Natural Language Processing to the Rescue?

Extracting “Situational Awareness” Tweets During Mass Emergency

Sudha Verma, Sarah Vieweg, William J. Corvey, Leysia Palen, James H. Martin, Martha Palmer, Aaron Schram & Kenneth M. Anderson

University of Colorado Boulder

EPIC
Empowering the Public with Information in Crisis

Microblogging & Emergency

- Online resources frequently used
- Twitter a popular tool used during emergencies

  Readily available & provides near real-time information

Twitter & Emergency

*"I got better **situational awareness** [from Twitter] before we got official word. Four or five years ago I wouldn't have gotten that quality of information."*

Craig Fugate, US FEMA Chief

Situational Awareness

A state of understanding the “big” picture in time- and safety-critical situations, so one can assess the situation and determine what action to take [Sarter and Woods]

Tweets during Mass Emergencies

- Tactical, actionable information

  The Red River at Fargo ND is at 33.15 ft which is 15.15 ft above flood stage #flood10 #fargoflood

- Empathetic & supportive messages

  Thinking of everyone working so hard to hold back the Red River. You can be sure there are many here in Cedar Rapids sending prayers.

Tweets with Information Contributing to Situational Awareness

Can they be categorized automatically?

Tweets with Information Contributing to Situational Awareness

Can they be categorized automatically?

Are there good linguistic indicators for detecting them?

Tweets with Information Contributing to Situational Awareness

Can they be categorized automatically?

Are there good linguistic indicators for detecting them?

Can automatic classification scale across different events?

Hypothesis

During disasters, tweets written in objective language with formal and impersonal styles are typically used to convey tactical information

Goals

- Identify linguistic features that can aid in locating tweets with information contributing to situational awareness (SA Tweets)
- Classify SA tweets

Our Approach

Collect Data

Tweets for crisis events

Our Approach

Collect Data

Tweets for crisis events

Annotate

Annotate for situational awareness

Annotate for key linguistic features

Our Approach

Collect Data

Tweets for crisis events

Annotate

Annotate for situational awareness

Annotate for key linguistic features

Classify

Classify tweets that contribute to situational awareness

Our Approach

Collect Data

Tweets for crisis events

Annotate

Annotate for situational awareness

Annotate for key linguistic features

Classify

Classify tweets that contribute to situational awareness

Evaluate

Evaluate results

Datasets

Data collected from Twitter using in-house collection architecture [Anderson & Schram, 2011]:

- Red River Floods 2009
- Red River Floods 2010
- Oklahoma Fires 2009
- Haiti Earthquake 2010

2009 & 2010 Red River Floods

- Red River flows from United States to Manitoba, Canada
- Seasonal threat
- 2009: record flooding
- 2010: moderate flooding

2009 Oklahoma Fires

- Grassfires on April 9-10, 2009
- Over 60 injuries and 100,000 acres burned

2010 Haiti Earthquake

- Occurred on January 12, 2010
- Caused more than 217,000 deaths and 300,000 injuries and left one million homeless
- Generated large international response

Annotation

Set of 500 tweets per dataset annotated by two annotators independently for:

- Contribution to Situational Awareness
- Subjective/Objective nature
- Informal/Formal register
- Personal/Impersonal style

Situational Awareness (SA)

SA Tweet – Has information that can be used to gauge the situation and inform decision-making processes

Team of doctors leaving from Knoxville Feb 3 for #Haiti. Need donations of antibiotics, tylenol, antacids by Jan 31!

Situational Awareness (SA)

SA Tweet – Has information that can be used to gauge situation and inform decision-making processes

Team of doctors leaving from Knoxville Feb 3 for #Haiti. Need donations of antibiotics, tylenol, antacids by Jan 31!

Not SA Tweet – Does not provide actionable information

Haiti was Bombed!!! - OMG I so wanna donate u guyz!1!!!1!

Subjectivity

Subjective Tweets – Contain opinion and/or convey sentiment

What a day! Crazy fires!! SO many people without homes. I'm headed to bed to get some sleep.

