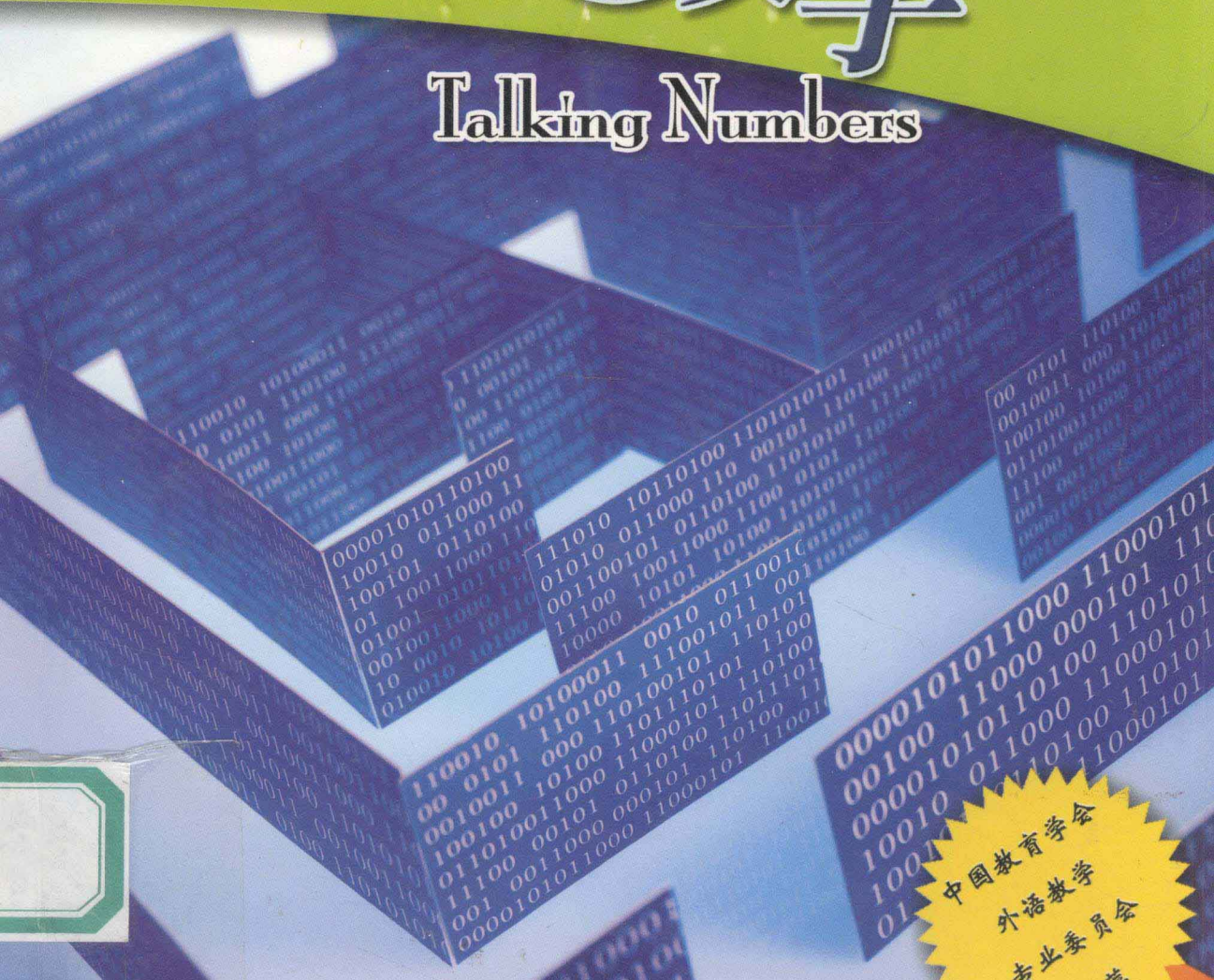
阅读空间 · 英汉双语主题阅读

谈谈数字

高中和大学低年级适用

Talking Numbers



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范素文 译

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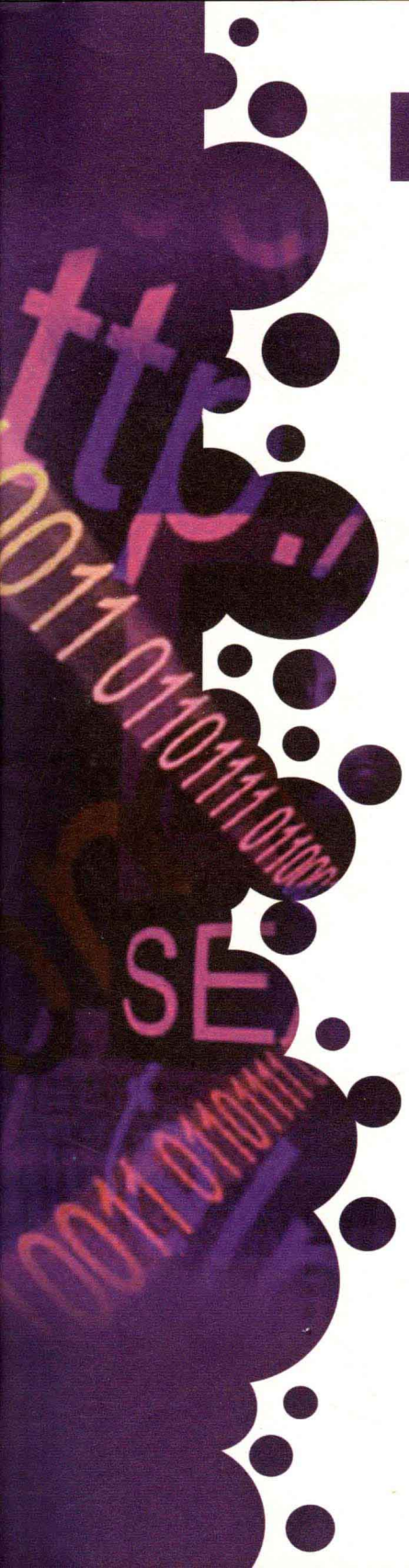


Contents 目录

Editor's Message 编辑手记

你是否想过，如何才可以使你的购物计划真正地经济省时？运用数学的一个分支——统计学来帮助你，这是一条可行之路。

事实上，统计是日常信息沟通的一种形式，它有助于我们更好地理解这个世界，从生物到体育运动……从市场营销到药物。

仔细阅读本书，你会发现实现你的计划会变得更容易。


END
FCN

Statistics:

A branch of math called statistics can help us better understand our world. But it can also be deceiving. How do you tell the good stats from the bad?

统计是数学的一个分支，它可以有助于我们更好地理解世界。但是，它也可能会有一定的欺骗性。如何区分可靠的统计和不可靠的统计呢？

How does Nokia determine what cell phone design you're most likely to buy? Or what neat features on it you're likely to use most? And how do scientists determine if that cell phone is harmful to your health? The answer is statistics – an area of mathematics that focuses on collecting, organizing, and interpreting information or data.

In the terminology of statistics, you're a *subject* – someone (or something) to collect data on. In many statistical applications – from determining the types of jurors in a court case who might favor a conviction to determining which player on a sports team might perform best in the playoffs – subjects are people. The data to be collected are *characteristics*.

In the case of the cell phone, the characteristics to be

诺基亚公司如何确定设计什么样的手机人们可能会购买？或手机上的什么新型功能人们最可能经常使用？科学家如何判断手机是否对人体健康有害？这些答案都涉及统计。统计是数学的一个领域，其主要功能是对信息或数据的收集、整理及解释。

在统计术语中，人是一个对象——收集的数据是关于人或事的。在许多统计应用中——从确定在法庭案件中最可能支持定罪的陪审员的类型，到判断运动队的哪个运动员在决赛中可能表现最好——其研究对象都是人。所需收集的数据称之为特征值。

Digging Into Data

by Lisa M. Sullivan & LeiLanie M. D'Agostino

measured are things like your age, how many calls you make, when and for how long you use a phone, and your economic status. That information is organized and summarized using specific techniques and procedures, and relationships are interpreted among the characteristics.

This process is called *statistical analysis*, and it can help marketers determine which Nokia model will be the hot phone of the season.

Cell phones aside, statistical analysis touches many areas of our lives. It tells investors what stocks achieve the best returns, points doctors to the medications that are most effective in treating disease, and can even help you to understand how exercising and eating right now will affect your health as an adult.

