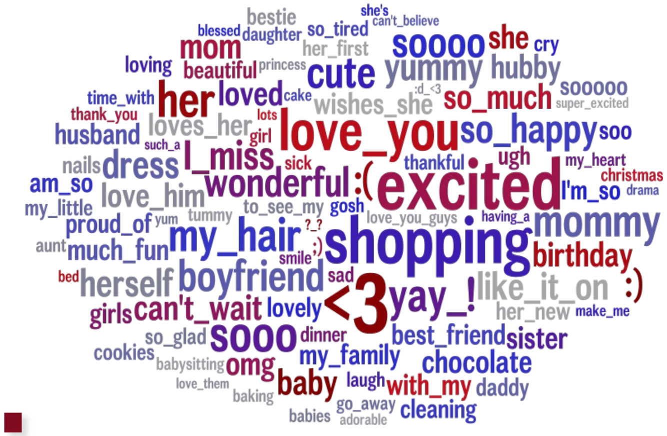


Model Interpretation

Lyle Ungar

Exploratory Data Analysis
Images, word clouds
Univariate vs. multivariate
Feature importance

(a) Extraverted.   (b) Conscientious.

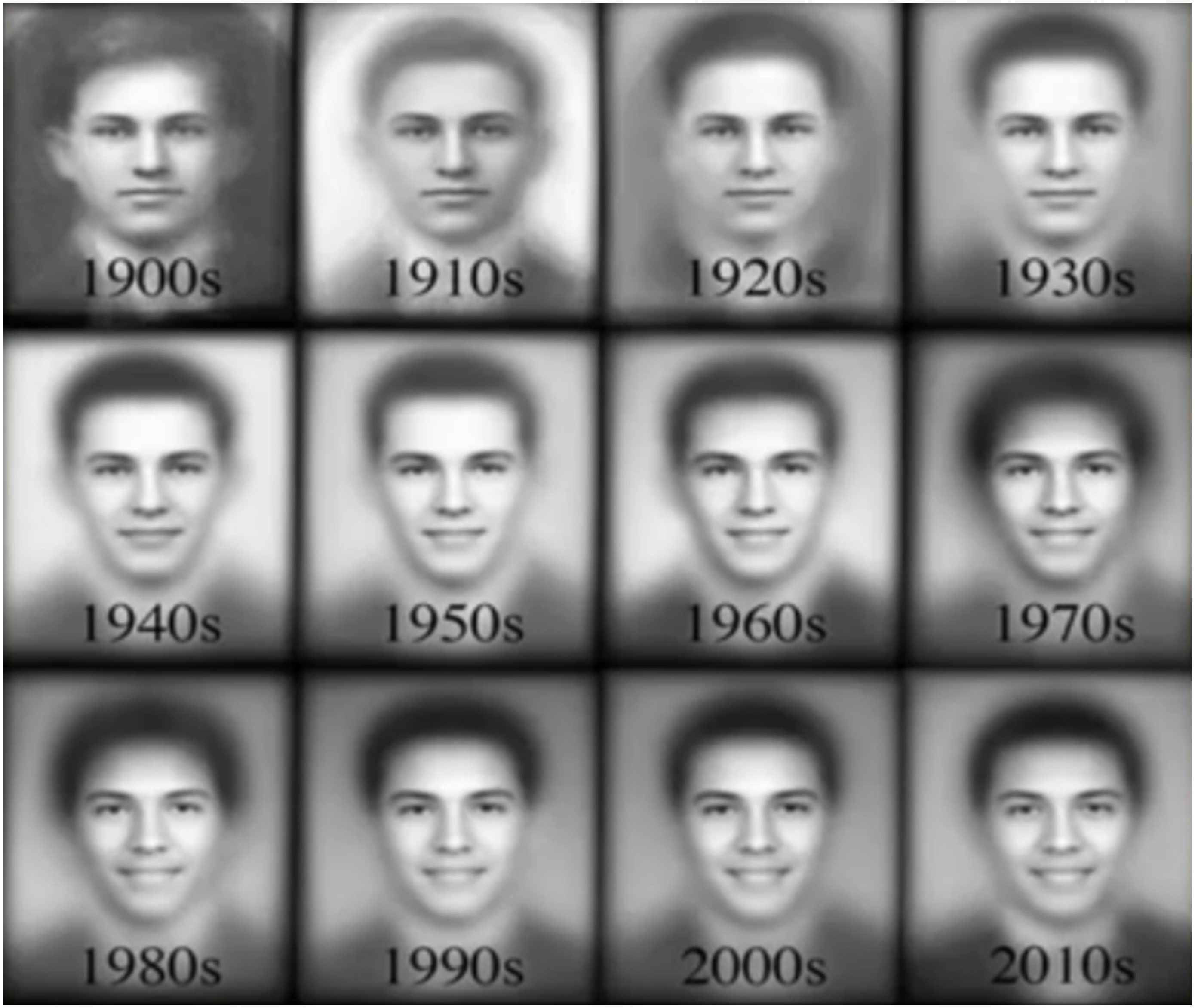
Figure 1: Example Twitter profile pictures for users scoring high in a personality trait.

