Learning Latent Groups with Hinge-loss Markov Random Fields

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Introduction

- Can we build **tractable** models that learn **latent mixed-memberships** in **rich data**?
- We achieve this goal using a graphical model that encodes **complex, yet interpretable dependencies** among
  - group membership
  - language usage
  - social interactions
- We demonstrate our approach by learning indicators of **latent political preferences**

Hinge-loss Markov Random Fields

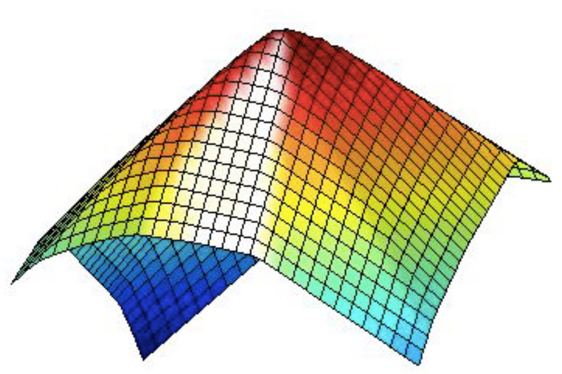
Hinge-loss Markov random fields are undirected graphical models analogous to discrete MRFs.

- Variables are **continuous valued** in [0,1]
- Potentials are hinge-loss functions

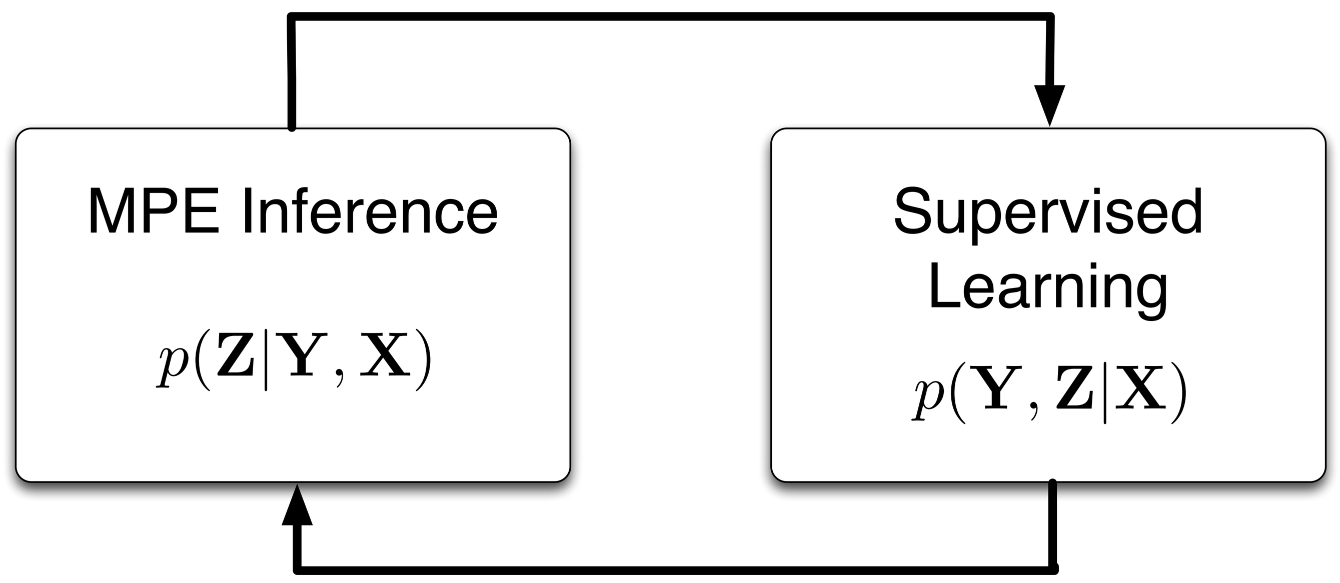
$$p(\mathbf{Y}|\mathbf{X}) = \frac{1}{Z}\exp\left[-\sum_{j=1}^{m} w_j \max\left\{\ell_j(\mathbf{Y},\mathbf{X}), 0\right\}^{p_j}\right]$$

