但是效果不理想。

接下来看同学们对于未使用过的治疗方法的评价



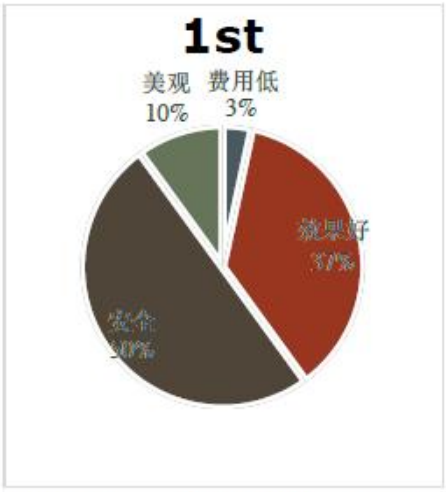
分析：

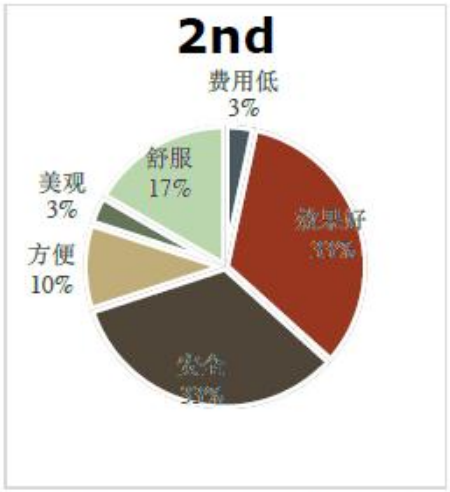
同样是综合得票最多的各种治疗方法的优缺点，我们可以看出，没有用过框架眼镜的人认为框架眼镜费用低，但是不舒服（和使用过框架眼镜的人评价基本相同）；没有用过隐形眼镜的人认为戴隐形眼镜美观，但是安全隐患高；没有戴过ok镜的人认为ok镜效果好，但是不舒服或者有安全隐患（这和使用过的人评价也基本一致。按理来说选“其他”的人最多，是因为大多数人对ok镜都完全不了解所以弃选，这一部分我全部归到“其他”里面）；没有使用过手术治疗的人普遍认为手术治疗效果好，但是安全隐患高，尤其是对于青少年来讲；没有使用过物理疗法的人认为物理疗法安全，但是效果不理想（这与使用过物理疗法的人评价也基本相同）

因为框架眼镜使用者过多，未使用者少，所以数据不能说明受调查者对框架眼镜的倾向趋势。Ok镜因为较为冷门，未使用过者往往未曾耳闻。其反应的数据不一定可靠。而隐形眼镜、手术治疗、物理疗法的数据都表明人们的一种成见。从其统计结果可以看出，人们虽然没有使用过这些疗法，但大部分印象基本可以和这些矫正方法本身的特点挂钩。

同学们在选择上最看重的前两个因素：

人们往往在选择考虑方法的时候优先考虑到安全和效果，其次是舒适，这也是最传统的思维。





而专家建议和网上资料都轻视的美观和方便比重仅次于舒适，因此在为近视患者推荐时也不得不考虑到这些矫正方法的特点。

采访专家结果：

1）框架眼镜：强烈推荐 专业人士都更加推荐框架眼镜。第一，框架眼镜费用较低。第二，因为使用了光学变焦这一直接的物理原理，框架眼镜费用较低，该治疗方式安全无痛苦，没有副作用，特别适合青少年群体使用。

2）Ok镜：不推荐，因为费用高，停止戴后会反弹，但是长期佩戴又容易引发并发症，治疗时间长。而且针对的是轻度近视的人群。事实上在欧洲这种眼镜一直没有得到推广，医生相信ok镜在中国的推广是因为有利益集团的存在

3）手术：不推荐，尽管手术原理并不复杂，操作技术也比较成熟，比较方便，但是手术的适合年龄是25-30岁，18岁以下的人群不能做手术。而且手术改变了角膜的解刨结构，可能出现严重的并发症，或者不可预料的后果。

4）物理疗法（眼保健操）： 推荐 最安全，适用于所有年龄段的人群，实践表明可以控制近视眼新发病例，保护视力，防治近视，但是需要长期坚持。

专家和同学综合各项考量因素，对于各种治疗方法的打分情况对比（满分10分）

	光学眼镜	ok镜	手术治疗	物理疗法
学生	7.75	7.2	6.75	5.52
专家	8.3	4.8	6	6.7

综合专家和学生的评价，我得出以下结论：

- 针对14-19岁的青少年，框架眼镜+（长期）物理疗法首选。虽然同学们普遍不看好物理疗法，但实践证明长期坚持做是一定有效并且安全的。
- 近视手术不推荐青少年去做，安全隐患比较高而且容易留下后遗症
- 如果父母都是高度近视且本人每年近视增长度超过50度的话推荐角膜塑形镜

试卷二：

Overview: This season of NBA, the Golden State Warriors become the strongest team. It lost only 4 games in 48 games of this season and has got a terrible average score per game of 115.4 so far until Feb. 5th. Every team in NBA desires to beat the Warriors, who won its opponents by an average of 12.7. Some consider playing defense hard a good choice while others would like to increase their score to play against the Warriors.

Question: Which one is a better strategy, playing defense hard or strenthen attack?

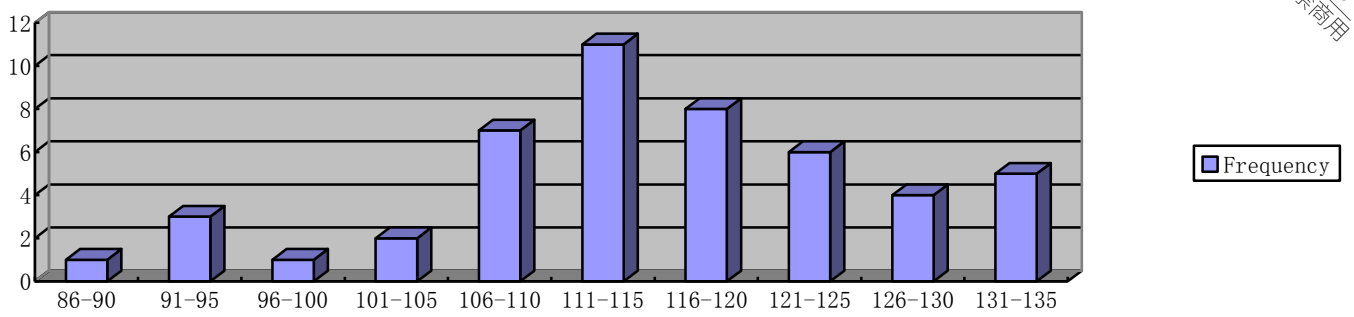
To answer this question, we need to analyze it from multiple aspects.

1. What happen generally when the Warriors' scores are low?

Below are the scores that the Warriors got in each game, arranging by time order. Note: average: 115.4

111	112	134	119	112	119	103	109	100	129
107	115	124	106	118	111	135	120	106	116
112	114	131	124	95	128	121	103	89	122
91	114	111	111	109	128	111	110	116	95
132	125	122	120	127	108	116	134		

And we can make a bar graph from the data. Set every 5 points as an interval.



It is amazing for a team to have such high scores. However, among these numbers, four 2-digit numbers stand out. Those are: 95, 89, 91 and 95, marked blue. For a team which scores an average of 115.4 points, such 2-digit scores are pretty rare. Yet, among these 4 games, the Warriors lost 3 of them! For the game that the Warriors got 89 but did not lose, it won its opponent by "only" 7 points.

Since the Warriors' average score is 115.4, we consider games in which the Warriors scored equal to or less than 110 are those of low scores. Then let's pull out those results.

Game	Scores(Warriors)	Scores(Opponents)
1	103	94
2	109	95
3	100	84
4	107	99
5	106	94
6	106	103
7	95	108
8	103	85
9	89	83
10	91	114
11	109	88
12	110	112
13	95	113
14	108	105
average	102.2	98.4

It is shocking, isn't it? In these 14 games in which the Warriors scored equal to or less than 110, it only wins its opponent by an average of 3.8 points, and it lost 4 times! Moreover, the strategy is broadly effective. 9 out of these 14 teams won the Warriors or lost by less than 10 points, which means they actually had a great chance of winning. Except the 4 teams, other 5 lost by only 5.8. What about other teams who lost by less than 10 points? A pie graph will be provided later. But now we can make a brief conclusion that strengthen defense is an effective strategy against the Warriors.

2. What happen generally when the Warriors' opponents scored high?

Similarly, we can do the same analysis to this topic. Below are the results of games in which the Warriors' opponent scored more than 110. Note: average: 102.7.

Game	Points(Warriors)	Points(Opponents)
1	134	120
2	129	116
3	124	117

4	135	116
5	131	123
6	124	119
7	121	112
8	91	114
9	128	116
10	110	112
11	95	113
12	122	110
13	134	121
Average	121.4	116.1

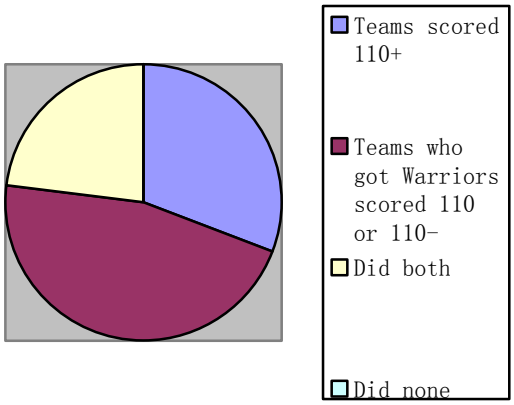
The result also looks not bad. The Warriors won these teams only by an average of 5.3. Among these 13 teams, 3 finally beat the Warriors. These 3 teams also appeared above: they excel at attacking and good at defending. How many of these teams lost by less than 10 points and stands a considerable chance of winning? Except the 3 teams which won, there are only 4, and even these 4 teams lost by an average of 7.25, which is a considerable number in NBA and not that far from 12.7. To conclude, enhance attack is effective as well, but not as effective as strengthen defense.

3. What happened in the 4 games that the Warriors lost? What about those games in which the teams lost by less than 10 points?
   Below are the points got in the 4 games.

Game	Scores(Warriors)	Scores(Opponent)	(Main) Objective Reason
1	95	108	Tiredness
2	91	114	Absence of an important player
3	110	112	Absence of an important player
4	95	113	None
Average	97.75	111.75	-

Despite the objective reasons, these 4 teams all restricted the Warriors attack effectively and had competent attacking ability as well. They combined both, but this is not possible for most teams without serious objective reasons.

Below is a pie graph of teams which won the Warriors or lost by less than 10 points. (teams won the Warriors included)



Conclusion: In general, playing defense hard is a better option. However, from experience so far, in order to beat the Warriors, a team had to strengthen both defense and attack.

试卷三：

Which country has the cleanest air?

Preface

Living in China, especially in , I have a special feeling towards the quality of air. I feel glad that I can see beautiful blue sky in many days of a year in ; I have also read many jokes about Beijing's thick smog. Air quality has become a part of my life; I always pay much attention to air quality in my city and other places. While looking at a photo, the first thing I notice is whether the sky is blue and clear. I want to live in places with clean air in the future. In this project, I will compare the air quality in different cities in China and in different countries in the world to find out the places where air quality is good enough for people to live.