Subjectivity

Subjective Tweets – Contain opinion and/or convey sentiment

What a day! Crazy fires!! SO many people without homes. I'm headed to bed to get some sleep.

Objective Tweets – Contain factual information and do not express opinion

The Gas Line that is on fire is 15th and Anderson Rd. Is a 3 inch supply pipe. They are working to shut it down. #okfires

Register

Formal Tweet - Grammatically coherent and express complete thoughts

Parliament has collapsed. The tax office has collapsed. Schools have collapsed. Hospitals have collapsed. #haiti

Register

Formal Tweet - Grammatically coherent and express complete thoughts

Parliament has collapsed. The tax office has collapsed. Schools have collapsed. Hospitals have collapsed. #haiti

Informal Tweet- Fragmented, lacking context; may include slang and have grammatical errors

if u in church ,,or goin later tonite,,pray for me,:) also dont forget to pray for haiti.

Style

Personal Tweet – The author injects him or herself into the situation

Relaxing after a whole day of sandbagging. I'm exhausted but we got a lot done and I met some great people. #fmflood

Style

Personal Tweet – The author injects him or herself into the situation

Relaxing after a whole day of sandbagging. I'm exhausted but we got a lot done and I met some great people. #fmflood

Impersonal Tweet - Displays emotional distance from the event

The Red River seems to have crested below 41 feet; dikes and levees seem to be holding.

Classification

1. Can SA tweets be categorized automatically?
2. Can linguistic features that co-occur with SA tweets be classified?
3. Do additional linguistic features improve classification of SA tweets?

Classification - Technique

Categorize SA tweets

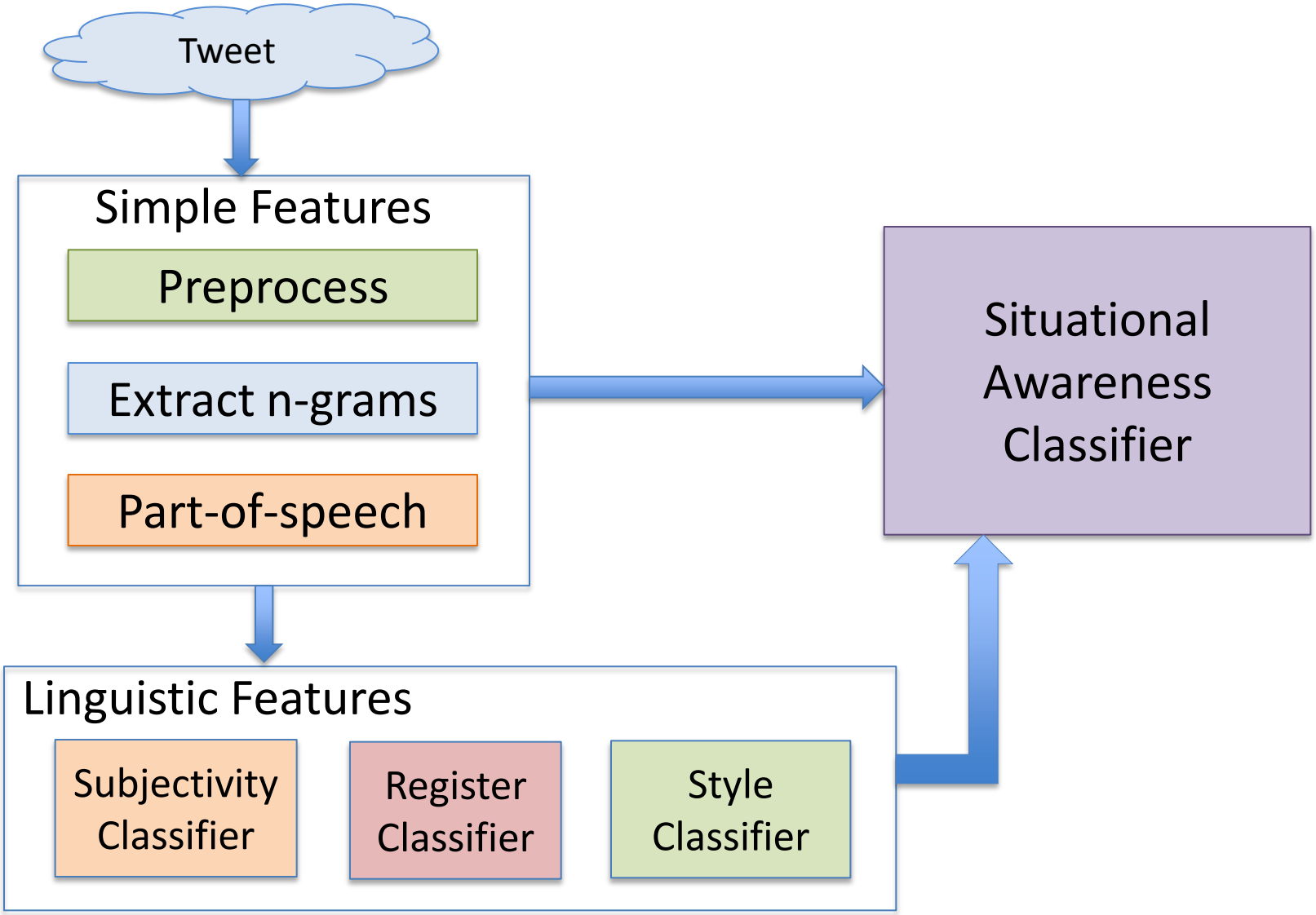
- Using Naïve Bayes and MaxEnt (Mallet)
- 10 fold cross-validation - 90% training and 10% for testing
- Performance calculated by taking the mean accuracy over the 10 runs for each event