Visualization matters

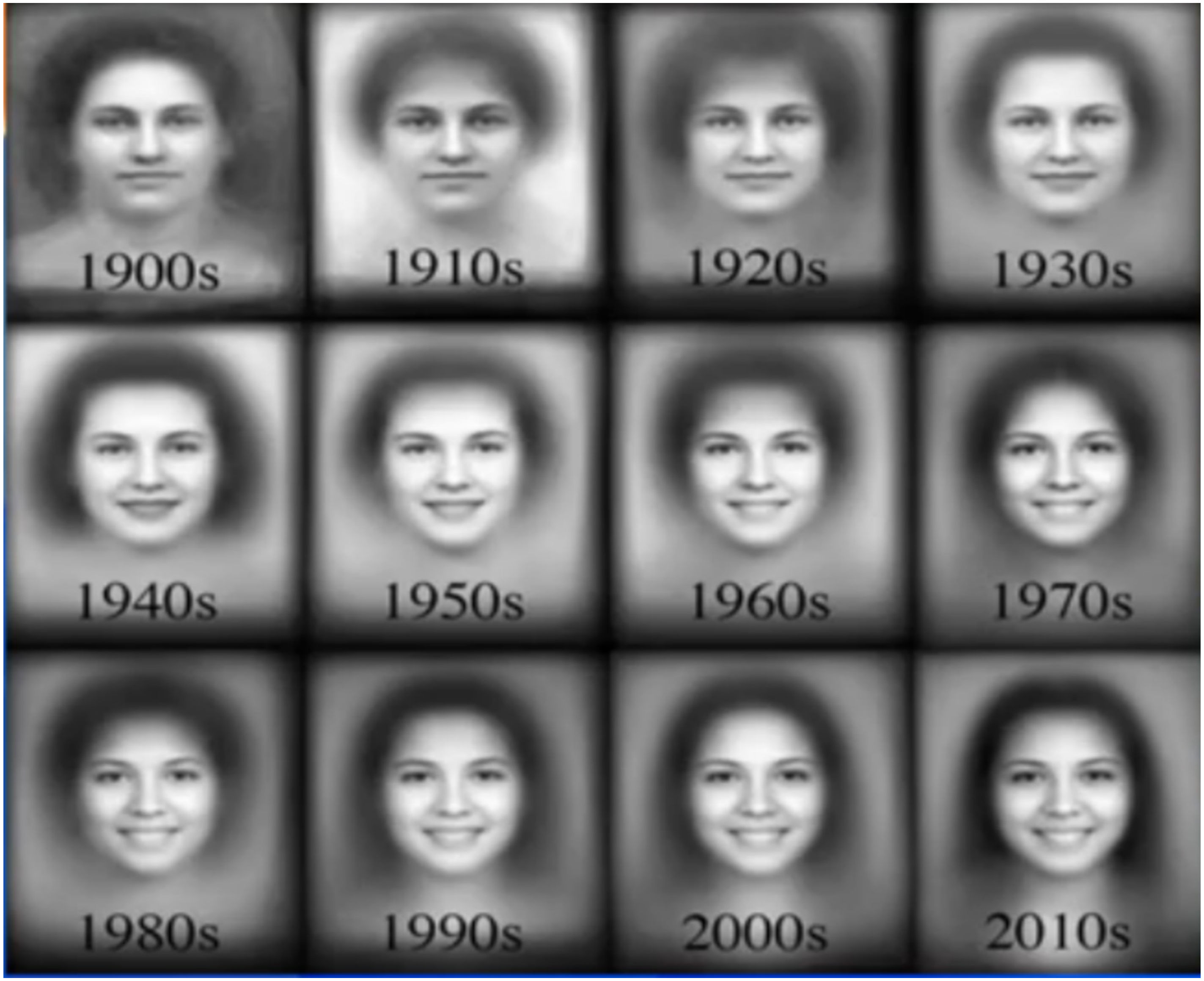
- Check data quality
- Understand the data
- Understand the model
  - To aid in model development
  - To explain results to users