The following pages include the contents below:
Introduction and standard provided
Part 1: Air quality in different countries in the world
Part 2: Air quality in different cities in China
Each part includes data presented, analysis and limits.

Introduction

The data and analysis are divided in two parts.

To compare the air quality in different countries, I compare weighted concentration of PM2.5 in 2014 collected by World Health Organization.

Weighted concentration means the concentration that is added weight of population. The bigger the population, the higher the weighted concentration based on the same concentration not weighted. I choose weighted concentration instead of concentration to compare is because that weighted concentration can reflect the extent of effect of air pollution on people.

To compare the air quality of different cities in China, I compare Air Quality Index of important cities in China in 2014.

PM2.5 concentration and AQI standard is provided below:

Level	PM2.5($\mu g/m^3$	PM10($\mu g/m^3$
Air Quality Guideline	0 .. 10	0 .. 20
Intermediate target - 1	10 .. 15	20 .. 30
Intermediate target - 2	15 .. 25	30 .. 50
Intermediate target - 3	25 .. 35	50 .. 70
Over target	35 .. 53	70 .. 105
Significantly over target	53 .. ∞	105 .. ∞

Table 1, PM2.5 concentration standard

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected.
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects.

Table 2,AQI standard

Part one

Data

The weighted PM2.5 concentration (ug/m^3) of 91 countries in 2014 is presented below (different background colors represents corresponding air quality level and the color of countries' name that are not black means developed countries):

PM2.5 concentration(ug/m^3) by country 2014							
Australia	5.7	Switzerland	15.1	Venezuela	24	Chile	26.8
Brunei	6.6	Jamaica	15.3	Ecuador	24.1	Poland	26.9
New Zealand	6.8	Belarus	15.7	Italy	24.1	Sri Lanka	28
Estonia	7.2	Lithuania	16	Colombia	24.5	Iran	34.2
Finland	7.3	Argentina	16	Slovenia	24.5	Saudi Arabia	28
Canada	7.5	Latvia	16	Israel	24.6	Vietnam	29
Iceland	8.2	Andorra	16	Serbia	35.8	Myanmar	30
Sweden	8.7	Denmark	16.7	Peru	38	Guatemala	33
Ireland	8.8	Netherlands	16.9	Mauritius	38.1	Oman	31
Liberia	9.3	Germany	17	Bulgaria	38.6	Honduras	32
Japan	10	Singapore	17	Turkey	39.1	Bolivia	32.5
Bhutan	10	France	17.4	Senegal	40	Bosnia and Herzegovina	33
Norway	10.9	Paraguay	18	China	41.4	Slovakia	25.4
Malta	12	Uruguay	18	Jordan	48	Hungary	26.7
Portugal	12.3	Belgium	18.1	Ghana	49	Mexico	23.9
Spain	12.4	Costa Rica	18.8	Bahrain	56.1	South Africa	24
United States	12.9	Austria	19.1	India	60.6	Philippines	22.6
Monaco	13	Thailand	20.6	Mongolia	61.8	South Korea	23
Malaysia	13.2	Romania	21	United Arab Emirates	64	Lebanon	23.4
Luxembourg	14	Indonesia	21	Egypt	73	Russia	22
United Kingdom	14.7	Greece	21.4	Bangladesh	83.3	Pakistan	115.7
Tanzania	23	Brazil	21.7	Afghanistan	86	Qatar	92.4
Cyprus	23.1	Czech Republic	21.9				

Table 3, weighted PM2.5 concentration (ug/m^3) of 91 countries in 2014

Analysis

The arithmetic mean, median, 1st quartile, 3rd quartile and range are shown below:

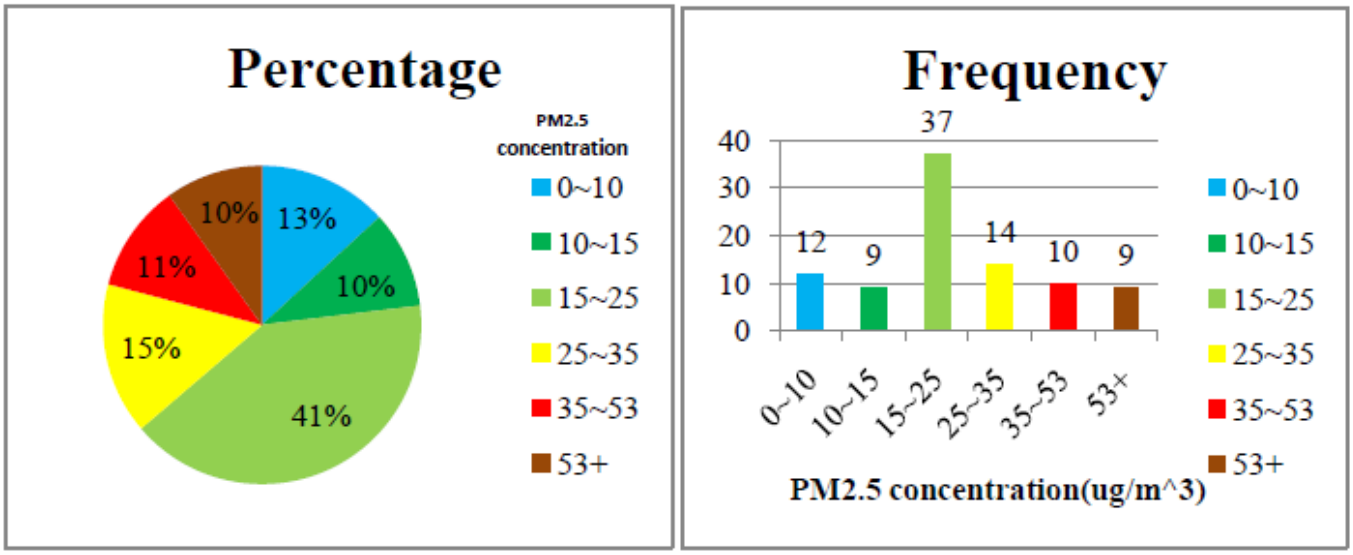
Average	Median	1st quartile	3rd quartile	Range
27.04889	22.3	15.4	31.75	110

Table 4, the arithmetic mean, median, 1st quartile, 3rd quartile and range of data from countries in the world

We can see that the average weighted PM2.5 concentration is 27.04889, which is in the fourth level. However, the number is not suited to reflect the situation in the world because the median is 22.3, which means that at least 50% of countries are in the third or lower level. The high arithmetic mean is caused by the high weighted concentration of PM2.5 in Pakistan.

We analyze further on the data:

The number and percentage of countries in each level of the air quality are presented below:



Graph 1 and 2, the percentage and number of countries in each level of the air quality

From the graph we can see that 64% of countries are in the third level or below. The third level includes the most countries. These graphs show that the PM2.5 pollution has not become so serious because there are still 64% of countries that do not reach the later half air quality levels.

The percentage of developed countries in each air quality level is presented below:

DC means developed countries:

Level	% of DC
	66.70%
	88.90%
	35.14%
	7.14%
	0%
	0%
Total	34.07%

66.7% of countries in the first level are developed countries and 88.90% of countries in the second level are developed countries, while there are no developed countries in the last two levels.

Table 5, the percentage of developed countries in each air quality level

About China, the PM2.5 concentration of China is in the 85.71th percentile, which means that the air quality of China is really bad in the world.

Limit

The data collected are only from 91 countries which are 40.6% of countries in the world, while there are 224 countries and regions in the world. There are only 44 developed countries in the world defined by United Nations but 31 developed countries are included in the data which are 75.61% of all the developed countries. Therefore, over half of developing and undeveloped countries are not included in the data but over 75% of developed countries are included in the data. This fact of the data can affect the analysis of the air quality situation in the world, since if all the developing and undeveloped countries are included, the air quality situation may be much worse. Besides, the data was collected 2 years ago in 2014, which cannot reflect the current situation accurately.

Part 2

Data

Air Quality Index of important cities in China 2014 (different background colors represents corresponding air quality level, the brown represents the deep purple level):

Air Quality Index of important cities in China 2014									
厦门	19	贵阳	52	洛阳	71	枣庄	93	唐山	132
茂名	19	宜宾	52	莱州	72	合肥	93	乌鲁木齐	133
深圳	19	盐城	53	渭南	73	济南	93	嘉兴	135
汕头	19	福州	53	沧州	73	平度	94	开封	136
阳江	20	温州	54	荆州	74	西安	95	常州	138
汕尾	21	韶关	55	铜川	74	菏泽	96	吴江	138
中山	21	胶南	56	遵义	74	桂林	96	濮水	138
海口	21	临汾	56	岳阳	75	胶州	96	杭州	139
潮州	22	梅州	57	延安	75	武汉	97	无锡	143
湛江	24	南昌	58	南充	75	东营	98	绍兴	147
珠海	24	泉州	59	承德	75	句容	98	上海	147
舟山	25	玉溪	59	西宁	76	湖州	100	太仓	148
南宁	26	乳山	60	威海	77	聊城	100	盘锦	149
拉萨	29	淮安	60	莱芜	77	潍坊	100	莱西	149
台州	30	宜昌	61	太原	77	淄博	100	葫芦岛	150
丽水	31	即墨	61	瓦房店	78	包头	103	苏州	153
佛山	32	攀枝花	61	长沙	80	滨州	104	南京	154
张家口	32	石嘴山	61	常德	80	文登	105	临安	157
三亚	34	连云港	61	阳泉	81	天津	106	海门	158
日照	38	荣成	61	曲靖	82	常熟	106	北京	160
揭阳	39	宿迁	62	焦作	82	寿光	106	扬州	161
广州	40	义乌	63	诸暨	82	平顶山	108	锦州	163
惠州	40	宝鸡	64	郑州	83	宜兴	108	保定	163
清远	40	克拉玛依	64	嘉峪关	84	德州	109	齐齐哈尔	164
肇庆	40	呼和浩特	65	德阳	85	马鞍山	109	镇江	171
张家界	40	蓬莱	66	衢州	85	廊坊	109	江阴	175
金华	42	本溪	67	招远	87	抚顺	109	大庆	181
鄂尔多斯	43	重庆	67	丹东	87	三门峡	111	张家港	182
昆明	44	徐州	68	咸阳	87	安阳	111	南通	184
北海	44	大同	68	兰州	88	昆山	115	哈尔滨	186
江门	45	银川	68	大连	89	邯郸	115	沈阳	188
柳州	48	青岛	69	临沂	90	芜湖	116	邢台	189
东莞	48	泸州	70	湘潭	91	株洲	116	泰州	189
河源	49	九江	70	自贡	91	富阳	119	吉林	200
金昌	51	秦皇岛	71	长治	91	济宁	119	石家庄	205
阜丘	52	泰安	71	成都	92	营口	120	牡丹江	229
宁波	52	库尔勒	71	绵阳	92	溧阳	126	长春	233
云浮	52	赤峰	71	烟台	93	金坛	126	鞍山	235

