

Is a line trending upward?

Consider the graph in Figure 1. Does the line have an upward trend? At first, it might seem that the answer is “obviously yes”. This note explains why the full answer is more involved.

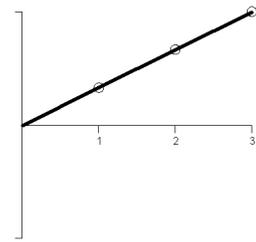


Figure 1

Before considering the graph further, consider a coin that is tossed ten times. If the coin came up Heads each time, we would have very significant evidence that the coin was not a fair coin. Suppose instead that the coin was tossed only three times.

If the coin came up Heads each time, we would not have significant evidence that the coin was unfair: getting Heads three times can reasonably occur just by chance.

The top graph in Figure 2 was drawn by flipping a coin three times. The graph has three segments, one for each flip of the coin. If the coin came up Heads, then the segment of the line was drawn upward; if it came up Tails, then downward. The top graph in Figure 2 illustrates flipping Heads, Tails, Heads. The bottom graph illustrates flipping Tails, Heads, Heads.

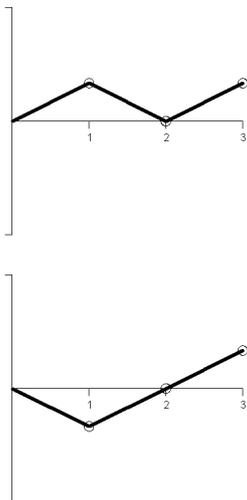


Figure 2

Now consider the graph in Figure 1 again. That graph illustrates tossing three Heads. Three Heads is not significant evidence for anything other than just chance occurring. A statistician would say that although the graph is trending upward, the upward trend is “not significant”. (If, however, the graph had ten segments, from flipping a coin ten times, then the upward trend would be very significant.)

Suppose that instead of flipping coins, we roll ordinary six-sided dice. We will roll each die three times. If a die comes up 1, the line segment is drawn downward; if it comes up 6, the segment is drawn upward; and if it comes up 2, 3, 4, or 5, the segment is drawn straight across. Figure 3 gives some examples: (left) 3, 6, 3; (middle) 1, 5, 2; (right) 4, 6, 1.

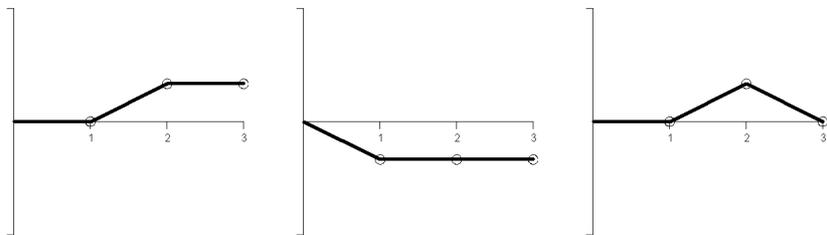


Figure 3

Now consider Figure 4. The graph corresponds to rolling three 6s. Three 6s will occur by chance just 1 out of 216 times; so this is significant evidence that the die is not rolling randomly. That is, the upward trend of the graph is significant.

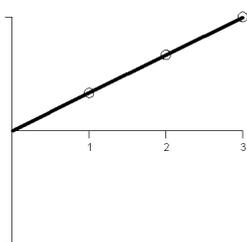


Figure 4

Notice that Figure 1 and Figure 4 look identical. In Figure 1, the upward trend is not significant; yet in Figure 4, the upward trend is significant. These examples illustrate that you cannot tell whether a line is significantly trending upward just by looking at it. Rather, you must know something about the process that generated the line, before attempting to determine whether there is a significant trend. In practice, the process might be very complicated, which makes determination difficult.