

Freaky Data

By [William R. Porter](#) Apr 25, 2018 7:00 am PDT

Abstract

Even the most carefully planned and executed experiments can sometimes yield bizarre bits of data that astonish us by their extreme deviation from the results we expect to obtain. To metrologists and statisticians, these rarely encountered seemingly aberrant observations appear to be what have been variously called outliers, anomalies, “flyers”, “rouges”, “mavericks”—discordant, suspect, spurious or wild measured results that deviate markedly from the results anticipated by our current guiding theory. Regulatory authorities find such data difficult to interpret, and in recent years standards-setting organizations such as the United States Pharmacopoeial Convention, ASTM International, and the International Organization for Standardization (ISO) have created guidance on how to detect and designate outliers in sets of measured values. These are compared.

Introduction

Stuff happens. The unanticipated occurs. Mistakes are made, or we wander into some strange, new territory unlooked-for by our guiding theories. But while theory guides, experiment decides. And occasionally we don't like the decision. Sometimes, when we perform a series of measurements, something untoward occurs and a result we did not expect to obtain pops up, seemingly out of nowhere. How do we handle observed results to which we are predisposed by theory to reject? Did we blunder? Or are we on the threshold of some new discovery?

Motivational Example

A school teacher is teaching a class of 26 students about measurement science. To illustrate how measurements vary somewhat and have inherent uncertainty, depending on who makes the measurement and what tools are used to do the actual measurement, the teacher passes around a ballpoint pen and asks each student in the class to measure the length of the pen using his or her own ruler and then write down the length in centimeters, rounded to the nearest tenth of a centimeter. These instructions are given to the class as a written quiz; consider this quiz document to be the SOP for the measurement test. After making the measurement requested, the students turn in their quiz papers, each with a single reported result. The teacher then asks one student to tabulate the results for the entire class. These are shown in Table 1:

Student	Measured length, cm	Student	Measured length, cm
A	14.2	N	14.3
B	14.3	O	14.4
C	14.3	P	14.2
D	14.2	Q	14.3
E	14.4	R	14.4
F	14.2	S	14.4
G	14.4	T	14.3
H	14.3	U	14.4
I	14.3	V	14.1
J	14.5	W	14.2

K	14.2	X	14.2
L	5.6	Y	14.3
M	14.2	Z	14.4

Table 1. Length of a ballpoint pen as measured by students.

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