Table 6, Air Quality Index of important cities in China 2014

Analysis

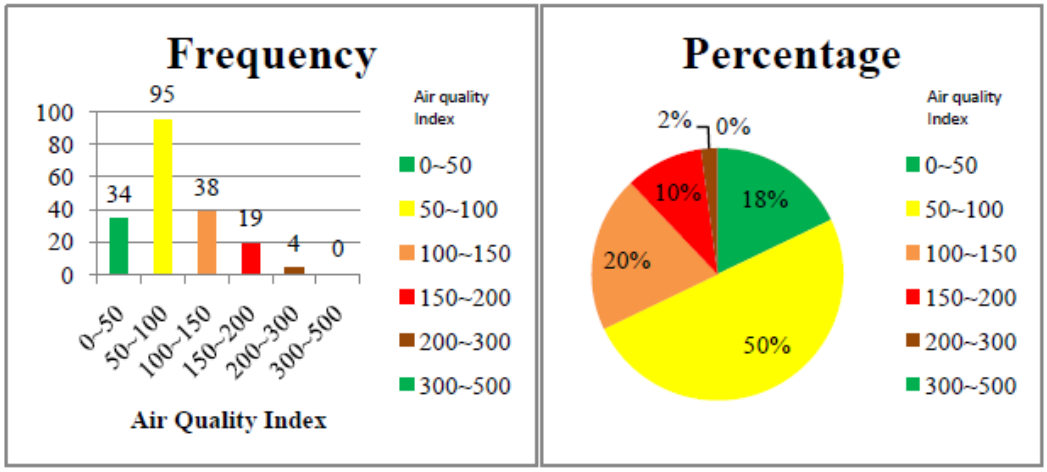
Average	Median	1st quartile	3rd quartile	Range
90.02632	81.5	58.25	111	216

Table 7, the arithmetic mean, median, 1st quartile, 3rd quartile and range of data from cities

We can see that the arithmetic mean of AQI in China is 90.03, which belongs to the yellow level that means the air quality is acceptable to most people. The median is 81.5 which shows that the air quality in at least half of the important

cities in China is acceptable to most people and will not cause health effect. The 3rd quartile is 111 in the orange level shows that at least people in 75% cities are not likely to be affected by air quality negatively.

Then we further analyze the data; the number and percentage of cities in each level of the air quality are presented below:



Graph 3 and 4, the number and percentage of cities in each level of the air quality

The graph shows that there are 88% of important cities that are in the first three levels, which means that most people in 88% of important cities in China are not likely to experience health effect because of air quality negatively. All the people in 10% of important cities including the capital Beijing may begin to experience health effects. All the people in 2% of important cities experience are likely to be affected seriously by bad air quality. Fortunately, there are no cities in the last level. The analysis shows that the situation in China may not be that bad.

For Shenzhen, it is the top one city with the lowest Air Quality Index.

Limit

The data only comes from the selected important cities in China, which may affect the analysis of the overall situation in China. The data was collected 2 years ago in 2014, which cannot reflect the current situation accurately.

试卷四：

As a middle school student preparing to select a high school, I would like to raise my Question:

Which school is the most outstanding in last year's senior high school entrance examination? In order to find out which middle school is relatively better.

As people continuously change their opinion I am always wondering which middle school provides students with best education.

Through observing in my daily routine, I believe one's score is still the most important measure of the quality of education for Chinese schools. Examination scores will directly show the quality education the students have. Since the score of last year's senior high school entrance examination is the most up-to-date and official, so I selected this data as the object of my study.

I have interviewed students and teachers from different schools in addition to obtaining official scores. In this project, I am going to give a five-number summary by this score.

In this text the full mark is 660.

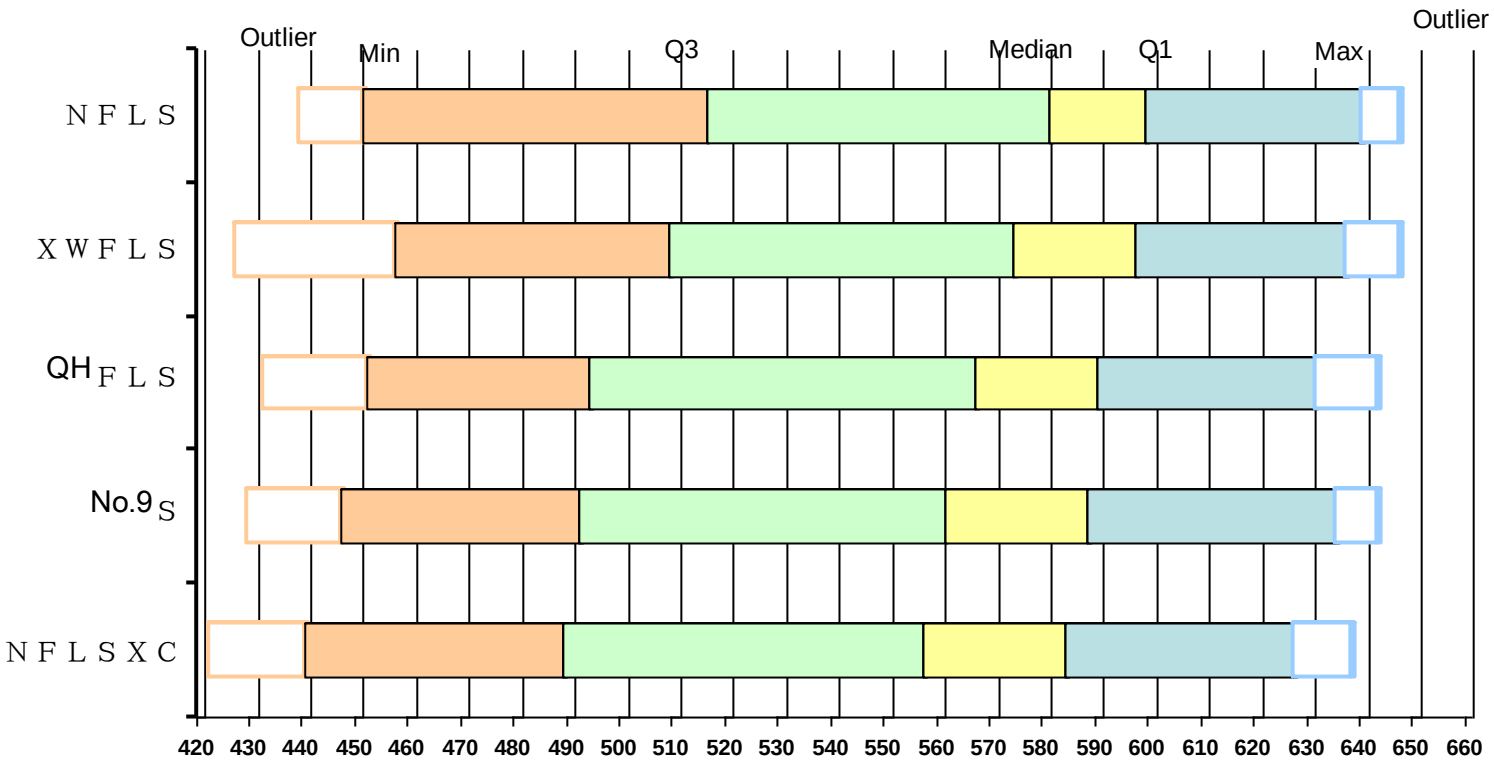
The number of students of NFLS, XWFLS, QHFLS, No.9S, NFLSXC is about respectively650, 350, 550,

600, 490.

SCHOOLS And The Score	Nanjing Foreign Language School (NFLS)	Qinhuai Foreign Language School (QHFLS)	Number Nine Middle School (No.9S)	Xuanwu Foreign Language School (XWFLS)	NFLS Xianlin Campus (NFLSXC)
Outlier(Max)	647	643	641	647	634
Biggest normal value	640	631	633	637	623
Quartile1	599	590	586	597	580
Median	581	567	559	574	557
Quartile3	516	494	492	509	489
Smallest Normal value	451	452	447	457	440
Outlier(Min)	439	432	429	427	422
IQR	83	138	94	88	91
Average	581	577	560	573	551

This data set includes five important numbers and two outliers.
Showing this data in a table makes it much clearer to read.
From the table we can note:

1) NFLS and XWFLS have the highest score (outlier) of 647 out of 660
2) NFLS has the highest normal value. It shows its strength.
3) NFLS is far ahead in the median number and average.
4) QHFLS has the largest IQR. It means it is the most discrete.
5) QHFLS and XWFLS have relative higher minimum and higher outlier (min). It means they have fewer students with absolutely low marks.
6) Only two schools, NFLS and XWFLS, have the Quartile 1 over 594, which is 90% of the full mark



To compare the school's performance better, I used box plots to show this data.
Right away we can see that NFLS seems to always lead in every data set except the minimum. What's more, it has the shortest distance between the median and the first quartile. From that we can discover their high score is more intensive. This means that NFLS has more top students and has high quality of its first 50% of students.From that we can indicate that NFLS is a selective school and owns a excellent education resources. We can also infer that there is hyper-competition between NFLS top students. They might suffer from lots of pressure to achieve a higher mark. For the top students at NFLS, other schools are much cushier. If a student receives the median of NFLS that student will still have a considerable higher rank in other schools.
But on the other hand, NFLS is not all-around great. The minimum of its normal value falls behind while XWFLS and QHFLS's latter part scored higher points. Through the data we can see XWFLS is still competitive to NFLS and it is also a considerable great school.
For the other schools, QHFLS and No.9S, they are neck to neck, but QHFLS's data seems more intensive than No.9S. NFLSXC totally falls behind in this examination.

In general, Nanjing Foreign Language School is the best ideal school for students through this examination. There is no doubt that it can provide most students with higher level of education. However, its students have more stress from hyper-competition. Meanwhile, Xuanwu Foreign language school also performed well. Both of them are considerale suitable school for students.

