Predicting from Correlations

Review - 1

- Correlations: relations between variables
  - May or may not be causal
- Enable prediction of value of one variable from value of another
- To test correlational (and causal) claims, need to make predictions that are testable
  - Operationally "define" terms
    - Construct validity—do the operational characterization capture what is intended?

Review - 2

- Use scatterplots to diagram correlations

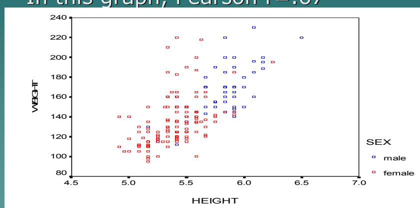
Person co-efficient measures strength of correlation:

-1.0	**0**	**1.0**
Perfect negative	**No Correlation**	**Perfect Positive**

Correlation Coefficients

Height and weight are positively correlated

In this graph, Pearson r=.67



Contains two subgroups: men and women

May exhibit different correlations

- For females (red) only, r =.47
- For males (blue) only, r = .68

How much does the correlation account for?

Correlations are typically not perfect (r=1 or r=-1)

Evaluate the correlation in terms of how much of the *variance in one variable is accounted for by the variance in another*

Amount of variance accounted for (on the variable whose value is being predicted) equals:

- Variance explained/total variance

This turns out to be the square of the Pearson coefficient: r^2

So:

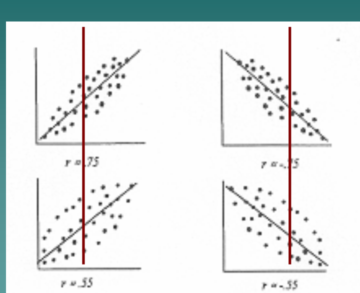
if r=.80, then we can say that 64% of the variance is explained.

If r=.30, then we can say that 9% of the variance is explained.

Variance Accounted for

r^2 = .56

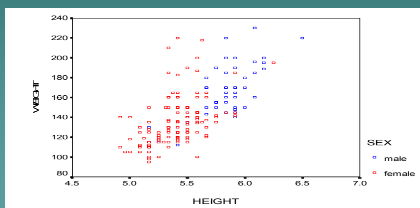
r^2 = .30



Variance accounted for - 2

Height only partially accounts for weight

- For females, r =.47, so r^2=22%
- For males, r = .68, so r^2=46%



Prediction

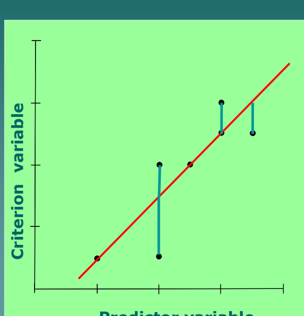
A major reason to be interested in correlation

If two variables are correlated, we can use the value of an item on one variable to predict the value on another

- Prediction of *future job performance* based on *years of experience*
- Actuarial prediction: *how long one will live* based on *how often one skydives*
- Risk assessment: prediction of *how much risk* an activity poses in terms of its values on *other variables*

Prediction employs the ***regression line***

Regression line



Start with scatter plot of data points

Find line which allows for the best prediction of the criterion variable (one to be predicted) from that of the predictor variable

which minimizes the (square of the) distances of the blue lines

Regression line

y = a + bx

y = predicted or criterion variable

x = predictor variable

a = y-intercept—***regression constant***

b = slope—***regression coefficient***

Note: the ***regression coefficient*** is **not the same** as the ***Pearson coefficient r***

Understanding the Regression Line

Assume the regression line equation between the variables mpg (y) and weight (x) of several car models is

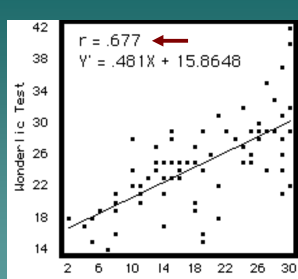
mpg = 62.85 - 0.011 weight

- MPG is expected to ***decrease*** by 1.1 mpg for every additional 100 lb. in car weight

Interpolating from the regression line

Correlation between

- Identical Blocks Test (a measure of spatial ability)
- Wonderlic Test (a measure of general intelligence)



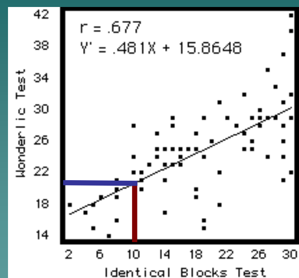
Calculate new value for x = 10:

y = .48 x 10 + 15.86

= 20.67

Interpolating from the regression line visually

- Draw line from the x-axis to the regression line
- Draw line from the intersection with the regression line to the y-axis



Sleep study

Correlations in samples and populations

The interest in correlations typically goes beyond the sample studied—investigators want to know about the broader population.

Two approaches

Estimating correlation in population (ρ) from correlation in sample (r)

- ***Confidence interval***

Determining whether there is a correlation in a given direction in the real population from correlation in sample

- ***Statistical significance***

Statistical significance and p-values

Fundamental question: **Is the result due to chance or to a real correlation in the population**?

How likely is a given correlation in the sample if there were **no correlation** (or a correlation in the other direction) in the population?

This is specified by the p-value

A p-value of .05 means there is 1 chance in 20 of a correlation in the sample without a correlation in the real population

That is, 19 times out of 20 the correlation in the sample is due to a correlation in the population

Statistical significance and p-values

p-values typically reported as less than some value

- <.05 is the most commonly used significance level
- <.01 is a higher, more demanding significance level
  - 1 chance in 100 of getting the result by chance

For some purposes, lower p values are useful to know

- Prediction with reliably of only .10 or .25 could be important to know
  - Chemical exposure and cancer, etc.

