Ideology Detection for Twitter Users via Heterogeneous Types of Links

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Quiz! Can we predict whether the following people are conservative or liberal, simply based on who they follow/mention/retweet on Twitter?

- Alice follows 100 Democrats and 0 Republicans.
- Bob follows 100 Democrats and 90 Republicans.
- Carly *follows* 100 Democrats and *retweets* from Republicans for 100 times.
- Dave *follows* 32 Democrats, 18 Republicans; *mentions* Democrats 56 times, Republicans 79 times; *retweets* Democrats X times and Republicans Y times …

Problem Definition

Given a heterogeneous Twitter network with multiple types of links (*follow*/*mention*/*retweet*), our goal is to:

- Learn the political ideology for all users in the network. For example, can we predict whether a citizen is liberal/conservative/neutral? Where is a citizen's position in the political spectrum? Is Democrat U more liberal than another Democrat V?
- Determine the strength of each type of links in terms of ideology detection. For example, does *retweet* behavior reveal one's ideology more than *mention* behavior?

Model – Multi-Link Ideal Point Estimation Model (ML-IPM)

Our model is based on the following assumptions:

- Network homophily: people with similar ideology tend to have links in between.
- In directed networks, each user has two roles: link-sender and link-receiver, which correspond to two different features. When a user issues links to others (e.g. choose friends), her intrinsic feature (ideology) will be considered; when a user receives links, her impression feature will be considered.
- The weight of each link type should reflect its strength in explaining the corresponding network.

The probability of a link from *i* to *j* of link type *r*:

$$p\left(G_{ij}^{(r)}=1\right)=\sigma\left(\boldsymbol{p}_i^T\cdot\boldsymbol{q}_j^{(r)}+b_j^{(r)}\right):=\sigma_{ij}^{(r)}$$

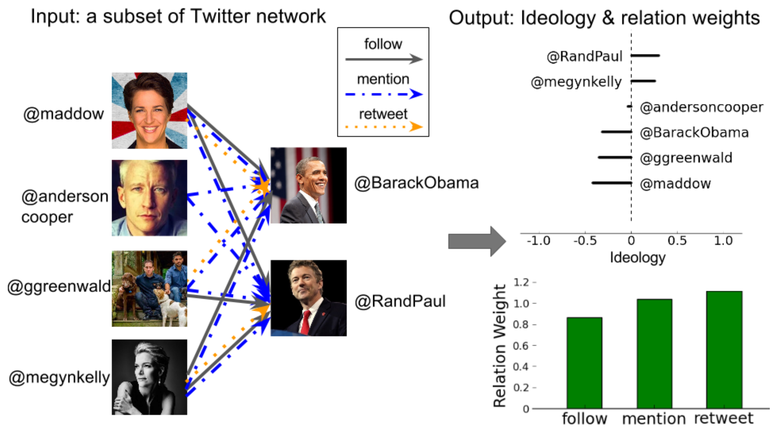
The likelihood of observing the network *r*:

$$l\left(G^{(r)}\right)=\sum_{i,j}I_{[G_{ij}^{(r)}=1]}\log\sigma_{ij}^{(r)}+I_{[G_{ij}^{(r)}=0]}\log(1-\sigma_{ij}^{(r)})$$

Maximize the following objective function w.r.t. model parameters $\{p_i\}_{i=1}^{N_1},\left\{q_j^{(r)},b_j^{(r)}\right\}_{r,j},\{w_r\}_{r=1}^{R}$

$$L=\sum_r w_r\cdot l(G^{(r)})$$

Overview



Experiments

Dataset: 46,477 politics-related Twitter users, including 487 congress people (labeled).

Method	Classification AUC
SL-IPM (follow)	0.980
SL-IPM (mention)	0.899
SL-IPM (retweet)	0.880
ML-IPM	**0.984**

Table 1: User Classification (on labeled politicians)

Method	Link Prediction AUC
AVER	0.606
B-IPM	0.770
SL-IPM	0.905
ML-IPM	**0.912**

Table 2: Link Prediction on Retweet Network

Link Type	w_r
follow	0.866
mention	1.035
retweet	1.117

Table 3: Relative Weights

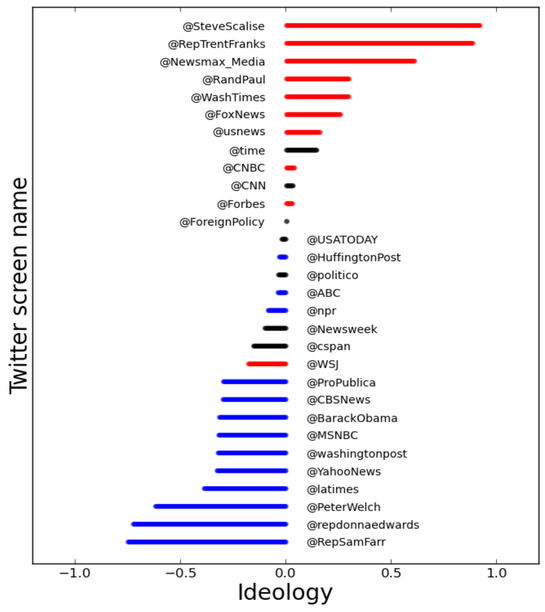


Figure 1: Detected Ideology for selected media accounts and some congressmen

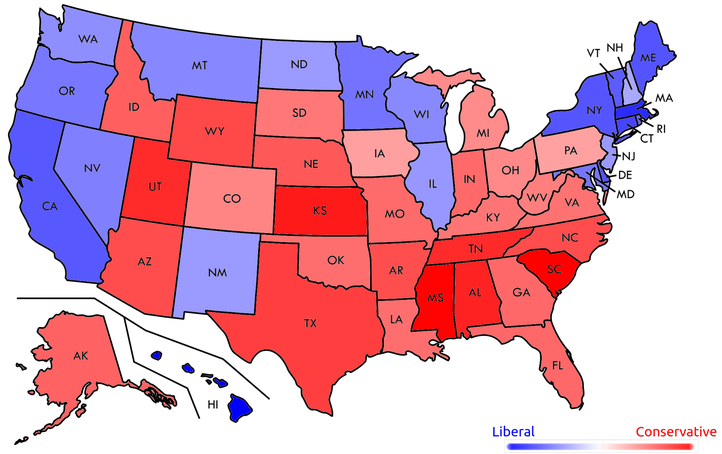


Figure 2: Average ideology score for users in different states