试卷五：

深圳中学高一高二学生对未来专业的认识及分析

一、研究原因及目的：

人成长一生必定遭遇数不清面临抉择的十字路口，从中学志愿的填报到大学专业的选择，每一次的决定都将会对一个人未来的人生轨迹产生重大的影响。在拓扑学中，蝴蝶效应指的是一个动力系统中，初始条件下微小的变化能带动整个系统的长期的巨大的连锁反应。这是一种混沌现象。任何事物发展均存在定数与变数，事物在发展过程中其发展轨迹有规律可循，同时也存在不可测的“变数”，往往还会适得其反，一个微小的变化能影响事物的发展，说明事物的发展具有复杂性。作为一名深圳中学国际体系的在校学生，我具有对周边事物及自我的敏感性。从小到大，或多或少听及或想及有关专业的事项。对专业的选择也是一位学生必定经历的选择，对未来就业、学习都将造成极大的影响。学生对专业的认识程度值得研究及探讨。

本实验主要探究各体系高一高二学生专业的认识程度、各体系高一高二学生选择专业所考虑的因素、各体系高一高二学生文理科偏向、各体系高一高二学生有无目标专业的比例、各体系高一高二学生最热门专业、各体系及高一高二年级各项数据的对比。

二、研究方法：

本研究将采用问卷调查法，也称问卷法，是调查者运用统一设计的问卷向被选取的调查对象了解情况或征询意见的调查方法。研究者将所要研究的问题编制成问题表格，以邮寄方式、当面作答或者追踪访问方式填答，从而了解被试者对某一现象或问题的看法和意见，所以又称问题表格法。从被调查的内容看，问卷调查法适用于对现时问题的调查；从被调查的样本看，适用于较大样本的调查；从调查的过程看，适用于较短时期的调查；从被调查对象的文化程度看，适用于初中以上文化程度的对象。

针对课题深圳中学高一高二学生对未来专业的认识程度及分析，问卷调查从浅至深涉及了六个问题，虽然数量不多，却胜在少而精。考虑到样本的代表性，本研究小组没有采用网络版的调查问卷（网络版调查问卷会排除不使用手机的学生的样本，从而使收集的数据缺乏代表性）。为了保证数据的有效性，本研究小组采取单人份的调查问卷的形式。在设计完问卷之后，问卷的发放分批在课间进行。

以下是本研究调查问卷的内容：

卷首语：您好，这是一份为研究“深圳中学高一高二学生对未来专业的认识及分析”所设计的调查问卷，请配合填写，谢谢支持！

问题一、您的性别是？（　）

A. 男　B. 女

问题二、您的文理倾向?（　）高二问卷则不设有这一问题，直接以文理班进行划分。

A.　文科　B. 理科　C. 其他　D. 暂时没有

问题三、您的理想专业是否明确？（　　）

A. 有一个明确的理想专业（例：我一定要读计算机专业）

B. 有多个理想专业（例：我喜欢经济，商科，法律，都有可能选择）

C. 暂无理想专业（如选择此项请停止作答，感谢您的参与）

问题四、您的理想专业？（请圈出您的选项）

数学　哲学　经济　商学　管理　法学　教育学　文学　艺术　电影　新闻传播　历史学　物理学　建筑学　计算机　农学　心理学　医学　军事学　地质学　人类学　天文学　化学　语言学　环境科学　酒店管理　其他

问题五、您对专业的认知程度？（对此专业的课程内容和就业等因素的了解）
请您在了解的因素后的横线出打钩：

- 课程内容 _____
- 就业难度 _____
- 对口职业的社会地位和工薪水平 _____
- 专业热门程度 _____

问题六、影响您选择专业的因素是：（请用“1” “2” “3” 表示影响程度，“1” 影响程度最大。在三个因素后面标注数字。*1 影响程度最大）

- 有关科目的成绩 _____
- 个人爱好 _____
- 家庭环境 _____
- 对应职业的社会地位 _____
- 专业热门程度 _____
- 经济条件 _____
- 挑战性 _____

三、**显著性差异分析**

3.4.1 基本含义

显著性差异，是一个统计学名词。它是统计学上对数据差异性的评价。是用于实验处理组与对照组或两种不同处理的效应之间是否有差异，以及这种差异是否显著的方法。 常把一个要检验的假设记作 H0,称为原假设（或零假设） (null hypothesis) ，与 H0 对立的假设记作 H1，称为备择假设(alternative hypothesis) 。

（1）在原假设为真时，决定放弃原假设，称为第一类错误，其出现的概率通常记作 α ；

（2）在原假设不真时，决定接受原假设，称为第二类错误，其出现的概率通常记作 β 。 通常只限定犯第一类错误的最大概率 α ，不考虑犯第二类错误的概率 β 。这样的假设 检验又称为显著性检验，概率 α 称为显著性水平。 最常用的 α 值为 0.01、0.05、0.10 等。一般情况下，根据研究的问题，如果放弃真假设损失大，为减少这类错误，α 取值小些 ，反之，α 取值大些。当数据之间具有了显著性差异，就说明参与比对的数据不是来自于同一总体，而是来自于具有差异的两个不同总体，这种差异可能因参与比对的数据是来自不同实验对象的。

3.4.2 原理

无效假设 显著性检验的基本原理是提出“无效假设”和检验“无效假设”成立的机率（P）水平的选择。所谓“无效假设”，就是当比较实验处理组与对照组的结果时，假设两组结果间差异不显著，即实验处理对结果没有影响或无效。经统计学分析后，如发现两组间差异是抽样引起的，则“无效假设”成立，可认为这种差异为不显著（即实验处理无效）。若两组间差异不是由抽样引起的，则“无效假设”不成立，可认为这种差异是显著的（即实验处理有效）。 *“无效假设”成立的机率水平 检验“无效假设”成立的机率水平一般定为 5%，其含义是将同一实验重复 100 次，两者结果间的差异有 5 次以上是由抽样误差造成的，则“无效假设”成立，可认为两组间的差异为不显著，常记为 $p>0.05$。若两者结果间的差异 5 次以下是由抽样误差造成的，则“无效假设”不成立，可认为两组间的差异为显著，常记为 $p\leqslant 0.05$。如果 $p\leqslant 0.01$，则认为两组间的差异为非常显著。

3.4.3 基本思想

显著性检验的基本思想可以用小概率原理来解释。 1、小概率原理：小概率事件在一次试验中是

几乎不可能发生的，假若在一次试验中事件 事实上发生了。那只能认为事件 不是来自我们假设的总体，也就是认为我们对总体所做的假设不正确。 2、观察到的显著水平：由样本资料计算出来的检验统计量观察值所截取的尾部面积为。这个概率越小，反对原假设，认为观察到的差异表明真实的差异存在的证据便越强，观察到的差异便越加理由充分地表明真实差异存在。 3、检验所用的显著水平：针对具体问题的具体特点，事先规定这个检验标准。 4、在检验的操作中，把观察到的显著性水平与作为检验标准的显著水平标准比较，小于这个标准时，得到了拒绝原假设的证据，认为样本数据表明了真实差异存在。大于这个标准时，拒绝原假设的证据不足，认为样本数据不足以表明真实差异存在。5、检验的操作可以用稍许简便一点的作法：根据所提出的显著水平查表得到相应的 值，称作临界值，直接用检验统计量的观察值与临界值作比较，观察值落在临界值所划定的尾部内，便拒绝原假设；观察值落在临界值所划定的尾部之外，则认为拒绝原假设的证据不足

3.4.4 选择原因

由于本组课题中要求对不同体系的每项数据进行对比研究，因此需要对数据的差异性进行研究，并计算出数据之间的差异大小。差异越大，则研究约有意义。在选择研究数据差异的方法上，本组成员选择用显著性差异分析的方法来探究差异大小，是因为它是统计学中比较数据差异时常用的有效方法。

3.4.5 利用 excel 计算显著性差异的方法

操作方法： 在“工具”菜单上，单击“加载宏”。 在“可用加载宏”列表中，选中“分析工具库”框，再单击“确定”。 如果必要，请按安装程序中的指示进行操作。 在“数据分析”对话框中，单击“t－检验”，再单击“确定”。 在出现的对话框中，设置所需的参数。OFFICE 2007 以后的版本要显示开发工具 功能区 加载项加载好以后在数据区**的最后可以看到。**

四、数据统计与初步分析

4.1 文科与理科

	高一标准	高一实验	高一荣誉	高一国际	高二标准	高二实验	高二荣誉	高二国际
倾向文科	15.15%	8.82%	8.7%	19.35%	/	33.33%	/	13.33%
倾向理科	80.81%	88.24%	89.13%	54.83%	/	66.67%	/	60.00%
其他	0	0	2.17%	9.67%	/	/	/	13.33%
无	4.04%	0	0	17.74%	/	/	/	13.33%

在文理倾向中，高一标准有 15.5%的同学，高一实验有 8.82%，高一荣誉有 8.7%，高一国际有 19.35%，高一国际有 14.4%的同学选择文科；高一标准有 80.81％的同学，高一实验有 88.24%，高一荣誉有 89.13%，高一国际有 54.83%，高二国际有 60%的同学选择理科的同学选择理科；最后，高一标准没有同学，高一实验没有，高一荣誉有 2.17%，高一国际有 9.67%的同学选择了其他；高一标准有 4.04%的同学，高一实验没有，高一荣誉没有，高一国际有 17.74%的同学选择了无文理科倾向。

有无文理科倾向能够侧面反映出学生对自己专业选择明确性。令人吃惊的是，在所有受访者中，最多的国际体系的学生选择了无文理科倾向。国际体系受访者在此题中也是最多元化的，即各选项选择人数较其他体系相比更为均衡，这可能是由于美国教育鼓励学生成为独特的人，因此国际体系学生

不愿或从根本上来不通通追寻一个大方向，而是向各个方面均衡发展。（更详尽的分析请看“五、结论”部分）

4.2 未来理想专业的存在性

	高一标准(%)	高一实验(%)	高一荣誉(%)	高一国际(%)	高二标准（%）	高二实验（%）	高二荣誉（%）	高二国际（%）
理想专业一个	13.13	16.13	0	24.19	13	33.33	14.29	26.67
多个	61.62	83.87	56.52	58.06	65.8	56.67	71.43	66.67
无	25.25	8.82	8.70	17.74	22.9	6.67	14.29	6.67

在理想专业方面，高一标准有 13.13%的同学，高一实验有 16.13%，高一荣誉有 25%，高一国际有 24.19%，高二标准有 13% ，高二实验有 33.33%，高二荣誉有 14.29%，高二国际有 26.67%的同学只有一个理想专业；高一标准有 61.62%的同学，高一实验有 16.13%，高一荣誉有 56.52%，高一国际有 58.06%，高二标准有 65.8% ，高二实验有 56.67%，高二荣誉有 71.43% ，高二国际有 66.67%的同学有多个理想专业；高一标准有 25.25%的同学，高一实验有 8.82%，高一荣誉有 8.7%，高一国际有 17.74%，高二标准有 22.9% ，高二实验有 6.67%，高二荣誉有 14.29% ，高二国际有 6.67%的同学没有理想专业。

未来理想专业的存在性可以直接反映出学生对未来理想专业的明确程度。可以看到，对未来专业非常明确、只有一个理想专业的学生还是占少数，而拥有多个理想专业的学生占绝大多数，少数同学还没有理想专业。令人惊讶的是，在所有受访者中，高一荣誉体系对未来专业的选择最为明确，这可能是由于荣誉体系主攻特定科目的竞赛，学生在参加荣誉体系之前便已对特定专业产生极大的兴趣，或在竞赛的过程中逐渐培养出了兴趣。（更详尽的分析请看“五、结论”部分）

4.3 对未来目标专业的认知

	高一标准(%)	高一实验（%）	高一荣誉（%）	高一国际(%)	高二标准（%）	高二实验（%）	高二荣誉（%）	高二国际（%）
认知课程	52.70	48.39	40.48	58.82	70	75	58.33	100
就业	44.59	41.94	50	60.78	46.7	64.29	58.33	76.92
工薪	52.70	54.84	59.52	72.54	43.3	53.57	41.67	69.23
热门	44.59	45.16	42.86	62.74	40	42.86	50	84.62

在认知程度方面，高一标准有 52.7%的同学，高一实验有 48.39%，高一荣誉有 40.48%，高一国际有 58.82%，高二标准有 70% ，高二实验有 75%，高二荣誉有 58.33% ，高二国际有 100%的同学对课程内容比较了解；高一标准有 44.59%的同学，高一实验有 41.94%，高一荣誉有 50%，高一国际有 60.78%，高二标准有 46.7% ，高二实验有 64.29%，高二荣誉有 58.33% ，高二国际有 76.92%的同学对其就业情况比较了解；高一标准有 52.7%的同学，高一实验有 54.84%，高一荣誉有 59.52%，高一国际有 72.54%，