THE BIG PICTURE

The goal of statistical analysis is to use a small group (a sample) to say something about a large group (a population). A *population* is *all* the subjects of interest – for example, ALL American males with heart disease or ALL middle school students who go to private schools.

In many situations, it's impossible or impractical (or both) to analyze an entire population. It may be too time-consuming or take so long that by the time the results are available they are no longer useful. And what about a characteristic that must be measured by a $2,000 laboratory test? It simply would be too expensive if every member of the population were tested.

So, in statistical analysis, a *sample* – or subset of

在手机案例中，被评测的特性包括诸如用户的年龄、打多少次电话、什么时候拥有手机、手机使用多长时间以及经济状况等。这些信息要用专门的技术和程序进行整理和总结，特征之间的联系就能得到解释说明。

这个过程就叫做统计分析，它可以帮助市场人士确定哪种诺基亚型号的手机将是本季节最畅销的机型。

除手机外，统计分析涉及生活的诸多领域。它可以告诉投资者哪种股票的回报最高；引导医生选用治疗疾病效果最好的药物；甚至还能帮助你了解目前的健身和合理饮食将如何影响你成年后的健康。

大画面

统计分析的目标是利用一小组个体（样本）来说明它的总体（群体）的一些特征。对象总体就是研究对象个体的总和——例如，所有患心脏病的美国男性，或者所有上私立学校的中学生。

在许多情况下，对整个总体进行分析或是不可能，或是不现实的（或两者都有），因为这可能太费时间，或者因为耗时太长，以致于当你获得数据时，这些数据已不再有用了。还有，如果一个特征的实验室测试要花费2000美元，这意味着不可能对总体的

统计：钻研数据

subjects from the population – is analyzed. If the sample is representative of the population, then it is reasonable to assume that what is observed in the small group will be similar to what would be observed in the entire population.

The process of collecting and organizing information from a sample is called descriptive statistics (a sample is described). When predictions are made about the population based on that sample, the process is called *statistical inference*. (Statisticians infer what will happen – they can never be 100 percent certain about their predictions.)

Mathematical theorems and principles of ***probability*** are used to quantify how much error or imprecision exists. For example, the following example has a probability component: We are 95 percent confident that 30 minutes of exercise per day will reduce the chance of heart disease for an individual by 10 to 20 percent over the next 20 years.

Probability
A number expressing the likelihood that a given event will occut, expressed as the ratio of the number of actual occurrences to the number of possible occurrences

Example A shows the two areas of statistical analysis – descriptive statistics and statistical inference.

每个对象都进行检验，因为这显然太昂贵了。

因此，在统计分析中，要分析的是个别样本——或者说是从对象总体中选出的子集。如果个别样本对总体具有代表性，那么，就可以合理地推断，对整个总体的观察结果应该和在样本组中观察到的情况相似。

收集样本和整理信息的过程叫做统计描述（对样本的描述），根据样本对对象总体进行预测的过程叫做统计推断。（统计学家推断什么情况将可能发生，这种预测从来不会有100%的准确性。）

数学定理和概率原理用于测算存在的误差或不准确性有多大。例如，下面的例子就包括概率的内容：我们有95%的把握说，每天锻炼30分钟，会使人们在未来20年中患心脏病的机会减少10%～20%。

案例A表明了统计分析的两个方面——统计描述和统计推断。

EXAMPLE A 案例 A

STATISTICAL ANALYSIS 统计分析

The Sample
统计样本

Statistical Inference — Make inferences about the **population** based on the sample.

统计推断——基于对样本的分析获得对总体的推论。

A Subject
统计对象

Descriptive Stats — Measure characteristics on each subject in the sample, and summarize the sample information.

统计描述——在样本上测算每个对象的特征，并对样本信息加以综合。

BUT WHY DO WE NEED STATISTICS?

We use statistics to make important decisions in our lives. For example, most people believe that regular exercise and eating a low-fat diet promote good health. (We bet you've heard that bit of advice from your mom just a few times.) This belief sometimes motivates us to exercise when we don't feel like it or makes us feel guilty when we eat a four-cheese pizza or a burger with super-size fries. Should we really feel guilty?