Exploratory Data Analysis (EDA)

- Look at the data!!!
- Look at some images; read some posts
- Counts
  - Present/missing
- Means/standard deviations
- Histograms
- Correlations of features with outputs



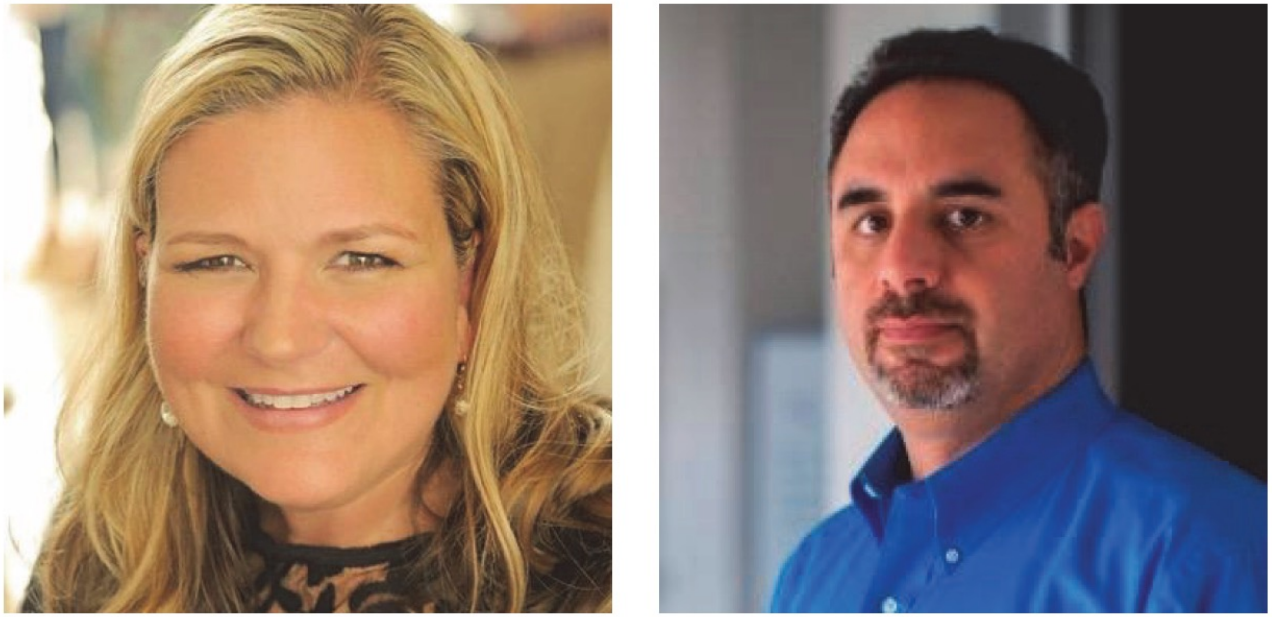
Shiry Ginosaur et al.