高二标准有 43.3% ，高二实验有 53.57%，高二荣誉有 41.67% ，高二国际有 69.23%的同学对薪资水平比较了解;高一标准有 44.59%的同学,高一实验有 45.16%,高一荣誉有 42.86%,高一国际有 62.74%,高二标准有 40% ，高二实验有 42.86%，高二荣誉有 50% ，高二国际有 84.62%的同学对其热门程度比较了解。

可以看到，在所有受访者中国际体系对于专业的了解最为广泛。“国际国际，世界高地”这一口号已经反应出了国际学生拥有的特质，那便是拥有开阔的视野。高二国际体系在这一方面表现更为突出,这是由于高二国际体系相较于高一国际体系额外开设了 AP 课程,并且学生能够自主选择 AP 课程,如此一来，学生便能够选择自己感兴趣的科目，并深入地了解特定的科目。(更详尽的分析请看“五、结论”部分)

4.4 热门专业

科目	高一标准(%)	高一实验（%）	高一荣誉（%）	高一国际(%)	高二标准（%）	高二实验（%）	高二荣誉（%）	高二国际（%）
数学	16.22	12.9	7.14	15.68	0.33	3.57	16.67	0
哲学	6.76	9.68	0	5.88	0.33	10.71	16.67	0
经济	40.54	32.26	38.1	25.49	56.7	17.86	33.33	30.77
商学	25.68	29.03	26.19	35.29	40	17.86	41.67	38.46
管理	24.32	32.26	28.57	31.37	30	14.29	33.33	46.15
法学	9.46	6.45	7.14	13.725	26.7	25	8.33	38.46
教育	9.46	0	14.29	11.76	16.7	3.57	8.33	0
文学	9.46	6.45	4.76	9.8	20	17.86	8.33	0
艺术	17.57	25.81	4.76	13.72	16.7	14.29	8.33	0
电影	9.46	22.58	4.76	5.88	10	7.14	8.33	
新闻	14.86	12.9	4.76	17.64	0	7.14	0	0
历史	6.76	6.45	4.76	7.84	6.7	0	0	0
物理	27.03	29.03	21.43	21.56	0.33	0	8.33	7.69
建筑	16.22	29.03	16.67	9.8	16.7	10.71	33.33	0
计算机	20.27	9.68	14.29	31.37	13.3	14.29	16.67	15.38
农学	2.70	6.45	2.38	1.96	0.33	0	0	0
心理	20.27	25.81	14.29	25.49	43.3	25	33.33	
医学	20.27	9.68	14.29	11.76	50	17.86	25	0
军事	9.46	0	4.76	3.92	0.33	0	0	0
地质	4.05	6.45	4.76	3.92	0.33	3.57	0	0
人类	5.41	9.68	4.76	5.88	0.33	14.29	0	0
天文	10.81	9.68	4.76	3.91	0	0	0	
化学	13.51	12.9	11.9	7.84	0.33	3.57	0	0
语言	17.57	12.9	0	13.72	10	7.14	0	0
环境科学	9.46	12.9	2.38	11.76	6.7	3.57	0	0
酒店管理	2.7	6.45	21.74	7.84	0	7.14	8.33	0
其他	5.41	22.58	4.7	5.88	/	14.29	0	23

高一标准有 6.76%的同学，高一实验有 9.68%，高一荣誉有没有，高一国际有 5.88%，高二标准有 0.33% ，高二实验有 10.71%，高二荣誉有 16.67% ，高二国际有没有同学对哲学感兴趣。

高一标准有 40.54%的同学，高一实验有 32.26%，高一荣誉有 38.1%，高一国际有 25.49%，高二标准有 56.7% ，高二实验有 17.86%，高二荣誉有 33.33% ，高二国际有 30.77%同学对经济感兴趣。

高一标准有 25.68%的同学，高一实验有 29.03%，高一荣誉有 26.19%，高一国际有 35.29%，高二标准有 40% ，高二实验有 17.86%，高二荣誉有 41.67% ，高二国际有 38.46%同学对商学感兴趣。

高一标准有 24.32%的同学，高一实验有 32.26%，高一荣誉有 28.57%，高一国际有 31，37%，高二标准有 30% ，高二实验有 14.29%，高二荣誉有 33.33% ，高二国际有 46.15%同学对管理感兴趣。

高一标准有 26.7%的同学，高一实验有 9.46%，高一荣誉有 6.45%，高一国际有 7.14%，高二标准有 13.725% ，高二实验有 26.7%，高二荣誉有 25% ，高二国际有 38.46%同学对法学感兴趣。

高一标准有 9.46%的同学，高一实验没有，高一荣誉有 14.29%，高一国际有 11.76%，高二标准有 16.76% ，高二实验有 3.57%，高二荣誉有 8.33% ，高二国际没有同学对教育感兴趣。

高一标准有 9.46%的同学，高一实验有 6.45%，高一荣誉有 4.76%，高一国际有 9.8%，高二标准有 20% ，高二实验有 17.86%，高二荣誉有 8.33% ，高二国际有没有同学对文学感兴趣。

高一标准有 16.22%的同学，高一实验有 12.9%，高一荣誉有 7.14%，高一国际有 15.68%，高二标准有 0.33% ，高二实验有 3.57%，高二荣誉有 16.67% ，高二国际有没有同学对数学感兴趣。

高一标准有 15.57%的同学，高一实验有 25.81%，高一荣誉有 4.76%，高一国际有 13.72%，高二标准有 16.7% ，高二实验有 14.29%，高二荣誉有 8.33% ，高二国际有没有同学对艺术感兴趣。

高一标准有 9.46%的同学，高一实验有 22.58%，高一荣誉有 4.76%，高一国际有 5.88%，高二标准有 0.33% ，高二实验有 3.57%，高二荣誉有 16.67% ，高二国际有 0.33%同学对电影感兴趣。

高一标准有 14.86%的同学，高一实验有 12.9%，高一荣誉有 4.76%，高一国际有 17.64%，高二标准没有 ，高二实验有 7.14%，高二荣誉有没有% ，高二国际有没有同学对新闻感兴趣。

高一标准有 6.76%的同学，高一实验有 6.45%，高一荣誉有 4.76%，高一国际有 7.84%，高二标准有 6.7% ，高二实验没有，高二荣誉没有 ，高二国际没有同学对历史感兴趣。

高一标准有 27.03%的同学，高一实验有 29.03%，高一荣誉有 21.43%，高一国际有 21.56%，高二标准有 0.33% ，高二实验没有，高二荣誉有 16.67% ，高二国际有 7.69%同学对物理感兴趣。

高一标准有 16.22%的同学，高一实验有 29.03%，高一荣誉有 9.8%，高一国际有 16.7%，高二标准有 16.7% ，高二实验有 10.71%，高二荣誉有 33.33% ，高二国际没有同学对建筑感兴趣。

高一标准有 20.27%的同学，高一实验有 9.68%，高一荣誉有 14.29%，高一国际有 31.37%，高二标准有 13.3% ，高二实验有 14.29%，高二荣誉有 16.67% ，高二国际 15.38 同学对计算机感兴趣。

高一标准有 2.7%的同学，高一实验有 6.45%，高一荣誉有 2.38%，高一国际有 1.96%，高二标准有 0.33% ，高二实验没有，高二荣誉没有 ，高二国际没有同学对农学感兴趣。

高一标准有 20.27%的同学，高一实验有 25.81%，高一荣誉有 14.29%，高一国际有 25.49%，高二标准有 43.3% ，高二实验有 25%，高二荣誉有 33.33% ，高二国际有 4.8%同学对心理感兴趣。

高一标准有 20.27%的同学，高一实验有 9.68%，高一荣誉有 14.29%，高一国际有 11.76%，高二标准有 50% ，高二实验有 17.86%，高二荣誉有 25% ，高二国际没有同学对医学感兴趣。

高一标准有 9.46%的同学，高一实验没有，高一荣誉有 4.76%，高一国际有 3.92%，高二标准有 0.33% ，高二实验没有，高二荣誉没有 ，高二国际有没有同学对军事感兴趣。

高一标准有 4.05%的同学，高一实验有 6.45%，高一荣誉有 4.76%，高一国际有 3.92%，高二标准有 0.33% ，高二实验有 3.57%，高二荣誉没有 ，高二国际没有同学对地质感兴趣。

高一标准有 5.41%的同学，高一实验有 9.68%，高一荣誉有 4.76%，高一国际有 5.88%，高二标准有 0.33% ，高二实验有 14.29%，高二荣誉没有 ，高二国际没有同学对人类感兴趣。

高一标准有 10.81%的同学，高一实验有 9.68%，高一荣誉有 4.76%，高一国际有 3.91%，高二标准没有 ，高二实验没有，高二荣誉没有 ，高二国际有 4.83%的同学对天文感兴趣。

高一标准有 13.51%的同学，高一实验有 12.9%，高一荣誉有 11.9%，高一国际有 7.84%，高二标准 0.33% ，高二实验有 3.57%，高二荣誉有 0% ，高二国际没有同学对化学感兴趣。

高一标准有 17.57%的同学，高一实验有 12.9%，高一荣誉有 0%，高一国际有 13.72%，高二标准有 10% ，高二实验有 7.14%，高二荣誉有 0% ，高二国际没有同学对语言感兴趣。

高一标准有 9.46%的同学，高一实验有 12.9%，高一荣誉有 2.38%，高一国际有 11.76%，高二标准有 6.7% ，高二实验有 3.57%，高二荣誉有 0% ，高二国际没有同学对环境科学感兴趣。

高一标准有 2.7%的同学，高一实验有 6.45%，高一荣誉有 21.74%，高一国际有 7.84%，高二标准有 0% ，高二实验有 7.14%，高二荣誉有 8.33% ，高二国际没有同学对酒店管理感兴趣。

高一标准有 5.41%的同学，高一实验有 22.58%，高一荣誉有 4.7%，高一国际有 5.88%，高二标准有 0% ，高二实验有 14.29%，高二荣誉有 0% ，高二国际有 23.07%同学有其他感兴趣的科目。

可以看到，经、商、管仍旧是最热门的三个专业，即使在国际体系也是如此。其次，心理学、计算机及物理学也是较为热门的专业对计算机感兴趣的学生主要集中在国际体系及荣誉体系，这可能是由于荣誉体系参加大量计算机竞赛，培养了学生深层次的兴趣，而国际体系开设 AP Computer Science 的课程，学生可自主选择，AP 课程加深及产生了学生对计算机学科的兴趣。（更详尽的分析请看“五、结论”部分）

4.5 影响专业选择的因素

	高一标准(%)	高一实验(%)	高一荣誉(%)	高一国际(%)	高二标准(%)	高二实验(%)	高二荣誉(%)	高二国际(%)
A 成绩	33.78	45.16	0	39.21	33.3	32.14	8.333	40
B 爱好	90.54	100	76.19	94.11	86.7	92.86	100	100
C 经济	43.24	29.03	0	39.21	16.7	14.29	8.33	13.33
D 热门	16.22	6.45	7.14	23.52	16.7	14.29	8.33	33.33
E 地位	39.19	6.45	14	29.41	0.33	28.57	41,67	26/67
F 收入	67.57	2.03	45.24	43.13	36.7	32.14	25	40
G 就业	33.78	12.9	23.81	27.45	43.3	21.43	33.333	40
H 挑战	31.08	45.16	23.81	35.29	16.7	28.57	50	33.33