Why do we believe that exercising and eating healthy are associated with better health in the first place? Well, there are a number of statistical research studies that have shown that these factors reduce the risk of heart disease.

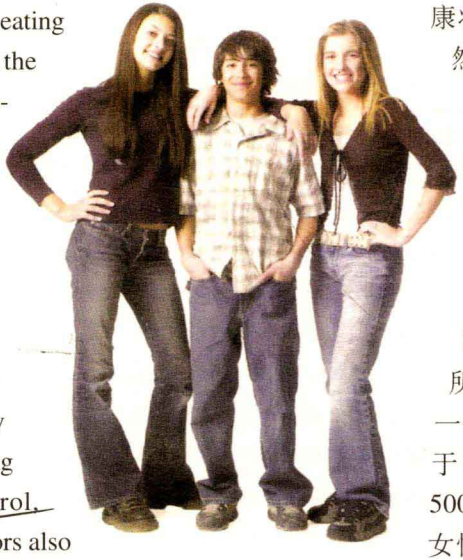
An example is the Framingham Heart Study. It began in 1948 with over 5,000 men and women participants. Each had a complete physical examination at the study's start. The participants came back for repeat examinations every two years, and the study is still going on today. Along with monitoring such things as blood pressure, cholesterol, exercise, and nutrition, the study investigators also monitor whether participants experience heart attacks or other heart disease over time.

In the mid-1970s, the Framingham study was expanded to include a second generation, the children of the original subjects and their husbands and wives. In 2001, a third generation (the children of the second generation) was recruited, and these samples are now being analyzed for genetic factors associated with disease. Much of what we understand today about heart disease has been learned from this very important study.

可是，我们为什么需要统计？

在生活中，我们要根据统计作出一些重大决定。例如，大多数人认为，日常锻炼和吃低脂肪的食物有利于身体健康。(我们敢打赌，从你妈妈那里你听到过多次这样的建议。) 这种信念有时会驱动我们在不愿意锻炼的时候去锻炼，或者当我们吃一个四层奶酪的比萨或一个汉堡配一份超大炸薯条时，会有一种内疚感。我们真应该内疚吗?

为什么我们相信这个前提，即锻炼和有益的饮食与良好的健康状态相关？显然，大量的统计研究报告表明，这些因素能够减少心脏病发生的风险。



弗莱明翰姆心脏研究所的项目就是一个例子。它始于1948年，有5000多名男性和女性参与者。在研究开始之前，每个人都做了一次全面的体检。参与者每两年返回来做一次身体的复查，这项研究一直持续到今天。除了监测血压、胆固醇、锻炼和营养等情况外，研究人员还关注参与者在这段时间是否有过心力衰竭或是否患其他心脏疾病。

20世纪70年代中期，弗莱明翰姆项目的研究范围延伸到第二代，即第一批参与对象的孩子以及他们的丈夫、妻子。2001年，第三代（第二代参与者的孩子）又补充了进来，这部分样本现在被用于分析与疾病有关的遗

The statistical results of the Framingham Heart Study often get reported in the newspaper or on television. But why should we believe that just because there was an association between exercise and heart disease among its participants (or those in any other study), the same would hold true for us?

The idea of generalizing or inferring associations from a study (a sample) to the population at large is the crux of statistical analysis. Let's look at an example.

COMPARING WEIGHTS

Because weight increases as we grow in our teens and then tends to rise with age, the focus of this analysis is on boys and girls between the ages of 10 and 19. The sample includes a total of 578 boys and 640 girls, and the data is similar to that in the second generation of the Framingham Heart Study.

In statistics, "summary measures" are used to describe characteristics. You've probably all heard of the *mean* and the *median*. Both are measures of average value.

The mean represents a typical value on a characteristic and is calculated by summing all of the values and dividing by the total number of subjects. (Your teacher might report the mean test score for the class.)

The median also represents a typical value and is defined as the middle value when all of the values are placed in order from lowest to highest. The interpretation of the median is that half of the values are above the median and half are below.

