Measuring Mountains

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Ryan Bowles at end of trail.
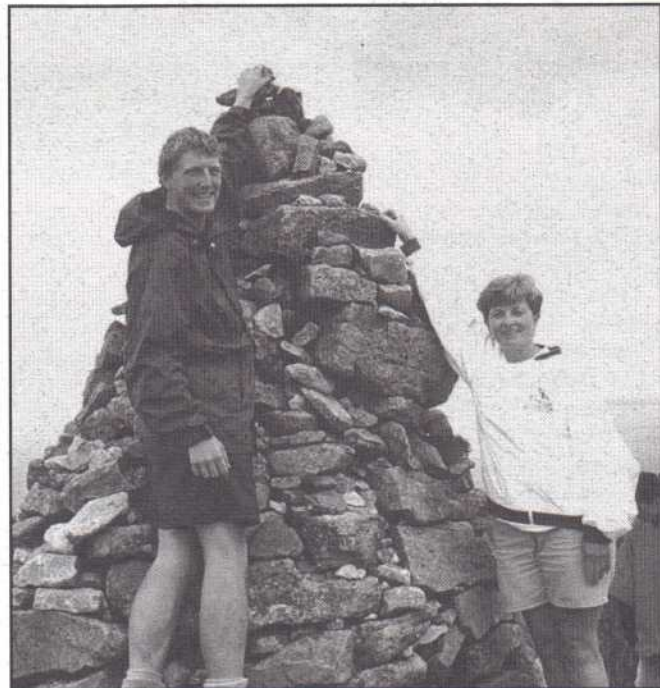
I hiked the entire Appalachian Trail in the spring and summer of 1997. I started in Georgia on Springer Mountain on March 16 and finished in Maine on top of Mount Katahdin on August 6. The Appalachian Trail is a footpath, 2160 miles long, running through woods and fields, along ridgetops and streams, through 14 states. The Trail goes up and down over many mountains, ranging in elevation from 142 feet above sea level on the Hudson River in New York, to 6643 feet on Clingman's Dome on the border of North Carolina and Tennessee. Every year over 2000 people attempt to hike the entire Trail in one season, a feat known as a thru-hike. Only about 10 percent are successful. Many different kinds of people try to thru-hike the Trail: old and young, fit and overweight, factory workers and company executives. Within a few weeks, though, these differences have disappeared and everyone is in nearly perfect shape. Even so, thru-hikers' perceptions about how difficult it is to climb a mountain differ because of such variables as weather, tiredness, and pack weight. I was curious about the difficulty of the mountains along the Appalachian Trail, but had no way to remove these idiosyncrasies, until I came across Rasch analysis.
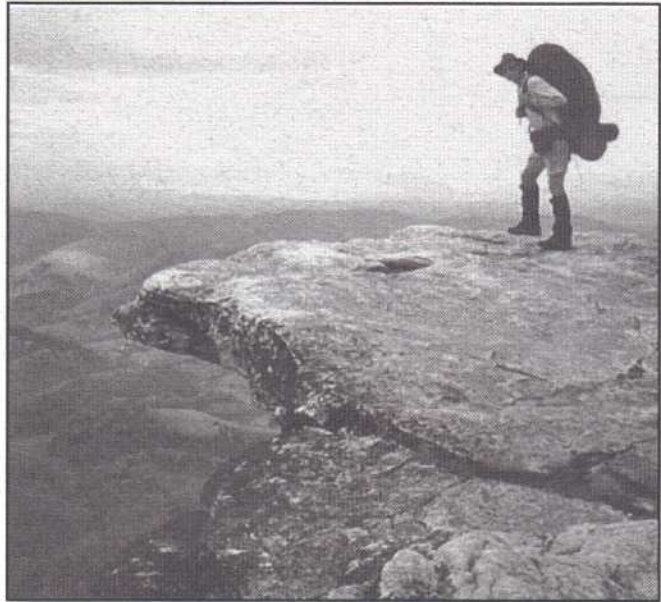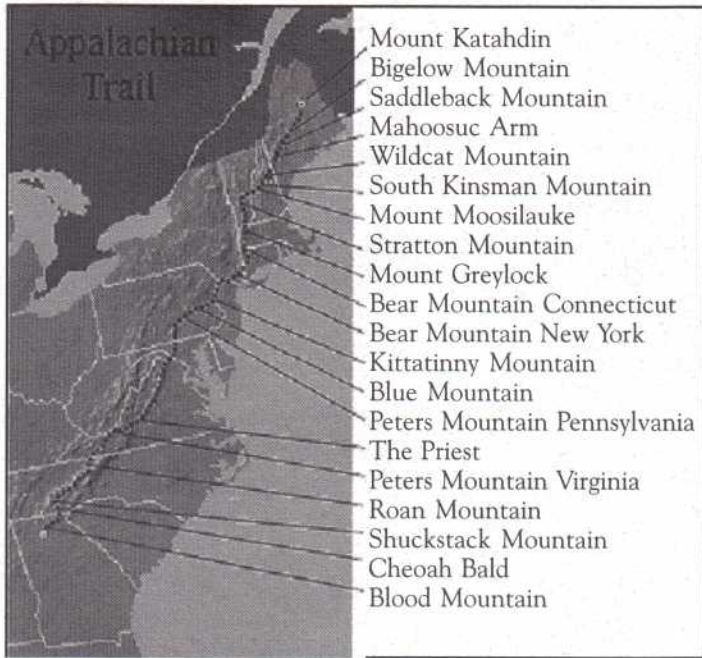
I asked 60 people who had hiked the entire Appalachian Trail to rate the difficulty of twenty mountains scattered

Ryan and another hiker

Author at a high point in his journey

along the length of the Trail. All had hiked the Trail from south to north within the last ten years. For each mountain, they said whether they thought the mountain was easy, medium, hard, very hard, or extremely hard. This survey was administered over e-mail, and responding was voluntary. Although my sample was not random, results from Rasch analysis are sample independent. I ran an analysis using the computer program Bigsteps. The following table lists the twenty mountains in order of difficulty according to the Rasch analysis, along with some information about each mountain.