Features

- **Easily constructed and interpreted** by mapping between logical rules and hinge-loss functions
- **Linear constraints** enable mixture models
- Log-concave density function admits **fast, exact MPE inference** using the alternating direction method of multipliers (ADMM)



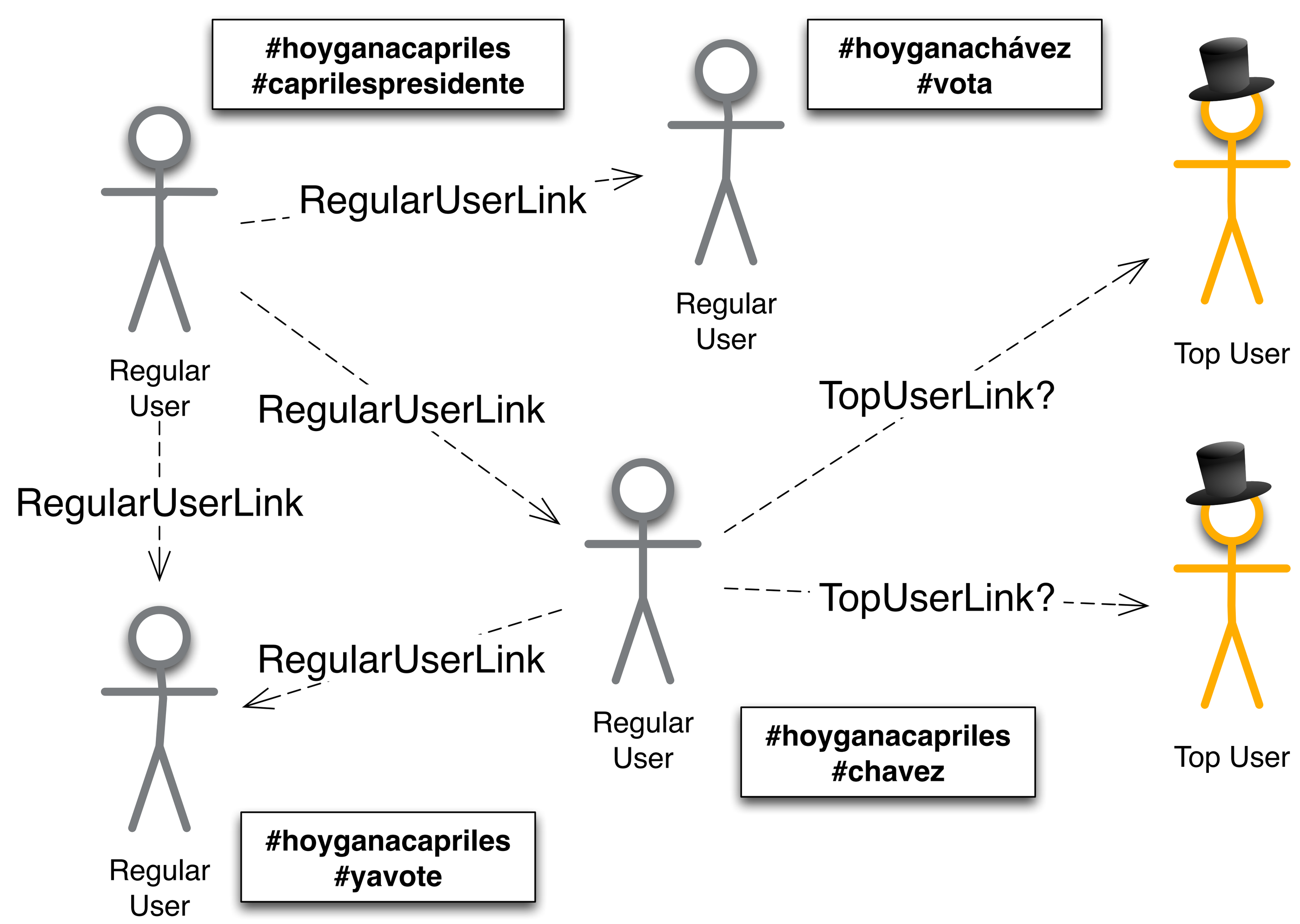
Latent-Variable Learning



Hard EM excels because of tractable inference and learning with expressive continuous variables