DESCRIBING THE SAMPLE

In our sample, the mean weight is 128 pounds and the median weight is 129 pounds. They are very close, but this isn't always the case. For example, suppose we have a sample of five test scores: 25, 80, 85, 90, and 100. The mean test score is 76 and the median is 85 (the middle number when we arrange the scores from low-

传因素。目前我们了解的有关心脏病的很多知识，都是来自于这项重要研究的报告。

弗莱明翰姆心脏研究项目的统计结果经常被报纸和电视台报导。但是，为什么就因为这些参与者（或其他研究项目的参与者）身上显示出锻炼和心脏病有某种联系，我们就相信这对我们也会同样适用呢？

将研究对象（样本）中得出的关联性推广或推断到总体的思路，是统计分析的关键所在。让我们看一个例子。

体重的比较

由于在我们十几岁时体重不断增加，而且随着年龄的增大，体重也在不断增加，因此这次分析主要集中在10～19岁的男孩和女孩。样本共包括578名男孩和640名女孩，调查的数据和弗莱明翰姆心脏研究项目中的第二代人的资料相似。

在统计中，“概述性测量”通常用于对特征的描述。你们也许都听说过平均数和中位数。两者都是衡量平均值的指标。

平均数代表了某一特征的典型值，它是通过将这一特征的所有数值相加，然后除以个体的数量而得出的。（你的老师一定公布过班上的平均考试成绩。）

中位数代表另一种典型值，它是这样确定的：将所有的数值按从小到大的顺序排列，最中间的数值就是中位数。中位数的含意是：一半数目的数值比中位数大，而另一半的数值比中位数小。

样本描述

在我们的样本中，平均体重是128磅，体重的中位数是129磅，它们非常接近，但情况并不总是这样。例如，假如我们有一组5个考试成绩的样本：25、80、85、90

est to highest). In this example, the very low test score of 25 "pulls down" the mean, making it seem like a typical test score was 76, when in fact most of the scores are very high. For this example, the median (85) is a better measure of a typical test score.

The score of 25 is an "outlier" — it does not fit with the rest, because it is extremely low by comparison. When there are no outliers, the mean and median will usually be close in value and the mean is the preferred summary measure.

Since weights are substantially different for boys and girls, especially after age 14, in this study their weights were analyzed separately.

Example B shows one way to "describe" the weights. It is called a *box and whisker plot*, and shows the whole distribution of weights for boys (on the left) and girls (on the right). The lowest and highest weights are indicated by the lines at the bottom and top. The boys' weights range from a low of 60 to a high of 234, and the girls', from a low of 66 to a high of 255. The ranges are very similar.

The shaded box shows the middle 50 percent of the weights for boys and girls. For the boys, the middle 50 percent of weights fall between 100 and 153 pounds. The box includes the middle 50 percent, which leaves 25 percent above it (weighing more than 153 pounds) and 25 percent below (weighing less than 100 pounds). For the girls, the middle 50 percent of the weights are between 114 and 142, 25 percent are below 114, and 25 percent are above 142 pounds.

和100。考试成绩的平均分是76，中位数是85（成绩从低到高排列时的中间数值）。在这个例子中，考试的最低成绩25分将平均分“往下拉”，成绩的典型值看起来是76，事实上这次考试的大多数成绩都比较高。对这个例子来说，中位数（85）能更好地衡量出一个有代表性的考试成绩。

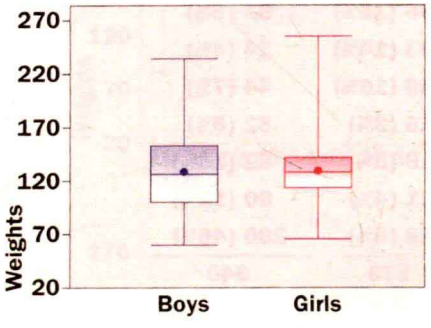
25分是一个“偏离者”，与其他成绩不相吻合，因为相比较而言它非常低。在没有偏离者的情况下，平均数和中位数在数值上通常非常接近，因而平均数就是较好的概述性指标。

由于对男孩和女孩来说，特别是在14岁以后，他们的体重差别相当大，因此在这次研究中对他们的体重进行了单独分析。

案例B是描述体重的一种方式，被称为方块图，表示男孩子（左边）和女孩子（右边）体重的整体分布情况。最低和最高的体重由低端线和顶端线表示。男孩子的体重从最低60磅（一磅约合0.45千克）到最高234磅，女孩子的体重在最低66磅和最高255磅之间。两者的范围非常接近。