Shiry Ginosaur et al.

Variable explanation/importance

- **Interpretation**
  - Find items closest to the cluster center
  - Find words closest to a vector embedding
- **Method *specific* or *agnostic* variable importance**
- **argmax_x f(x) for hidden nodes or outputs**
  - Which input (Image, document …) maximizes the p(Y=y)?



(a) Extraverted.

(b) Conscientious.

Figure 1: Example Twitter profile pictures for users scoring high in a personality trait.

Variable Importance

- $y = 1000\ x_1 + x_2$
- **Which is more important:** x_1 or x_2?
- How should you measure importance?
- Possible answers:
  - Standardize x_1 and x_2
  - Change each of the features over its usual range and see you much y changes
  - Remove each of the features and see how the prediction changes - *with or without retraining the model*

Variable Importance: Regression

- **Univariate and multivariate are different**
  - Since features are usually highly redundant
- **True model:** $y = x_1 + x_5$
- **Fit:** $y = c_1 x_1 + c_2 x_2 + c_3 x_3 + c_4 x_4 + c_5 x_5$
  - with $x_1 = x_2 = x_3 = x_4$
- **Giving:** $y = \frac{1}{4} x_1 + \frac{1}{4} x_2 + \frac{1}{4} x_3 + \frac{1}{4} x_4 + c_5 x_5$
- **How important is** x_1?
  - ¼ or 1?

Kinds of generic variable importance

- The accuracy loss from leaving out a variable when building a model
  - What is the importance of x_1 in

    $y = c_1 x_1 + c_2 x_2 + c_3 x_3 + c_4 x_4 + c_5 x_5$

    with $x_1 = x_2 = x_3 = x_4$
- The accuracy loss from pegging a variable to its average value in a trained model

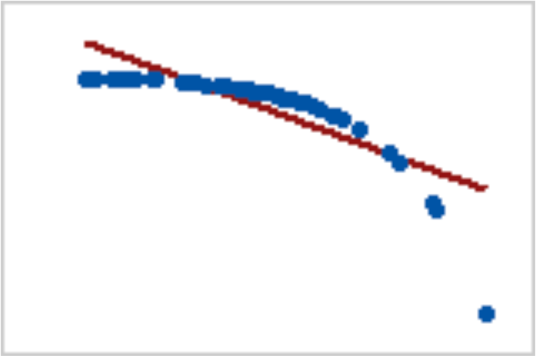
Random Forest Variable Importance

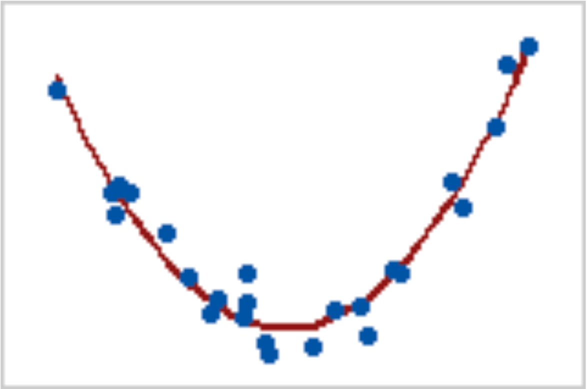
- **Find test set error,** Err
- **Permute a variable** x_j**, find new test set error,** Err_t
- **Variable importance is the difference,** $(\mathrm{Err} - \mathrm{Err}_t)$ **divided by the standard error**

From the R package for Random forests

For interpretation

- **Find correlation of each feature x_j with y**
  - But beware on nonlinear relations
  - Pearson vs. Spearman correlations