Latent-Group Model

Domain



Rules

$$w_{h,g} : \textsc{UsedHashtag}(U,h) \rightarrow \textsc{InGroup}(U,g) \qquad \forall h \in H, \forall g \in \mathcal{G}$$

$$w_{\text{social}} : \textsc{RegularUserLink}(U_1,U_3) \wedge \textsc{RegularUserLink}(U_2,U_3) \wedge U_1 \neq U_2 \wedge \textsc{InGroup}(U_1,G) \rightarrow \textsc{InGroup}(U_2,G).$$

$$w_{g,t} : \textsc{InGroup}(U,g) \rightarrow \textsc{TopUserLink}(U,t) \qquad \forall g \in \mathcal{G}, \forall t \in T$$

Learn more: http://psl.umiacs.umd.edu

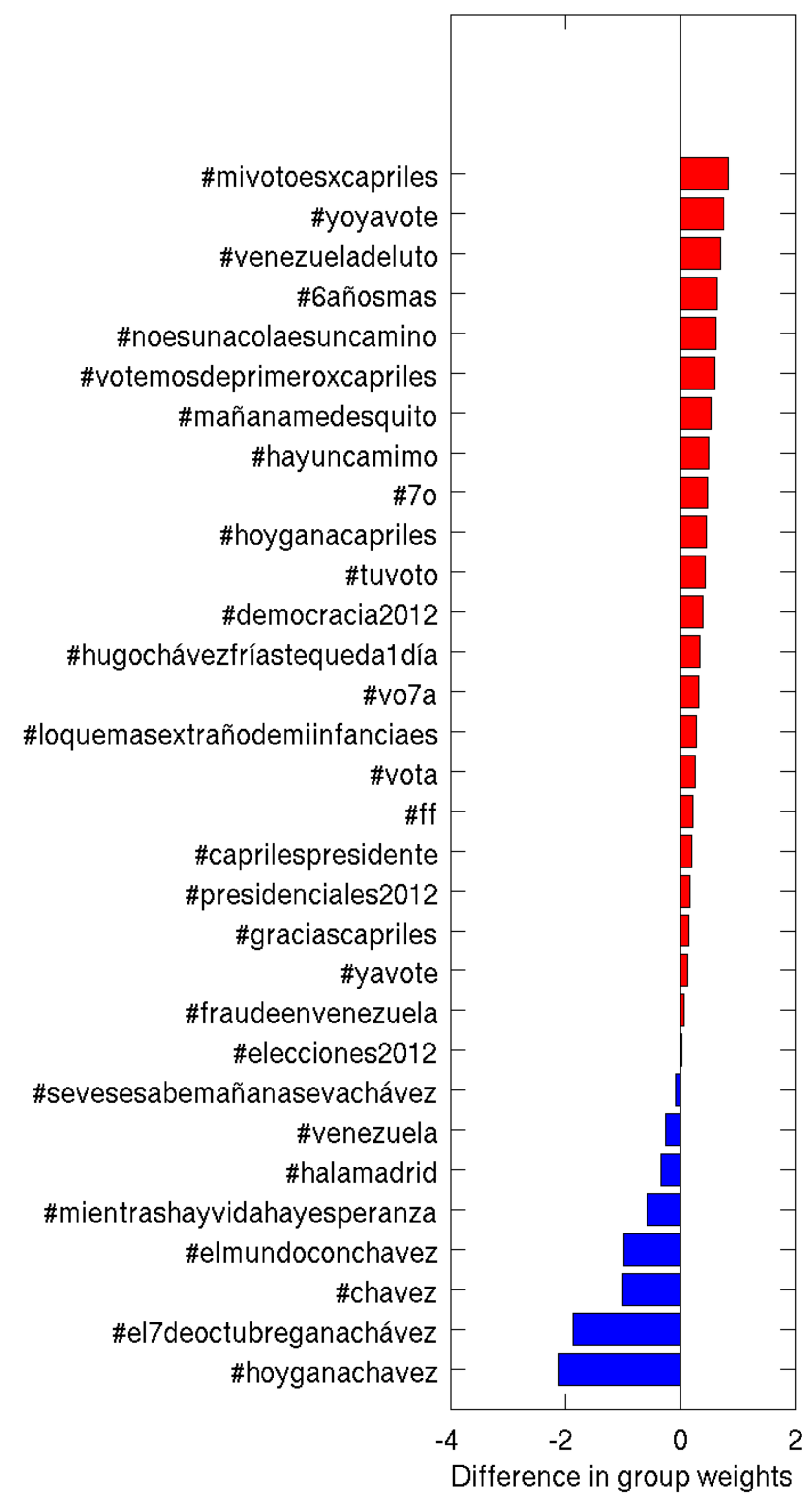
Case Study: 2012 Venezuelan Presidential Election