带阴影的方块表明的是中间50%的男孩和女孩

EXAMPLE B 案例 B



的体重。对于男孩来说，中间50%的体重在100～153磅之间。方块包含了中间的50%，另外有25%（体重超过153磅）在其上，25%（体重低于100磅）在其下。对于女孩来说，中间50%的体重在114～142磅之间。有25%低于114磅，有25%高于142磅。

The bar across the middle of the shaded box is the median, and the dot is the mean. The mean weight for boys is 127 and the mean weight for girls is 130. Overall the weights look similar, but there is much less variability (spread) in the weights of the girls, at least in the middle 50 percent. Were you wondering why the girls' shaded box was narrower? That's why.

In this sample, the girls are, on average, three pounds heavier than the boys. Wow! Does that make sense? What's happening here?

To find out, let's look at **Example C** and another characteristic of our sample: the ages of the boys and girls.

Since there are a total of 578 boys and 640 girls in the sample, the best way to compare their ages is by using percentages. In general, are the boys younger or older than the girls?

EXAMPLE C 案例 C

Age	Number (%) of Boys	Number (%) of Girls
10	63 (11%)	13 (2%)
11	86 (15%)	12 (2%)
12	83 (14%)	6 (1%)
13	86 (15%)	31 (5%)
14	83 (14%)	24 (4%)
15	96 (16%)	44 (7%)
16	16 (3%)	52 (8%)
17	16 (3%)	82 (13%)
18	21 (4%)	80 (12%)
19	28 (5%)	296 (46%)
TOTAL	578	640

Right. . .the majority of the boys are younger, between ages 10 and 15 (85 percent), while the majority of the girls are older, between ages 16 and 19 (79 percent). A box and whisker plot of the ages readily

横穿过阴影方块中间的线是中位值，小圆点是平均值。男孩子的平均体重是127磅，女孩子的平均体重是130磅。从总体上看，双方的体重看起来很相似，但是女孩子的体重变化（分布）不是太大，至少在中间的50%是这样。你是不是纳闷为什么女孩子这边的阴影方块较窄？这就是原因所在。

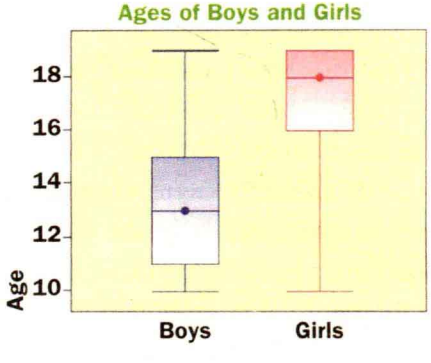
在这个样本中，女孩子的平均体重比男孩子重3磅。喔！这种情况合理吗？到底怎么回事？

为了找到答案，让我们看看**案例C**和样本的另一个特征：男孩子 和女孩子的年龄。

由于样本中共有578名男孩和640名女孩，比较他们年龄的最好方法是用百分数。总体上，男孩是比女孩小还是大呢？

嗯……大多数男孩要小一些，年龄在10～15岁之间（占85%）；而大多数女孩要大些，年龄在16～19岁之间（占79%），年龄的方块图已经表明了这种差别。

要注意，中间50%的男孩的年龄在11～15岁之间，而位于中间50%的女孩



年龄在16～19岁之间。男孩年龄的变化相对于女孩（她们的年龄大部分集中在

shows the difference:

Notice that the middle 50 percent of the boys' ages are between 11 and 15, while the middle 50 percent of the girls' ages are between 16 and 19. There is more variability (or more spread) in the ages of the boys as compared to the girls (whose ages are mostly concentrated between 17 and 19). The mean age of the boys is 13, while the mean age of the girls is 18. How would this affect our interpretation of the weights of boys and girls?

MAKING AN INFERENCE: SO WHAT DOES IT TELL US?

As we look more closely, we realize that the girls are older than the boys in our sample. That's why they weigh more! To make a "fair" comparison of their weights, we should be looking at boys and girls of similar ages. **Example D** is a better comparison and shows the mean weights for boys and girls at each age.