Pearson = −0.799, Spearman = −1

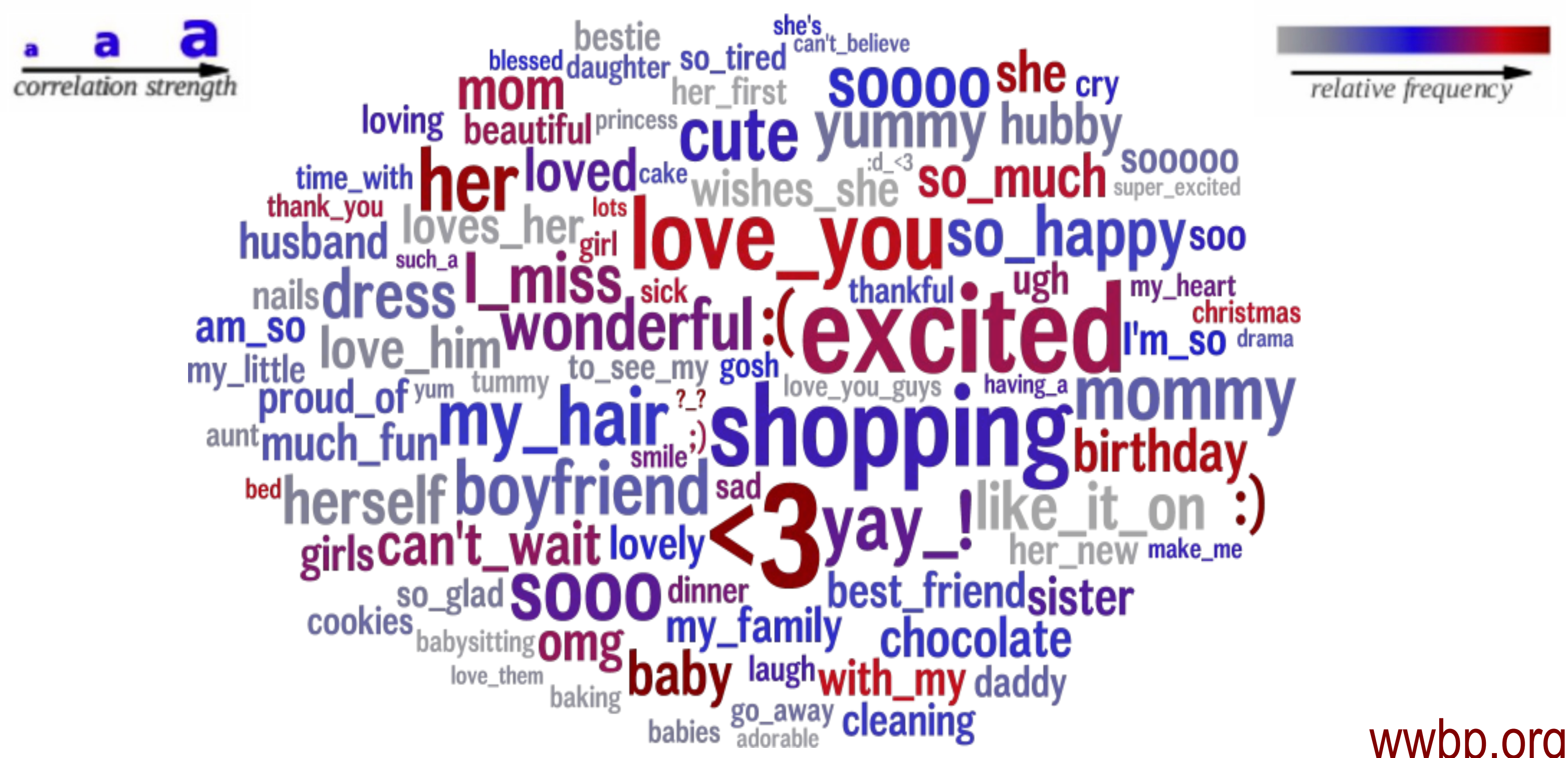
https://support.minitab.com/

Look at the data!