对于选择专业的因素，高一标准有 33.78%的同学，高一实验有 45.16%，高一荣誉有 0%，高一国际有 39.21%，高二标准有 33.3% ，高二实验有 32.14%，高二荣誉有 8.33% ，高二国际有 40%同学认为成绩较为重要;高一标准有 90.54%的同学,高一实验有 100%,高一荣誉有 0%,高一国际有 76.19%,高二标准有 94.11% ，高二实验有 86.7%，高二荣誉有 92.86% ，高二国际有 100%同学认为爱好较为重要；高一标准有 43.24%的同学，高一实验有 29.03%，高一荣誉有 0%，高一国际有 39.21%，高二标准有 16.7% ，高二实验有 14.29%，高二荣誉有 8.33% ，高二国际有 13.33%同学认为经济较为重要；高一标准有 16.22%的同学，高一实验有 6.45%，高一荣誉有 7.14%，高一国际有 23.52%，高二标准有 16.7% ，高二实验有 14.29%，高二荣誉有 8.33% ，高二国际有 33.33%同学认为专业热门程度较为重要；高一标准有 39.19%的同学，高一实验有 6.45%，高一荣誉有 14%，高一国际有 29.41%，高二标准有 0.33% ，高二实验有 28.57%，高二荣誉有 41.67% ，高二国际有 26.67%同学认为成绩较为重要；高一标准有 33.78%的同学，高一实验有 12.9%，高一荣誉有 23.81%，高一国际有 27.45%，高二标准有 43.3% ，高二实验有 21.43%，高二荣誉有 33.33% ，高二国际有 40%同学认为就业较为重要；高一标准有 31.08%的同学，高一实验有 45.16%，高一荣誉有 23.81%，高一国际有 35.29%，高二标准有 16.7% ，高二实验有 28.57%，高二荣誉有 50% ，高二国际有 33.33%同学认为挑战性较为重要。

可以看到，在所有供选择的因素中，兴趣被广泛的重视。然而，纯粹靠兴趣选择未来专业并不可靠，因为高中生的兴趣是不停变化的，很可能产生到大学时选择的专业已不再与自己的兴趣相符，但由于已经选择，只能硬着头皮读下去，对学习效率产生重大影响。除了爱好以外，考虑因素排序中较

为靠前的其他几项都是比较现实的，包括收入，成绩，就业难易。这一结果也是我们预料之中的。而且可以很明显看出高二在考虑未来专业时因素更多，考虑更为周全。（更详尽的分析请看“五、结论”部分）

五、研究深入分析及结论

通过对回收的问卷进行数据分析主要得出以下结论：

5.1 认识程度：

1）国际体系对未来专业的认识最广泛，实验体系第二，荣誉体系第三，标准体系第四

2）深圳中学高二学生对未来专业的认识较高一学生相比更为广泛

不难看出国际体系的同学对自己的未来更有规划。这或许是因为国际体系的学生为了大学申请需要参加各种活动以丰富自己的经历，所以较之其他体系的学生，国际体系的学生有更多的机会接触到各种各样的职业。且早早确定一个目标专业并在给外国大学的申请中中展示出尽可能长时间在此专业方面的努力与成就对成功申请到自己的理想大学有着极大的好处，所以这更促使国际体系的学生需要通过各种各样的途径了解不同的专业以尽早确定自己将来的方向。而在对其他体系的学生的采访中我们了解到很多同学都致力于在高考中取得一个好成绩。而新闻也报道许多高中生甚至是在高考出分到填报志愿那短短的一周时间内草率决定自己的未来专业。因此，其他体系的同学中有很多人并没有过多的关注各个专业，认识程度也自然较低。第一项排序中还提到高二同学对专业的了解程度大于高一同学。这个结论是早已料到的，对最终数据分析得出这样的结果也并不意外。而这项结论也进一步佐证了本次研究的数据分析不论如何还是具有一定的有效性。

5.2 考虑因素：

1）深圳中学高一学生考虑未来专业时的首要因素是爱好，其次收入也是一项较为重要的考虑因素

2）深圳中学高二学生在考虑未来专业时的首要因素也是爱好，其次是收入，成绩以及就业难易，高二比较于高一更注重与就业、收入有关的因素。

第二项考虑因素的排序有一个非常明显的特点，那就是不论高一高二都将爱好纳入对他们选择未来专业最重要的考虑因素之一。这一点在实验体系和荣誉体系表现的尤为明显，甚至有三个班级中出现了所有参与问卷填写的同学全部选择了爱好这一选项。但实际上许多新闻报道及学术论文均指出这一因素太过于现实，很多同学在最终多决定的时候实际上并不能选择自己所喜欢爱好的专业。不过考虑到深圳中学的学生一直都有着颇为鲜明的个性以及勇于创新，挑战自我的特点，我们猜测也许深圳中学的学生真的有别于其他学校的学生，在最终做选择时真正能够选择自己的爱好作为专业。除了爱好以外，考虑因素排序中较为靠前的其他几项都是比较现实的，包括收入，成绩，就业难易。这一结果也是我们预料之中的。而且可以很明显看出高二在考虑未来专业时因素更多，考虑更为周全。

5.3 文理科偏向：

1）深圳中学高一高二学生中偏向理科类的学生多于偏向文科类的学生，比例大约为 8：1

从第三项文理科偏向中可以看出，深中偏向于选择理科的学生远多于选择文科的。而在对高二发放问卷的过程中也发现理科班级多于文科班级。故根据大胆推测选择深中的学生中，理科生占 20%。

5.4 有无目标专业的比例：

1）深圳中学高一高二学生多数有着多个目标专业，还有部分同学只有一个目标专业，没有目标专业的同学很少。在四个体系中，国际体系学生选填有多个目标专业的人数比例最高，体现出了国际体系的多元化。

2）深圳中学高二学生有目标专业的人数比例大于高一学生，对未来专业更加明确

从第四项有无目标专业的比例可以看出大部分学生没有一个明确的目标专业。我们在统计问卷中

的此题时发现，多数选择有多个目标专业的同学选择的多个目标专业具有一定的一致性。例如，很多同学在选择了商科的同时也选择了金融和管理，在选择艺术的同时也选择了电影制作等。而在统计时也发现有部分同学在选择多个专业的选项天差地别，例如有的同学选择了数学的同时也选择了新闻，选择了商科却也选择了医科。对于前一种同学，我认为这样的同学虽然没有确定一个特定的目标专业，但主要原因可能是因为兴趣点较多或对各个专业了解程度不够深，不敢贸然决定自己未来的专业。对于后一种同学，只能推测他们可能兴趣点较为分散，思维跳跃性较强，各科目能力较为平均。从第四项中还可以看出，无目标专业的比例是最少的。在统计时，只有个别班级有人填写无目标专业，且其中还包含有一部分同学不愿配合问卷调差工作，因此草草填写，为了省事直接填写无目标专业。因此得出结论，深圳中学的高一高二学生对自己的未来基本都是有一定规划的。

5.5 最热门专业：

1）在深圳中学高一高二学生中最热门的前三项专业分别为经济，商学和心理学

在第五项最热门专业中我们可以看出，经济、商学、心理学位居三甲。虽然经济和商学的确都是当今比较热门的专业，在榜单上排名第一的计算机专业从我们的研究结果中看似乎并不热门。本次研究选取的采访对象中有着已经申请到大学决定学习商学的国际体系学长，也有处于高一虽然未来专业不打算选取心理学但自己对心理学无比热爱的学生。通过采访我们发现，有部分选择商科作为专业的学生是因为就业趋势以及家庭原因所导致，但也有不少选择此方面专业的学生是因为这是自己的兴趣所在。但心理学则是不同，有部分家长不愿意让自己的孩子学习心理学，因为这些家长对心理学的认识存在着一定的误区。在本组的采访对象中，有两位同学自己想要学习心理学，并一直坚持阅读此方面的书籍，但是家长却十分反对，并要求自己的孩子学习商学。虽然本次研究的采访结果可能具有一定的偶然性，但是我们所获得的信息至少能够说明这样由于家长阻挠而导致孩子无法选择自己喜爱的未来专业的事例是客观存在的。而针对为何心理学的热门程度仍然位居前三甲，我们将这样的结果与第二项考虑因素的统计结果相结合，发现这或许是因为深圳中学的高一高二学生更加独立而敢于自己选择自己未来的人生。

Part 2 Essay (Credit: 90)

Pros and Cons of Math Competitions
by Richard Rusczyk

Mathematics competitions such as MATH LEAGUE, MATHCOUNTS, and the American Mathematics Competitions are probably the extracurricular math programs with the widest participation. The most immediate value of these math contests is obvious – they pique students' interest in mathematics and encourage them to value intellectual pursuits. Kids love games, and many will turn just about any activity into a contest, or in other words, something to get good at. Math contests thus inspire them to become good at mathematics just like sports encourage physical fitness. Eventually, students put aside the games. By then, hopefully an interest in the underlying activity has developed.

Beyond encouraging an interest in mathematics, contests help prepare students for competition. For better or worse, much of life is competition, be it for jobs or resources or whatever. Competition of any sort trains students to deal with success and failure, and teaches them that effective performance requires practice. Moreover, nearly every interesting and worthwhile venture in life comes with some element of pressure; competition teaches students how to handle it.

Despite all the benefits of math contests, they are not an unmitigated good. First of all, not all contests are designed well. Students shouldn't take too seriously contests that greatly emphasize speed or memorization. Curricular contests (particularly calculus contests for high school students) can also be misleading, as they deepen the misconception that there is no more to math than what is in the classroom. Such contests run the risk of encouraging students to overvalue skills that aren't nearly as valuable as the one asset a contest should help them develop – the ability to think about and solve complex problems.

A second danger of contests is extending kids beyond their ability. Students should certainly be challenged with problems they can't do from time to time, but if this happens consistently, the experience goes from humbling and challenging to humiliating and discouraging.

A third potential pitfall, burnout, often comes on the heels of the first two. Participants in math contests are just as much at risk of burnout as musicians or athletes. Parents, teachers, and the students themselves should be on the lookout for signs of decreased interest, and they must be willing to back off and allow the student to rediscover an interest in mathematics on his or her own. Burnout is particularly pernicious because the end result often isn't a backlash against competition, but against math in general. Indeed, even students not involved in contests have to watch out for burnout, though the pressure of contests tends to encourage burnout more quickly than the classroom.

These possible perils are usually more than offset not only by the values we've already mentioned, but also by the greatest asset of math contests - cooperation. These competitions bring together students of like interests and abilities, allowing them to form their own community in which they will find friendship, inspiration, and encouragement to a far greater degree than most of these students can find in the typical classroom. Whereas a student may be one of only three or four in her school who pursues math the way others play basketball, she will not find herself so lonely at a math contest, where she'll find many kindred spirits.

In summary, math contests are a tremendous social and intellectual opportunity for students, but exposing

students to contests must be done wisely, else they become counterproductive to the goal of encouraging a lifelong interest in mathematics and other intellectual pursuits.