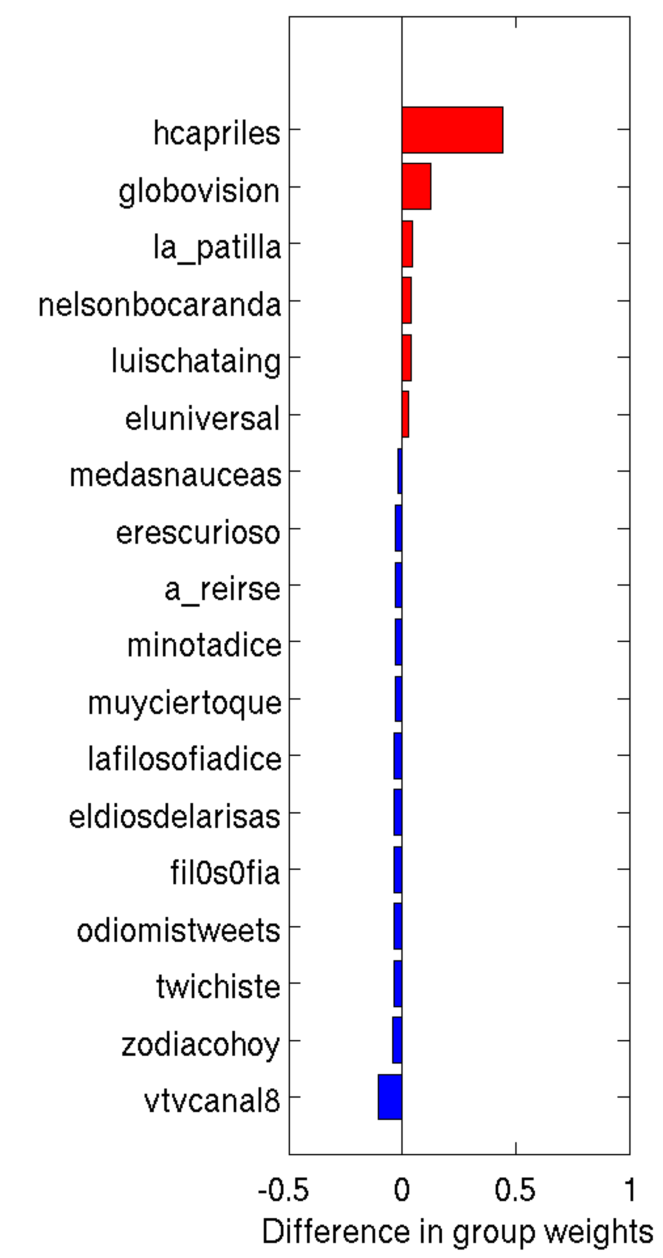
Candidates

Hugo Chávez
Incumbent
Won with 55% of vote

Henrique Capriles
Challenger

Learned Groups





Highlights

- Pro-Chávez and pro-Capriles hashtags separated
- Anti-Chávez hashtags identified as pro-Capriles
- Superficially pro-Chávez hashtag "#6añosmas" is correctly identified as pro-Capriles
- Capriles's account associated with pro-Capriles group
- Independent and state-owned media accounts separated

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