- Frequency
- Correlation (Pearson)

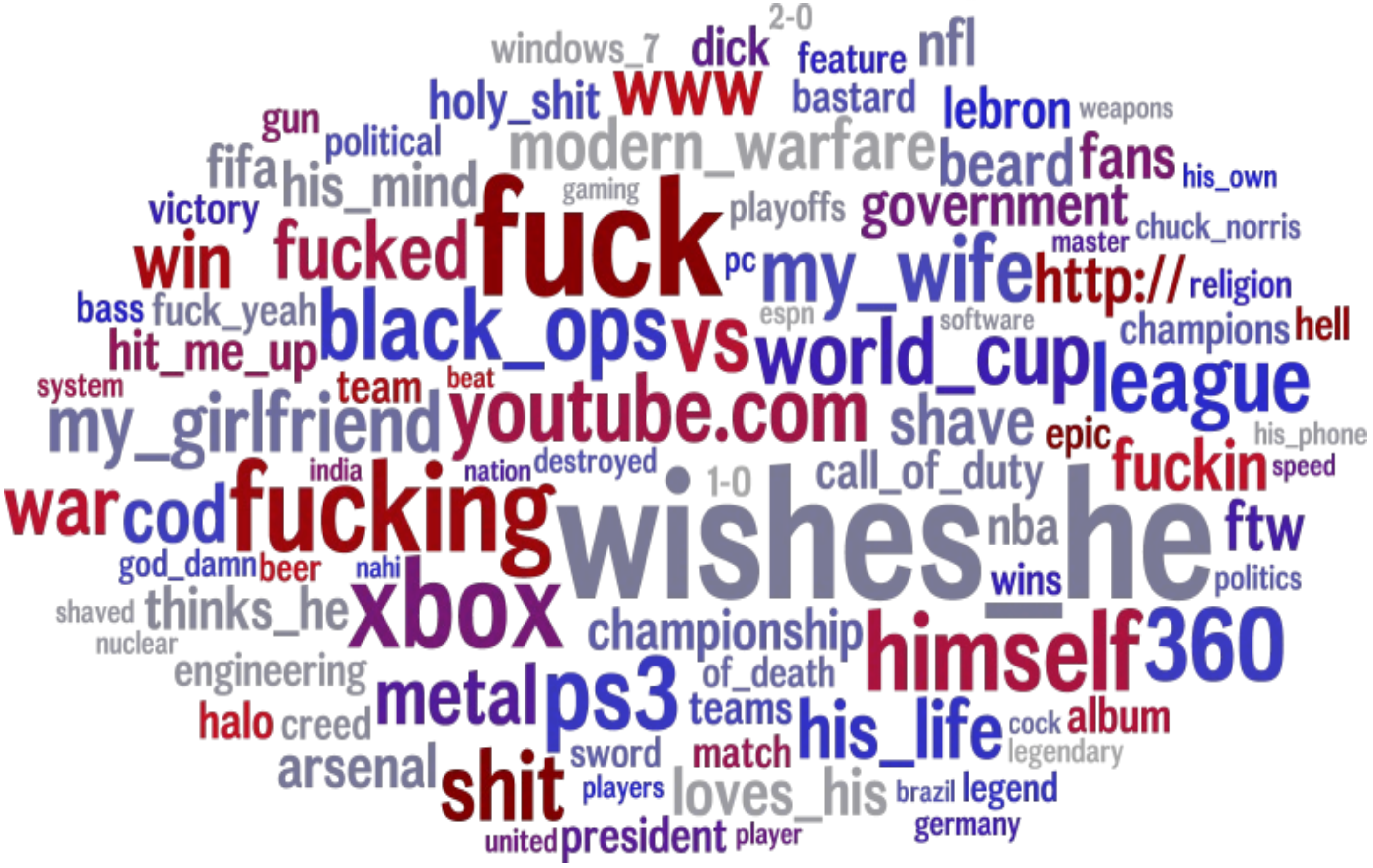
$$corr(x,y) = E[(x- \mu_x)(y-\mu_y)] / \sigma_x\sigma_y$$