Now how do the weights compare between

EXAMPLE D 案例 D

Age	Mean Weight for Boys	Mean Weight for Girls
10	83	80
11	90	95
12	120	122
13	132	135
14	136	132
15	157	130
16	159	138
17	156	130
18	165	129
19	159	127
ALL	127	130

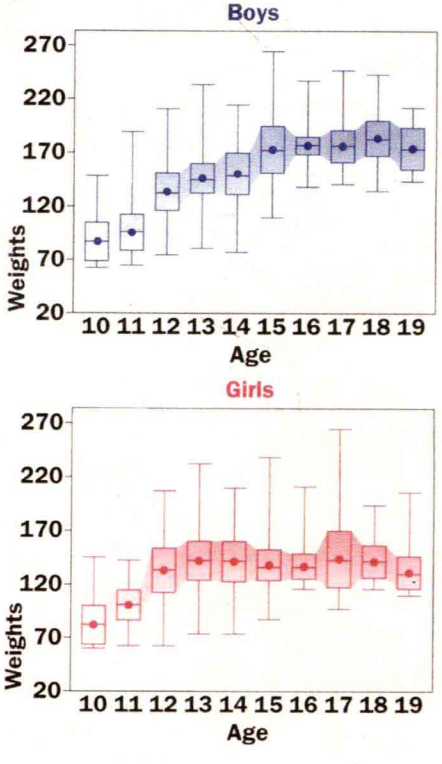
17～19岁）而言也比较大（或者说分布广泛），男孩的平均年龄是 13 岁，女孩的平均年龄是 18 岁。这将如何影响我们对男孩女孩体重情况的解释？

结论推断：数据告诉我们什么？

当仔细观察时，我们发现，在样本中女孩的年龄要比男孩大。这就是她们的体重大的原因！为了“公平”地比较他们的体重，我们应该看看相近年龄段的男孩和女孩的情况。**案例 D** 作了很好的比较，表明了各年龄段男孩和女孩的平均体重。

现在，男孩和女孩体重的比较结果如何呢？当我们观察每一个年龄段时，可以看到，在 14 岁前，男孩和女孩的平均体重相近（记住这只是样本）。（在统计学中，可以通过一些测试来判断，什么情况下这种差别太大，或

EXAMPLE E 案例 E



boys and girls? When we look at each age, the mean weights for boys and girls are similar (remember that these are only samples) until about age 14. (In statistics, there are tests that can be run to determine when differences are large or when the differences are within what we would expect just by chance.)

For age 15 and older, the boys have higher mean weights than the girls. This is a more appropriate interpretation of the data, wouldn't you agree? **Example E** presents box and whisker plots of the weights for boys and girls at each age that show in detail the weight differences for this sample.

CAUTION!

As our weight example shows, it's crucial to look carefully at how data is analyzed. Statistical analysis can be applied to almost anything, including agriculture, biology, sports, chemistry, psychology, sociology, political science, economics, engineering, and on and on. It can reveal much about our world if we view it with a critical and sometimes skeptical eye.

The next time you read stats from a newspaper, magazine, book, television newscast, or the Internet, do some analyzing on your own. Since just a few of us will ever participate in a research study as a subject, we have no choice but to rely on well-conducted research to keep us informed. Just remember to dig into the data!

什么情况下其差别是在我们期望的可能发生的范围之内。)

在15岁及其以上的年龄群，男孩的平均体重要高于女孩的平均体重。这才是对数据更合适的阐释，难道你不这么认为吗？**案例E**是每个年龄群的男孩和女孩体重的方块图，详细表明了这一样本中体重的差别。

注意！

正如我们的体重样本显示的，要仔细地观察资料是如何分析的，这非常关键。统计分析可以应用于几乎所有领域，包括农业、生物学、体育、化学、心理学、社会学、政治学、经济学、工程学等等。如果我们用批判和怀疑的眼光看待它，它能够揭示我们这个世界上的各种信息。

下一次，你从报纸、杂志、书籍、电视新闻或者互联网上读到统计资料时，一定要用自己的分析。由于我们之中只有极个别的人能够作为个体亲自参与某些研究活动，因此，我们没有别的选择，而只有依靠优秀的研究报告为我们提供信息。千万记住：对数据要深入钻研。

Will Santa See Snow?

by Faith Hickman Brynie

Are you dreaming of a white Christmas?
Will your dream come true?
Just ask a statistician!