The column labeled "Diff. Meas. 1 to 10" shows the measure of difficulty from the Rasch analysis, on a scale of 1 to 10, with 1 being the difficulty of the easiest mountain on the list, Kittatinny Mountain, and 10 the hardest, Mount Katahdin.

It is important to note that this is an equal interval scale. That is, we can consider the difficulty measure as a scale where the difference in difficulty between Mount Katahdin and Mahoosuc Arm, .86 difficulty units, is the same as the difference in difficulty between Blood Mountain and Peters Mountain (Pennsylvania).

The Infit and Outfit columns show measures of fit, or how much disagreement there is among the responses of the hikers. The expected value of both statistics is 1. We can see that three mountains are quite a bit different from 1 in either statistic: Bigelow Mountain, Blood Mountain,

Table 1:
Mountains along the Appalachian Trail in order of Difficulty

Mountains	State	Elevation in feet	Elevation Gain in feet	Distance of Ascent in miles	Diff. Meas. 1 to 10	Infit	Outfit
Mount Katahdin	Maine	5260	4100	5.2	10.00	1.65	1.57
Wildcat Mountain	New Hampshire	4400	2400	4	9.70	0.85	0.89
South Kinsman Mountain	New Hampshire	4300	2000	2.5	9.68	1.05	1.00
Mahoosuc Arm	Maine	3800	1600	1.4	9.14	1.04	1.17
Cheoah Bald	North Carolina	5500	4000	8.2	7.76	0.93	0.99
Mount Moosilauke	New Hampshire	4600	3500	5.5	7.69	1.16	1.04
Roan Mountain	Tennessee	6300	2200	2.7	7.63	0.96	1.22
Bigelow Mountain	Maine	4200	2950	6.8	6.82	0.49	0.48
Saddleback Mountain	Maine	4100	2500	5.6	6.73	0.89	0.82
Shuckstack Mountain	North Carolina	3800	2000	3.4	6.36	1.07	1.12
Stratton Mountain	Vermont	3900	1700	3.8	5.91	0.70	0.76
Blue Mountain	Pennsylvania	1500	1000	1.2	5.70	0.97	0.96
The Priest	Virginia	4100	800	1.2	5.32	1.23	1.22
Peters Mountain	Virginia	3300	1600	2.6	4.94	1.05	1.11
Mount Greylock	Massachusetts	3500	2500	7.5	4.88	0.81	0.85
Blood Mountain	Georgia	4500	650	1.3	4.81	1.42	1.42
Peters Mountain	Pennsylvania	1300	900	2.1	3.95	0.80	0.82
Bear Mountain	New York	1250	600	1.6	2.75	0.84	0.87
Bear Mountain	Connecticut	2300	1600	5.5	2.67	0.97	1.01
Kittatinny Mountain	New Jersey	1200	900	2.7	1.00	1.02	0.83

and Mount Katahdin. Blood Mountain has high fit statistics, indicating more disagreement than expected. Blood Mountain is the first major mountain on the Trail, about 28 miles from the start. Thru-hikers have not yet gotten into nearly perfect shape, and there is great variety in ability, explaining the disagreement. The infit of .49 and outfit of .48 for Bigelow Mountain indicates that hikers agreed more than expected on the difficulty of the mountain. I am at a loss to explain this. Mount Katahdin had even higher disagreement than Blood Mountain, with infit of 1.65 and outfit of 1.57. There are three parts to the explanation of the variability in responses. First, Mount Katahdin gets the worst weather of any mountain on this list. Second, when you get to the top of the mountain, you must turn around and go back the way you came, so some people do not carry packs. Third, since the five-mile climb up to the summit is the last five miles of a 2160 mile thru-hike, the emotional aspect varies. Some hikers are elated to be done finally, while others are depressed at losing this great adventure, and emotions affect how easy anything seems. These three sources of differences in experience explain why hikers have the most disagreement about the difficulty of Mount Katahdin.

When I got to the top of Mount Katahdin, I was exhausted. I thought it was the toughest climb on the entire Trail. At the top of Mount Katahdin, I reached the sign marking the end of the Trail. After nearly five months of hiking every day, I was done, and I was ecstatic. I had seen the tops of hundreds of mountains. I had met thousands of people, some out on the Trail for a day, some out for months. I had encountered wildlife, including two rattlesnakes, a porcupine, and two bears. I had observed a large portion of the United States, in such close detail few have seen. I had taken about five million steps to get to the top of what Rasch analysis has shown to be the hardest mountain on the Appalachian Trail. No wonder I was tired!

Ryan Bowles is originally from New Freedom, Pennsylvania, and presently lives in Chicago. He is a Program Associate at Computer Adaptive Technologies in Evanston, IL, and is pursuing a Ph.D. in Economics at the University of Chicago. In his spare time, Ryan enjoys reading great literature, visiting strange places, and hiking long trails.

Here's my stats song:
(sung to the tune of On the Road Again)
Doing Rasch again
I won't do traditional stats again
Not having linearity is a sin
I just can't wait to calibrate again.

GAMES PEOPLE PLAY