Words reflect who says them



wwbp.org

Words reflect who says them



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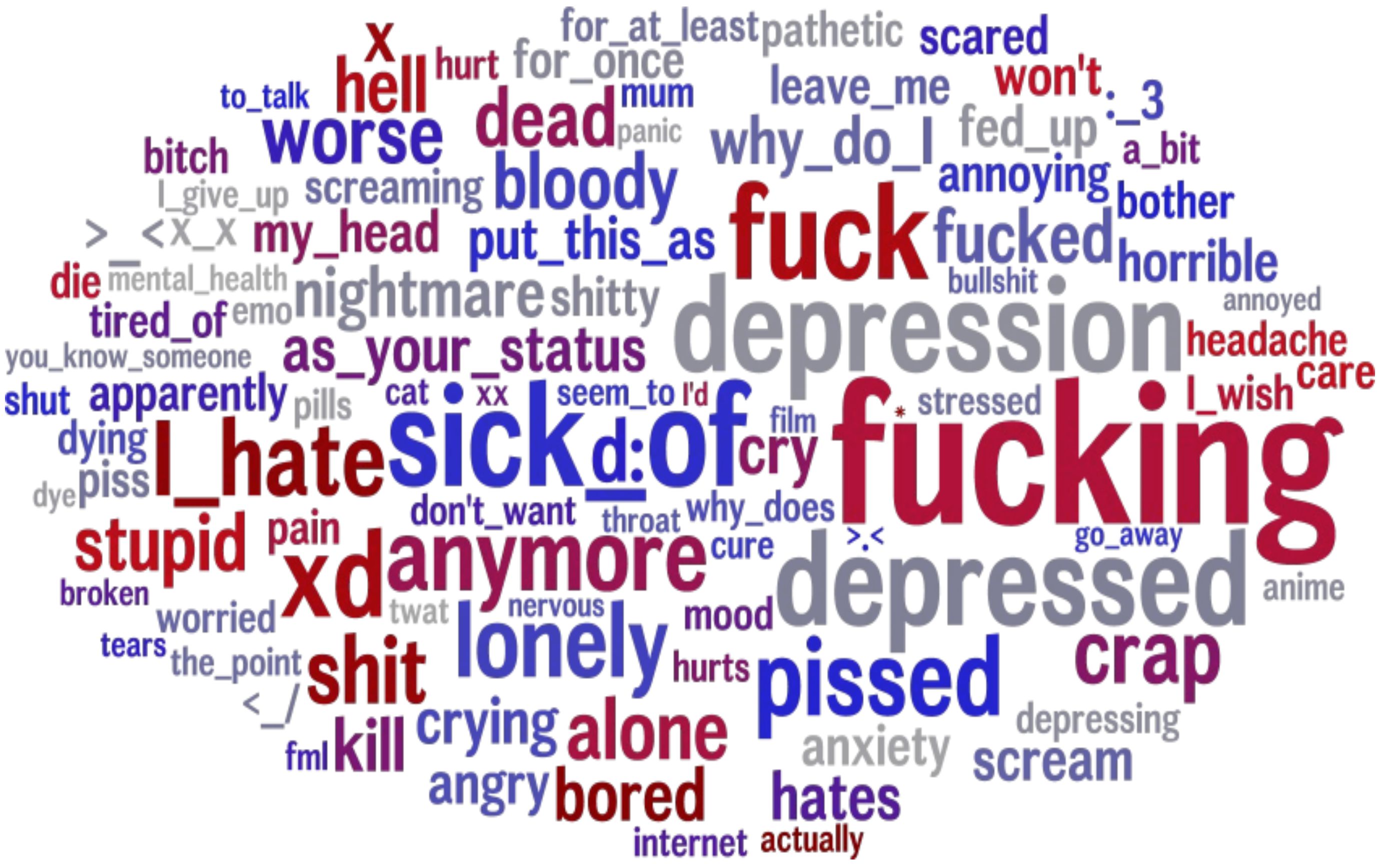
Neurotic words