Classification – Training data

Roughly 500 tweets per event

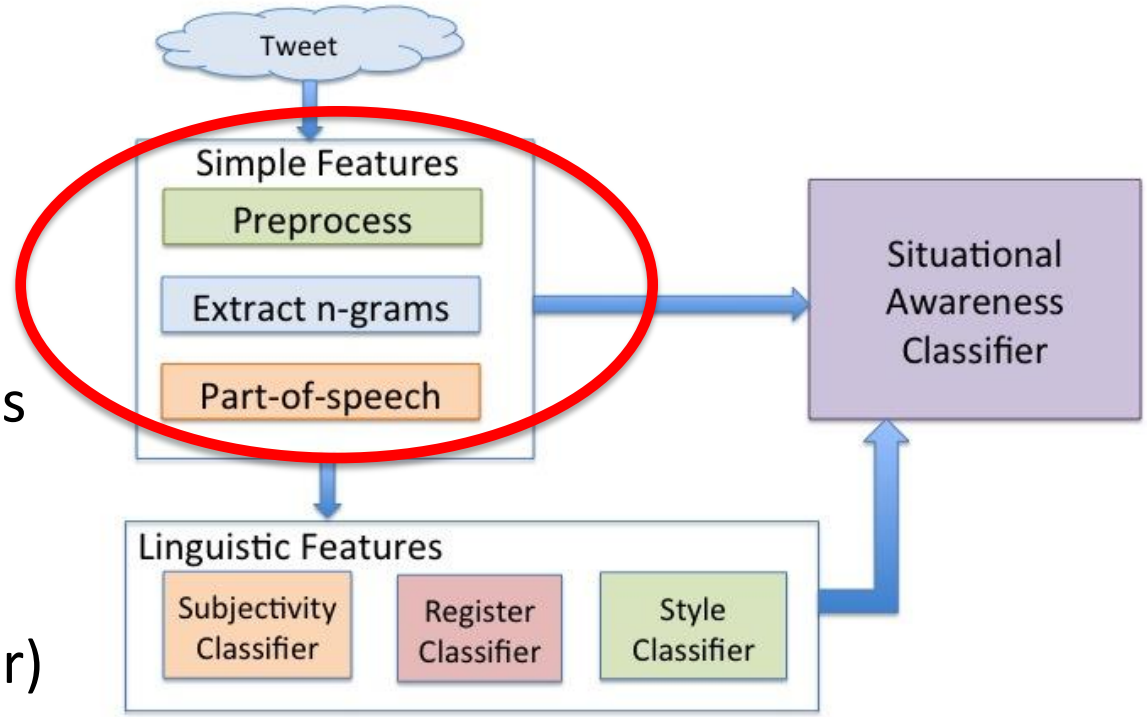
Approximately 2000 tweets in total

Classification - Overview



Simple Features

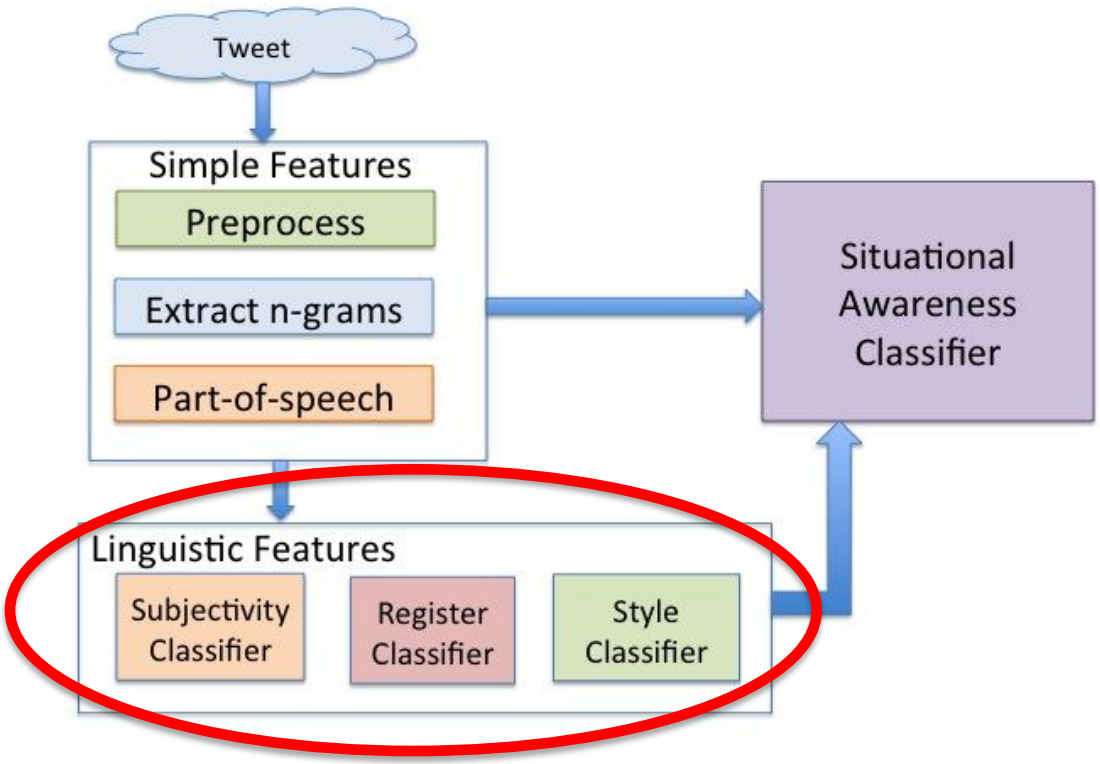
- Preprocess Tweets
  - Normalization
  - Stemming
  - Tokenization
- Unigrams and counts
- Bigrams and counts
- Part-of-speech tags (Stanford POS-tagger)



Linguistic Features

Features predicted from linguistic classifiers:

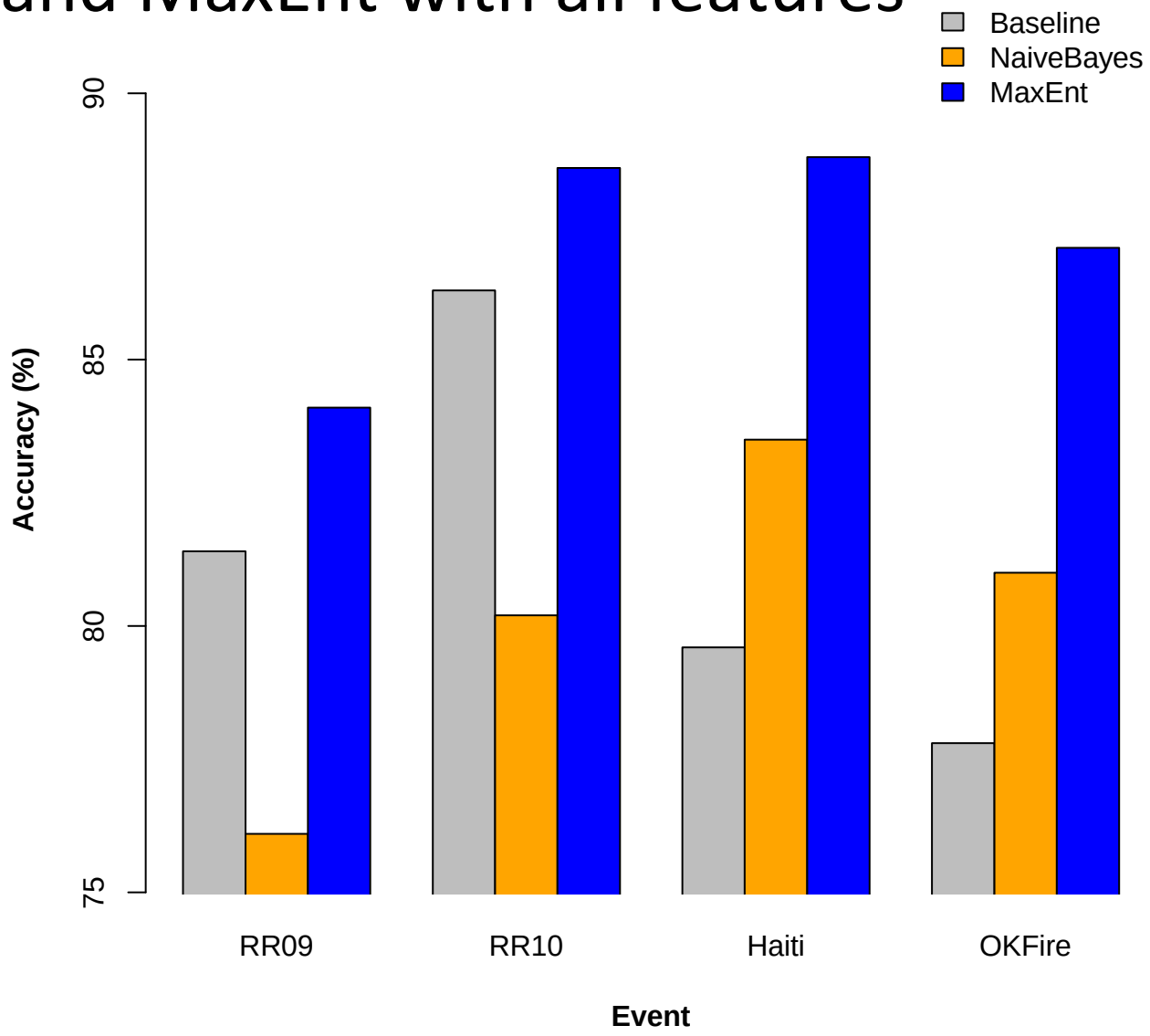
- Subjectivity: Is it subjective or objective?
- Register: Does it show formal or informal register?
- Style: Is it written in personal or impersonal style?



Classification Results

Can SA Tweets be categorized automatically?

SA Classification using Naïve Bayes and MaxEnt with all features



Classification Results

Are the linguistic indicators we identified useful for detecting SA Tweets?