Direction (Note: For this question, please write your answer on file "high-school-answersheet.doc", downloadable together with this document at www.mathleague.cn, and submit file "high-school-answersheet.doc" at www.mathleague.cn after you are done.**):**

In his article "Pros and Cons of Math Competitions", Richard Rusczyk lists and explains the advantages and the disadvantages of math competitions. Are math contests beneficial or harmful to students? Everything always has two sides: the good and the bad. This proverb probably also applies to math competitions. Write a response in which you discuss whether students should be encouraged to participate in math competitions. You may draw examples from your reading, studies, experience, observations, and etc.

Hint: Here are some questions to think about. You do not have to answer them, but they will help you to craft your response.

1. What is the purpose of math contests?
2. What are the good and the bad sides of math contests?
3. How should you value your scores on math contests?
4. What are the most important qualities that a successful mathematician should have?
5. To a student who is highly interested in mathematics, what are much more important than math contests?

以下是一些同学提交的试卷，供大家参考。这些试卷并不代表是写得最好、最正确、最全面、得分最高的，只是给大家参考，因为这道题目本身就是 open question，没有标准答案或者最佳答案。

试卷一：

It is undoubtedly true that mathematic is the principal subject of all science. Since the first school day children have been required to commit themselves to learning maths. In daily life the mathematic capability is also the most important criterion to judge one's intelligence quotient. However, there is no consensus on the issue whether students should be encouraged to participate in the Mathematics contest. As far as I am concerned, mathematic contest is an essential way to discover and cultivate talented students and children should be encouraged to actively participate in every stage of their schooling period, but students' values towards mathematic contests should be correct. Otherwise it would only results in counterproductive effects.

Before I examine the good and bad sides of math contests, I should firstly ask what is the purpose of mathematics contests. The answer actually differs drastically from each participant. Some may say maths contest is to attend a good college, cumulating soft power for leaving admission offer a good impression. Other people may say it is to better undertake mathematic career in the future or merely out of interests in mathematics. Despite the disparity, I think the original intention of all math contests is to serve as bait to let students fall in love with math and increase different kinds of personal qualities.

There are numerous advantages brought by math contest. First of all, since most math contests are novel and creative in which the questions are far beyond the requirements in the textbook, the most obvious advantage brought by math contest is to widen the scope of knowledge. Nevertheless, the potential and implicit benefits far exceed learning knowledge. Based on my own experience and observation, mathematics contests play a significant role in every stages of lives: Interests for children, practical abilities for teenagers and philosophical enlightenment for the elder.Just like what Richard Rusczyk says, kids love games. Solving Mathematic problems is an enjoyable process that could pique students interests in learning. For instance, when I was young my teacher often plays with us the 24 points game. As a result, every time when I saw a series of plate numbers on the street, I tend to subconsciously combine those numbers to achieve a number 24. Similarly, the questions in the math contest are full of pictures, including fairy tales figures to ask a question like "how can the rabbit find her mother in the nearest way?" For me as a kid such a maze was virtually a game so that I have been interested in Math since I was very young. As I grow older, mathematic contest becomes an approach to form my personal qualities as well as gain different sorts of ability, including drawing inference, self-learning, summarizing information by myself, thinking critically and logically, being creative and imaginative as well as collaborating with other people. Traditional curriculum in China usually supports procedural approaches, which may include memorization, drill, and practice of rules and definition as the optimum way to teach and learn math. On the other hand, nontraditional approaches used by mathematic contest such as Mathematic League, encourage students to utilize their innate abilities to gain ownership of the specified mathematical topic. For doing the questions in Mathematic League, I have to learn the unfamiliar topic of normal curve,a useful statistic method, by myself. Besides, some questions require me to consider the practical uses of the knowledge in daily lives. Moreover, for writing this paper now I have to consider the meaning of studying math and participating in this contest more profoundly and thoroughly, thereby gaining further illumination. Since it encourages me to think, my level of thinking is gradually enhanced and sometimes could up to a philosophical level. Another example of math contests in modeling teaches me how to collaborate with other people, how to deal with the situation when our opinions differs and how to enable each group member actively contributed to the group and encourages other people to come up with ideas. Even though we have encountered numerous problems during that intense 36 hours, we eventually acquire a great sense of achievement after finalizing and feel deeply the team spirits. Thanks to so many mathematics contests I joined, I have acquired so many useful abilities which could also be applied in many other fields.

However, ever coin has two sides. Because I have grown in China, I wanna mainly focus on discussing the my discontentment on the math contest in China. First of all, most contests require students to utilize to

complicated method and formula to solve the questions. In my opinion this kind of design is neither practical nor encouraging. According to the philosophy of taoism, the greatest truth is the simplest. Math contest should be a motivator for students but not purposely make difficulties for them. Then, unlike the educational system in America, the Chinese educational system is misleading since it overemphasizes students' scores but not overall qualities. Children usually are forced to take math contest in order to get good rewards, even though they are not truly interested in math. That is a problematic and dangerous trend. Consequently, too many math contests would do nothing but increase students' pressure and render them an distorted value toward scores. Math contests discourage most people who take them because most people don't get close to winning. For instance we can usually hear some negative news that numerous students commit to suicide every day since they usually lack of the courage to confront a little bit failure. Even though a student achieve good score, winning a competition is not necessarily helpful for the winner either. For instance, although I have seen a lot of students achieving numerous mathematics rewards, they still do not be quite preeminent later in their lives. Except for a few students having strong self-control, most Chinese students who do not need to take college entrance exam due to the awards in math contests mistakenly believe that their missions are eventually finished. As a result they lag behind in the college. Therefore, due to the deep air of utilitarian, the misleading emphasis on scores and the bad design of some questions, maths contests in China could do a lot of harm to children.

Despite all the limitations, I still believe that the children should be encouraged to participate in math contests on the premise of healthy attitude and great interests. Indeed, every contest is unavoidably bond with utilitarian. Therefore, it is important to combine interests and utilitarian together instead of being pure utilitarian. When we carefully examine the criticism of math contest, we could find that it were usually those parents who are utilitarian and force their children to attend the contest. However, parents shall not interfere students' own choice and interests since maths contest is after all not mandatory and there are many other things much more important than scores. For those people like me who truly love math, attending math contest provides them great opportunity to fully explore their potentials, broaden their eyesights, enhance their levels of thinking, but not simply to gain knowledge.

All in all, mathematic contests should still be holden, yet many of them must be improved in some ways for cultivating interests and personal qualities but not solely for utilitarian purpose.

试卷二：

There are many math contests in China served for purpose to encourage students to further their pursuits in math. Every year, there are more than 2 million students participating in the *HopeCup*, one of the most well-known contests in China. There are also millions of students taking part in the American Mathematics Contest every year. However, there has been discussions about whether math contest is overall beneficial or harmful to students. As a student in China who has personally participated in many types of Chinese, American and International Mathematics contests, I believe students should be encouraged to take part in math contest.

There are many benefits that math contest can do for students. Initially, like many other contests, it

helps students find whether they obtain great potential in math. In school, tests usually cannot differentiate those outstanding students from normal students since usually many students get high marks. These tests are designed to test whether students learn well in class, but not to test their potential in math. Thus, math contests become the effective means to reach this purpose. The original purpose of the very first contest is to distinguish talented students from others, and provide them confidence to pursue their excelled discipline in future.

Moreover, math contests help students further their interest in mathematics and related fields, as well as interest in challenging themselves. There are a large quantity of students whose interest in math is potentially strong while cannot be aroused by ordinary math class in school. In America, the math learnt at school is common-used, but too fundamental and not challenging. Students seldom find fun in it. In China, there are certain difficult problems in quiz and tests, but these problems are not designed well generally. Some of these problems appear for the sole purpose of setting obstacles on the way to full-mark, and they are highly not practical in life. In both cases, math at school cannot inspire students' interest in math. However, math contests are to provide challenging problems from all levels and subtopic of math for students. AMC is a typical example. The difficulty of problems in an AMC contest is arranged in order from easy to hard. Students who have different ability can find fun solving problems of corresponding levels. The hard problems are about frequently used topics such as possibility and solid geometry, which students have a great chance to encounter in the future. These different levels of common but challenging problems can surely catch students' interest and motivate them to intensify their effort to solve such problems. Equally importantly, they become passionate in facing these challenges and get used to encounter challenges that they sometimes cannot accomplish. This point is also mentioned in the professor's article. He stated that students will learn to handle success and failure from contests. When getting used to handling failure, they can turn it into motivation and promote their passion encountering challenges.

It is no doubt that participating in math contests is a crucial way to discover individual talent and inspire interest in math. Why are these important? Mathematics is the foundation of numerous disciplines such as physics, computer science and economics. Only with advanced, sometimes complicated mathematical methods, theories and tools can these disciplines keep improving. Experts in these fields have to excel at using math to solve problems. In recent years starting from 2012, there have been 3 mathematicians who won the Nobel Prize of Economics. Math contests, by inspiring students' interest enhance their ability and selecting ones that are talented in math, actually help find future experts in these fields and encourage their further enhancement, thus stimulate the improvement of many fields related to math in a long run.

Furthermore, math contests play a significant role in enhancing students' ability to think and solve problems, which is also widely required in many fields. It is actually one of the most vital purposes of studying math originally. Nonetheless, as mentioned before, math in school can no longer satisfy particular outstanding students in math. Thus, they strengthen this ability through extra math training and contests.

Besides these common advantages, some contests have their own unique benefit. The MathLeague encourages students to obtain multiple abilities related to math, including understanding of the subject math, learning math efficiently, connecting real problems in life with mathematical tools, writing and debating about certain topics and problems. These abilities are precious for youth willing to pursue their improvement in math. HiMCM requires participants to focus on a big topic and apply math into real life problems. This is exactly what some scientists and economists do. Teamwork competitions such as ARML and PUMaC provide students opportunity to work on a team to on math. Students will be frequently working on a team to solve certain problems in their life, thus it will be beneficial if teamwork on academic subject can be practiced during youth. These are only a few typical instances. To conclude, students can gain different experiences and enhancement by taking part in different math contests.

On the other hand, most of the disadvantages of math contests can somehow be avoided or mitigated

in different means. Wrong emphasis of contests is misleading, but it can be highly mitigated by careful and proper design of contests, which is supposed to be the educators' job. Math contest won't "extend" kids' beyond their ability as long as they have a positive attitude. Once students learn to deal with failure and face those problems they cannot solve and only pursue to improve themselves, they won't be "extended". Burnout is a very serious consequence, but it can be avoided by parents' and teachers' consistent encouragement and individual adjustment.

All the disadvantages do happen, but are pretty subjective. Once educators, students and parents done their job, these perils' existence will be a lot fewer. Quite many benefits will surely help students improve themselves from all aspects, thus students should be encouraged to take math contests.

试卷三：

Nowadays, more and more parents tend to encourage their children to participate in different kinds of math competitions. Is it a good phenomenon? In my view, every coin has two sides, so do the math competitions.

The original intention of math competition is to discover the beauty in math. However, the main purpose to participate math competitions for different kinds of people are various. Some people hold that it is to select students who have math talents, some hold that it is to foster students' interests, some hold that it is to improve students' abilities to solve problems, and etc. However, among all the people in China, I believe that a lot of them are utilitarians, especially the parents and students who want to try their best to enter a good school. The ones who are really interested in math are rare. Most of people send their children to math competition courses and force their children to learn the things which some students don't want to learn. In my opinion, the main reason for this should be winning math competition would be easier for children to get into a better school, sometimes there might lie a vanity behind them. One very typical example would be the "Tiger Mom". It even be an element in a TV show. The children are forced to do a lot of things by their mom, including taking the math competition courses.