Significance vs. importance

- A statistically significant finding may or may not be important.

  All statistical significance means is that the finding is statistically *reliable—not likely to have occurred by chance*

- Whether it is important—worth knowing—depends on the finding

Correlations are hard to detect

Humans are terrible at recognizing intuitively whether two variables are correlated

We see correlations where none exist
We fail to see correlations that do exist

Must actually look at the evidence, not rely on our impressions
Perform statistical analyses!

Seeing correlations that don't exist

- "When I'm waiting for the bus, the one going in the other direction always comes first!"
- Are men or women more likely to have a sister?
- Evelyn Marie Adams won the New Jersey lottery twice, a 1 in 17 trillion likelihood—seem unlikely?
  Given the millions of people who buy state lottery tickets, it was practically a sure thing that someone, someday, somewhere would win twice.

Coincidences happen

- Loarraine and Levinia Christmas are twins. They set out to deliver Christmas presents to each other near Flitcham, England. Their cars collide!
- Philip Dodgson, a clinical psychologist at South Downs heath center in Sussex, England, does psychotherapy with clergy and members of religious orders. He surfs the web to see if there are is anyone else named Philip Dodgson. He finds one in Ontario and writes to him.
  - The second Philip Dodgson is also a clinical psychologists working at Southdown Center, a residential psychotherapy center for clergy and members of religious orders!

Coincidences happen

- Adams, Jefferson, and Monroe, three of the first five presidents of the US, died on the same date—July 4!
- Charles Schulz died of a heart attack on the day his last published Peanuts cartoon!

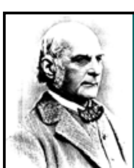
Limits to Regression analysis: Regression to the mean

Last month you took the SAT/GRE and scored 750 out of a possible 800 on the quantitative part.

- For kicks, you decide to take the test again
  - different questions, but of the same difficulty
  - assume that there was no learning or practice effect from the first test
- What score should you/we predict for you on the second test?

The surprising answer is that the person is more likely to score below 750 than above 750

- the best guess is that the person would score about 725.



Regression to the Mean

- Phenomenon discovered by Francis Galton, half cousin of Charles Darwin
- Developed a regression analysis of height between human children and their parents
- Found that *"It appeared from these experiments that the offspring did not tend to resemble their parents in size, but always to be more mediocre than they - to be smaller than the parents, if the parents were large; to be larger than the parents, if the parents were small."*

A way to understand regression to the mean

A given test is really a sampling from a distribution. Assume that there is a large number, say 1,000 forms of a test and that

- you takes all 1,000 tests
- there are no learning, practice, or fatigue effects.

Scores will be distributed:

Identify the mean of this distribution as the "true score"

A way to understand regression to the mean - 2

Differences in the scores on these tests are due to *chance* factors:

- guessing
- knowing more of the answers on some tests than on others.

A way to understand regression to the mean - 3

How could a first score of 750 have arisen:

- It reflected the true score (all chance factors balanced out)
- Your true score was <750 and you scored above it due to chance factors pushing you up
- Your true score was >750 and you only scored 750 due to chance factors dragging you down

Which is more likely?

- There are very few people with "true" scores above 750 (roughly 6 in 1,000)
- There are many more people with true scores between 700 and 750 (roughly 17 in 1,000).
- Thus, it is more likely that you are from the latter group

A way to understand regression to the mean - 4

Same principle applies to anyone at an edge of the normal distribution

More likely their true score is less different from the mean than the score obtained on a particular occasion when they obtained a very high score

- Baseball player who has a great or horrible batting average one year
- Sales representative who had a spectacular or horrible year

More regression examples

- The "sophomore slump": Almost 9/10 rookies of the year perform worse in their second year than in their rookie year
- Of 58 Cy Young Award winners, 52 had fewer victories the next year and 50 had higher earned-run average
- Hitters who hit 30 home runs before mid-season hit fewer thereafter, and those who hit 30 in the second half hit fewer before mid-season

Regression and punishment

Makes it seem like punishment works:

When someone is doing particularly poorly (for them), chastising them seems to result in better performance

But in fact it is only a case of regression

But praising someone does not seem to work:

When someone is doing particularly well (for them), praise is usually followed by poorer results

Just another instance of regression!

"Nature operates in such a way that we often feel punished for rewarding others and rewarded for punishing them" (David Myers, *Intuition*, p. 148).

Watch out for pseudo explanations

A program proposes to help those who score at the very bottom end of a standardized test
- For example, intervenes with those scoring less than 300 on the SAT

After the intervention, the individuals are tested again
- A larger proportion of this group exhibits improved scores than decreased scores

The program claims success BUT
- It may have contributed nothing!
- The results might totally be due to regression

The problem with relying on intuition

Humans are terrible at judging relations intuitively

This is why we need to turn to formal statistical analysis!

Do streaks require explanation?

3.1415926535
THTTTHHTTT

3.1415926535 8979323846 2643383279 5028841971
THTTTHHTTT HTTTTHTHHH HHHTTHTHTT THHHHHTTTT
6939937510 5820974944 5923078164 0628620899
HTTTTTTTTH THHHTTHTHH TTHTHTHTHH HHHHHHHHTT
8628034825 3421170679
HHHHHTHHHT THHTTTHHTT

Hot hand?

If someone just hit three shots in a row, is it a good idea to pass to them? What if they had missed three in a row?

Philadelphia 76ers' game data from the 1980-81 season (using all shots from the field)—success on next shot

Three Straight Hits	**.46**
Two Straight Hits	**.50**
One Hit	**.51**
One Miss	**.54**
Two Straight Misses	**.53**
Three Straight Misses	**.56**

Source: Gilovich, Vallone, and Tversky (1985, Cognitive Psychology, Table 1)