你梦想过白雪覆盖的圣诞节吗?
你的梦会变成现实吗?
快去问问统计学家!

After examining historical records, Keith Eggleston, a climatologist at Cornell University's Northeast Regional Climate Center, found that if there is an inch or more of snow on the ground on Dec. 18, regardless of when it fell, the chances for a white Christmas in certain areas greatly improve.

For example, Santa has a 76 percent chance of seeing snow as he leaves Concord, New Hampshire, on the morning of Dec. 25. But if there were an inch or more of snow on the ground in Concord a week before, the probability jumps to 85 percent. His chances of seeing a white holiday in Portland, Maine, are 71 percent normally; but the probabilities rise to 96 percent if an inch or more of snow is measured on Dec. 18. In Albany, New York, the chances grow from 51 to 74 percent. But Caribou, Maine, the snowiest populated town in the region, has a 94 percent chance whether there is snow on Dec. 18 or not.

The Author wanted to find out more about how these statistics were estimated and what they mean.

康奈尔大学东北气候研究中心的气候学家基思·埃格尔斯顿通过研究历史记录发现，在12月18日，如果地面上有1英寸或者更厚的积雪，无论这雪是在什么时候下的，那么，在特定地区出现一个白雪圣诞节的几率就大大增加。

例如，当圣诞老人在12月25日早晨离开新罕布什尔州康科德市时，他有76%的概率看到雪；但是如果一周之前康科德市的地面上有1英寸或者更厚的积雪，这种概率就会上升到85%；正常的情况下，他在缅因州的波特兰市看到白色节日的概率是71%，但是如果那里在12月18日有1英寸或者更厚的积雪，这种概率就会升到96%；同样，在纽约州奥尔巴尼市，这种概率将从51%上升到74%；但是在缅因州卡里布这座该地区雪量最大的城市，无论在12月18日这一天地上是否有雪，白雪圣诞的概率都是94%。

作者想进一步了解这些统计数字是如

圣诞老人能见到雪吗?

Keith Eggleston was happy to explain the science of estimating probability.

HOW DID YOU ESTIMATE THESE PROBABILITIES?

It's quite simple. The first probability was just the chance of a white Christmas. That is the number of years between 1951 and 2000 when Christmas had an inch or more of snow on the ground divided by the number of years with snow data. For example, if we had data for Dec. 25 for all 50 years in this period and 23 of them had at least an inch of snow on the ground on Christmas, the probability would be 23 over 50, or 46 percent.

The second probability was the chance of a white Christmas when Dec. 18 had an inch of snow on the ground. This statistic was computed in a similar manner. We isolated the years with an inch or more of snow on Dec. 18 and then counted the number of these years when there was also an inch or more of snow on Christmas. The probability was the quotient. For example, if 40 of the 50 years had snow on Dec. 18 and of these 40 years, 20 also had snow on Christmas, the probability was 20 over 40, or 50 percent.

WHY DID YOU PICK DEC. 18 AS A PREDICTOR DATE? WOULD PICKING ANOTHER DATE HAVE CHANGED THE CONCLUSION?

We picked Dec. 18 because it is exactly a week before Christmas. Picking another date certainly would have changed the probabilities. I felt that – especially in the colder cities – if there were at least an inch of snow on the ground on the 18th, it either might not melt by Christmas or would indicate an active weather pattern that might continue to produce snow through the following week.

何得出来的，它们具有什么意义，基思·埃格尔斯顿高兴地解释了概率估计的科学。

你是如何估算这些概率的？

非常简单。第一个概率仅是白色圣诞节的概率。从1951年到2000年间，根据下雪记录，把圣诞节这天地面上有1英寸或者更多的积雪的年数除以总的年数，就得出这个概率。例如，如果在这50年中的12月25日这一天都有天气记录，而其中的23年在圣诞节这天地面上有至少1英寸的雪，那么这个概率就是23／50，即46%。

第二个概率是在12月18日地面上有1英寸积雪的情况下出现白色圣诞节的概率，这个统计数字是用相似的方法计算得到的。我们把在12月18日地面上有1英寸或更多积雪的年份标出来，然后计算一下在圣诞节也有1英寸或更多积雪的年数。概率就是它们的商。例如，假如50年中有40年在12月18日下雪，在