To be honest, I think I am also some kind of utilitarian in competition. Because our teacher told us that the subject competitions can give us some bonus point to get into a better university or send us to a good university without having to take the pressure of "Gaokao" in China. When I chose which subject I would like to take for my competition, I didn't listen to my mind, instead, I asked which one would be the easiest to gain a price. Because the teacher said that Biology would be easier for girls to learn compared to physics and math. I took the Biology. Everyday after school I had to take this extra-course. I felt very tired. However, what I found from learning Biology was that I hated memorizing all those biology terminologies. They were too boring for me. At last, I gave it up. Although my experience was not about math, I think this can apply to math competition and math learning. At some points, there are lots of similarities among those subject competitions. They all show that our hearts are filled with competitiveness, not curiosity that the competition really want to discover and to foster. I remember Einstein once said that "Education is not used to induce students' aggressive competitions, but to use the curiosity to inspire students' interests in science. "Most of us mislead the main idea in math competitions. This situation especially happen in China.

Now, Let us think about what kind of students are caused in such situation in China? Probably there are three kinds of students.

One kind of students who are very talented in mathematics themselves. They derive the good sides from

math contests. They find their interests in the whole process of solving a difficult math problem. Sometime it would take them hours and hours to solve one single problem, but they never give up because they obsess with such things instead of playing computer games like most of the naughty kids.

Take my brother for example. (not my real brother, just my familiar friend and he is older than me, so I always call him brother)He is really quiet, he doesn't want to talk too much. Once we went hiking together, when most of us sat down and played cards. I noticed he sat down alone under a tree, took out his pencil and drafts. He sat there still for over three hours. He didn't divert his attention by anyone. I was really surprised about it. I experienced the real obsession of math. Nothing can compare that kind of love for math. Talent plus hardworking create success. Although my brother didn't go to IMO, but he gained a good price in CMO. Another benefit he gained from his math competition I think would be the clear logical mind. When we played some games together or he taught me some of my homework, I could understood his ideas and methods easily. Besides, I think he always want to solve a problem from a different view. He persists in all the things he is doing as well. The math competition influences him not only his skill to solve problem , but also an attitude towards life. I love running, especially jogging. Sometimes my brother and I take jogging together on holidays, just for fun to compete who can run for a long time. Actually his endurance is not so good, I think I have a running talent, so I always want to laugh at him(maybe sometimes I am a bit bad), but he always take the challenge. I know that it would be really difficult for him to continue running for such a long distance, nevertheless, he runs and runs and runs even I was tired and needed to stop. I was surprised by his strong mind. He said to me that whenever he made his mind to do something, he will continue doing it regardless the result , just like the process of solving the math problem. The main thing he wanted to find was not the key-the correct answer, but the process he experienced.

The Hong Kong team member Andy Lu in IMO2012 once said that he reminded his experience gained from taking math competition. He thought that the main benefit of math competition would be it can trigger the love for math among the teenagers and build their interest in math. No matter they want to choose math as a carrier or not in the future, participating in math competition may have an important influence to teenagers when choosing the carriers in the future. However, those who may not gain benefit from math competition for some reason are indeed lack the enthusiasm and persistence towards math.
The last part of Andy's words talk exactly I want to talk about for the second kind of students.

The second kind of students are also very talented in math. However, they may not have a strong mind to persist into math. Various factors influence them. This cause a certain phenomenon. Among all the participants in math competitions, many students because of great talents became famous mathematicians later in their life. For example, the William Lowell Putnam Mathematical Competition is a math competition for the undergraduate students in America, and the students who gained price from this competition later became important Mathematics award winners, like Putnam Fellow.

However, several those participants' levels are still on the level of solving math competition problems, but not the level to become a mathematician even they continue to develop in their math fields. In my opinion, this isn't the main problem. Because everybody has his/her own interest. However, what I want to mention here would be that they don't have the real enthusiasm and interest in math field. They lost the main qualities which the mathematicians should have, like rich imagination, critical thinking and creativity. If students don't meet the real purpose that the math competitions want to make, it would be easy for them to loose their enthusiasm and interest，like excessive math training for math competitions would go to the bad sides. They just try to improve their skills to solve one kind of problem. They only follow the strict steps to find out the answers. Without the methods that the teachers teach them, they can hardly solve it. So they are

not the one to become mathematicians, only the robot for the math competitions instead.

There are also different opinions about the bad influence that the math competition bring about. It is said that the famous Russian mathematician Pavel Segeevich Aleksandrov（1896-1982）last century once said that if he participated in math competition earlier in his life, he would no longer make such huge contribution to mathematics field. Besides, the winner of Wolf Prize Qiu Chengtong against the math competition in public.

A main reason for opposing to math competition is the participants must solve all the problem in a limit time. Some people think that this limitation damages the original interest that doing math problems bring. The traditional math competition doesn't benefit the ones who really have a creative mind, but creativity is significant for math research. Because math research needs a lot of thinking time, finding data in libraries and on the internet and cooperating with other people. But the traditional competition can't make such things for students.

Although these opinions may go to the extremity, such effect still exists in reality. And this caused third kind of students who suffer from math learning and math competitions.

In China, there is a kind of saying called "Cramming Education". Parents and teachers put all the things into children' mind regardless whether they can absorb them or not. As we all know that we all have individual differences. The fields which we are talented in are all different. Not all students are suitable to learn math competition. Some students think that the math courses they learn at school are enough difficult for them to handle. However, the vanity drives the parents to let their child to learn math to prove their intelligence and later rely on the price that math competitions bring to go to a famous university . They don't consider their own situation. This not only make the children who don't have a talent in math really weary , but murder their own interests in other field. When those students who try his best to learn, but they just find that they can't learn as fast as and as well as other students. They feel a big frustration and it will loose their confidence. They suffer a lot from math competitions later in their future life , too. They can't find the beauty in math, they only consider math as an evil to them.

Therefore, these three kinds of students exactly show the two sides that the math competitions bring to us. Another factor that most of us like to thing about is the score which we gain from math contests. I asked my brother, who I mention earlier in this essay, I want to share his answer with you. He said that when he knew his score, he was actually a bit frustrated and this was normal for him, because entering IMO was his dream, but when he calmed down himself , he still thought the score can't determine anything, it just shows that he hasn't solved the problem, but it doesn't mean he can't solve those problem. He thought what the competition really bring to him would be increasing his love for math.

I know that for a person who really obsess with one kind of thing, the result doesn't mean so important in this person's mind , like my brother. To a student who is highly obsessed in mathematics, there are factors which are more important than math contest itself which only taken once a year, like the beauty which they discover from math.

There's a math project in America called Ross mathematics summer camp. The selection is very strict, only few students could participate in this camp. This project has an implement-closed management. The students are told to commit to a specific problem of number theory research, mainly of the study includes integer and prime. The problem they solve are very similar to Goldbach's conjecture. They don't compete who solve it quickly, and there certainly no competition between them , and there is no score as well. They have to

cooperate together, using their creativity and critical thinking to solve the problems in the end. This summer camp may seem boring to most of people because the students must stay there to solve math problems for over 6 weeks without TV and entertainment, even their cell phones are limited to use. But for the students in this camp they enjoy focusing all the time and energy into a single problem and having lots of fun solving them. This is totally different from the utilitarian environment that math competition taken place in China . This is more like a spirit of math research. From that point of view, solving math problems is an enjoyable process which brings you creativity, imagination, critical thinking and happiness. These qualities are all prepared for a future mathematician.

All in all, math competition can not all be considered as a bitter thing or a sweet thing. It depends on our attitudes towards it and our view to look at it.

Like the tip of the iceberg, math competition is only a tiny part of interesting math activities. In my opinion, we can consider other activities expect holding math competitions. For example building math club , publishing math magazines, doing some math researches and etc. In this way, we can let those teenagers who are willing to share their interest and enthusiasm in math with other like-minded people. We can put math in different forms in our life. If so, then the bad sides of math competition will go away.

Indeed, math is everywhere in our life and everyone can enjoy and benefit from it.

Math is truly beautiful.

试卷四：

The purpose of Mathematics competition is to pique our interest in mathematics and encourage us to value intellectual pursuits. Or in other words, just using the way of competition to arouse our interest and get a sense of success and then transform it into the motivation to dig into mathematics which really brings about a lot of benefits.

First of all, competitions can encourage our interest in mathematics. As the questions that the Competition Organizing Committee raised are always very challenging and interesting which let us know that Mathematics is not a subject that we have learnt in daily life but also a intensive study of why this was so. In this process, we have to ask ourselves how the Mathematical Formula was developed and how the Mathematical Theorem was formed continuously. This is a really complex process. For instance, in the study of Koch Snowflake, I have to calculate the areas and perimeters when it was in different times of iteration. And then I need to make a generalization and summarization of it to find the definition of limitation in Mathematics which is an area that I have never touched. During the process, I met a lot of difficulties for lack of professional knowledge. Even so, after I solved the question, the sense of success that it had brought cannot be replaced and stronger than any time that I just use the formula that the teacher has told me to solve the question. Since then, I found my interest in Mathematics was greatly improved for I knew that Mathematics is a subject on not only how to use the formula I have learnt but also how to develop it.

Moreover, contests prepare us for competition. For life is just like competition, it cannot be plain sailing. During the period that we pursue the thing which is meaningful and charming to us, something frustrated will happen, such as failure. However, in our daily life, most of our parents and teachers just told us how to be successful, as a result, they told us so many successful examples such as Jobs and Bill Gates. They told

us that as long as we stick to something and be hardworking on it, we will succeed. But the fact is that most of us are not as lucky as them, we may be faced with a lot of setbacks, and eventually, we may fail. As ambitious young people, we have so many expectations on ourselves, we hope to be outstanding people and make contributions to the society. However, the wide gap between the expectation and reality will really make us feel frustrated. And this process just like the period that we finish our math contest. We may put a great deal effort and conquer the problems we have met to solve question. To our surprise, the result later was turned out to be wrong. So, what are our feelings now? We may feel very depressed on it. And then, what should we do, go on trying it or just abandon it? It is a choice that we should make. And we may choose to adhere to make another effort, and the result may still is a failure, but as the more times we try, the more possibility we succeed. And this process just imitates the situation we may meet in our job career in the future and help us to handle it better.

However, every coin has two sides, so does the Mathematics competitions.

Sometimes the contest will be designed not very well, as it paid too much emphasize on skills and may not benefit us a lot. And in such situation, we do not need to pay much attention on it. And as some questions were designed too challenging on us so that we cannot solve it and even have no ideas on it. As a result, we may have doubts on ourselves about whether we are intelligent or am I interior than other peers which leads us to be discouraged.

And sometimes we may lay too much emphasizes on the scores we achieved, this will also give rise to self frustration and depression. To some degree, score is the best standard to reflect our performance on the contest in a direct-viewing way. However, score does not mean everything. It just reflects the result we get finally, but it cannot reflect what we have got from the process which is significant or relevant to us. And this is the point. As a result, to scores, we should take a rational attitude

Mathematic competition is really a challenging task to almost all of us. During the way we pursue it, we need to be persistent and surefooted and have the spirit of self-study. Eventually, we will success even though the terminal point is still far away from us.

Thank you for your reading!