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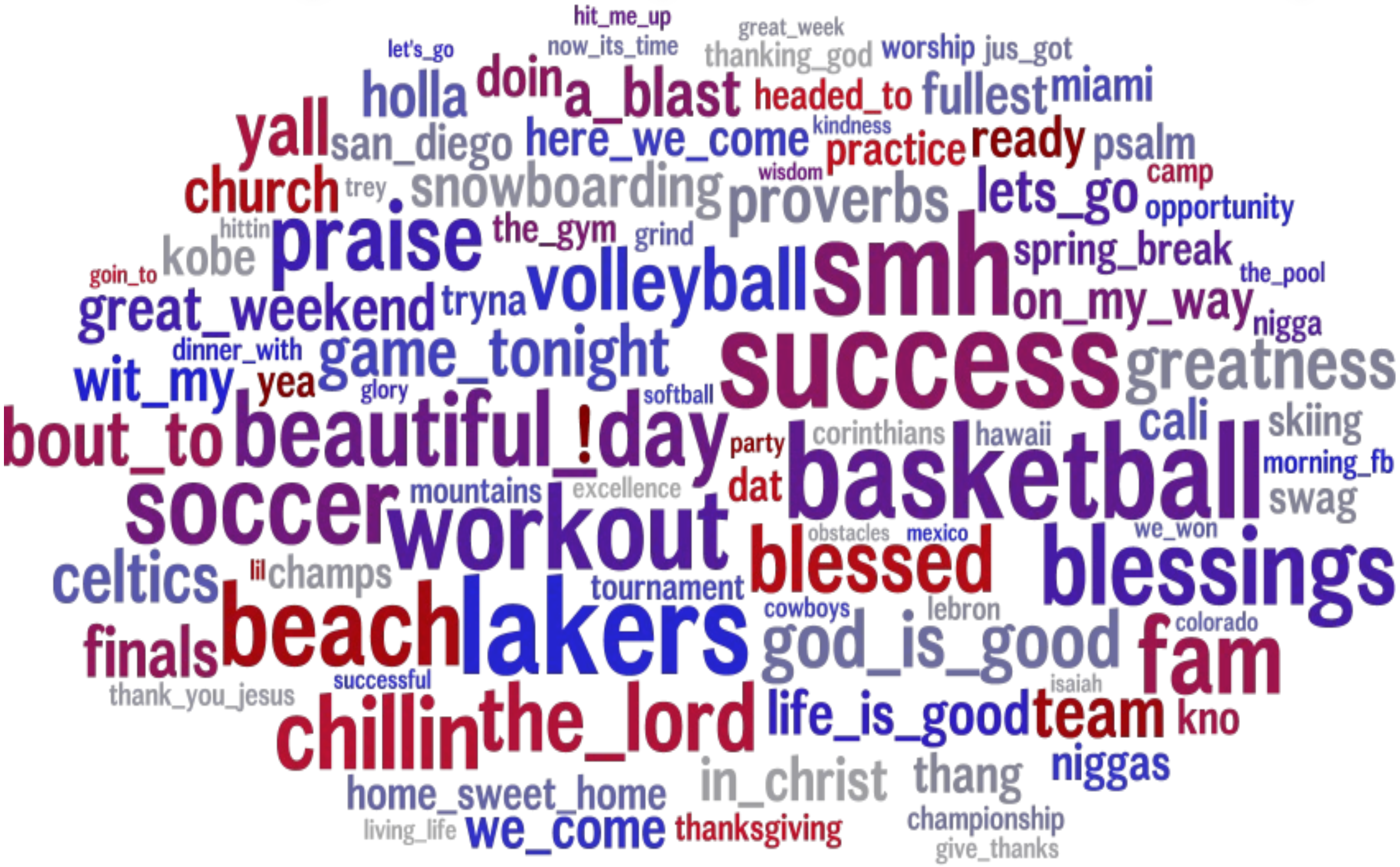
Well adjusted (anti-neurotic) words



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What you should know

- **Start by looking at distributions**
  - Look for outliers
  - Label clusters with frequent items close to the center
- ***$argmax_x$ f(x)* for feature detectors or outputs**
  - Images, words/documents …
- **Correlations (Pearson or Spearman)**
  - E.g., word clouds
- **Univariate vs. multivariate variable importance**