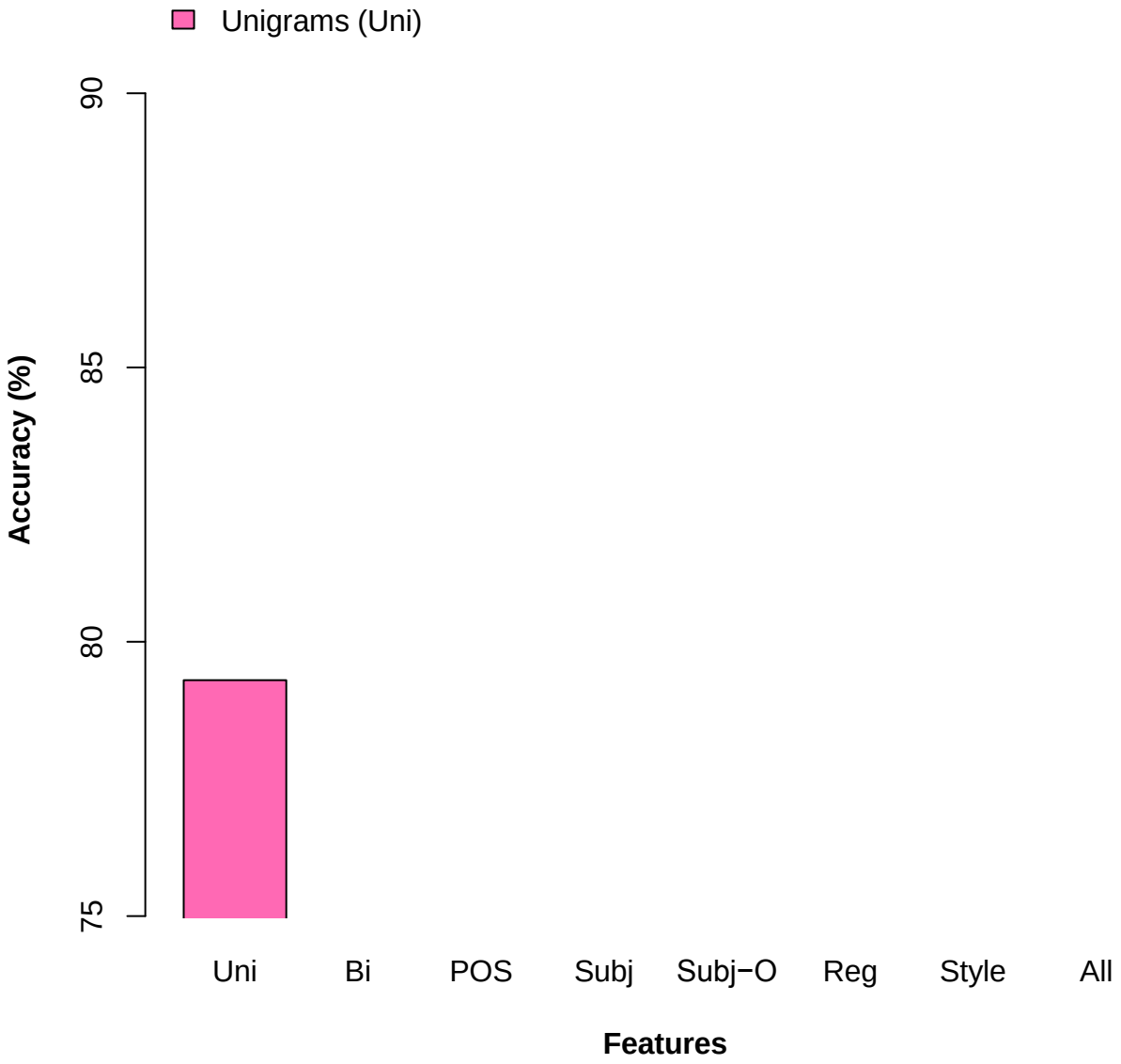
Balanced DataSet:

500 SA Tweets

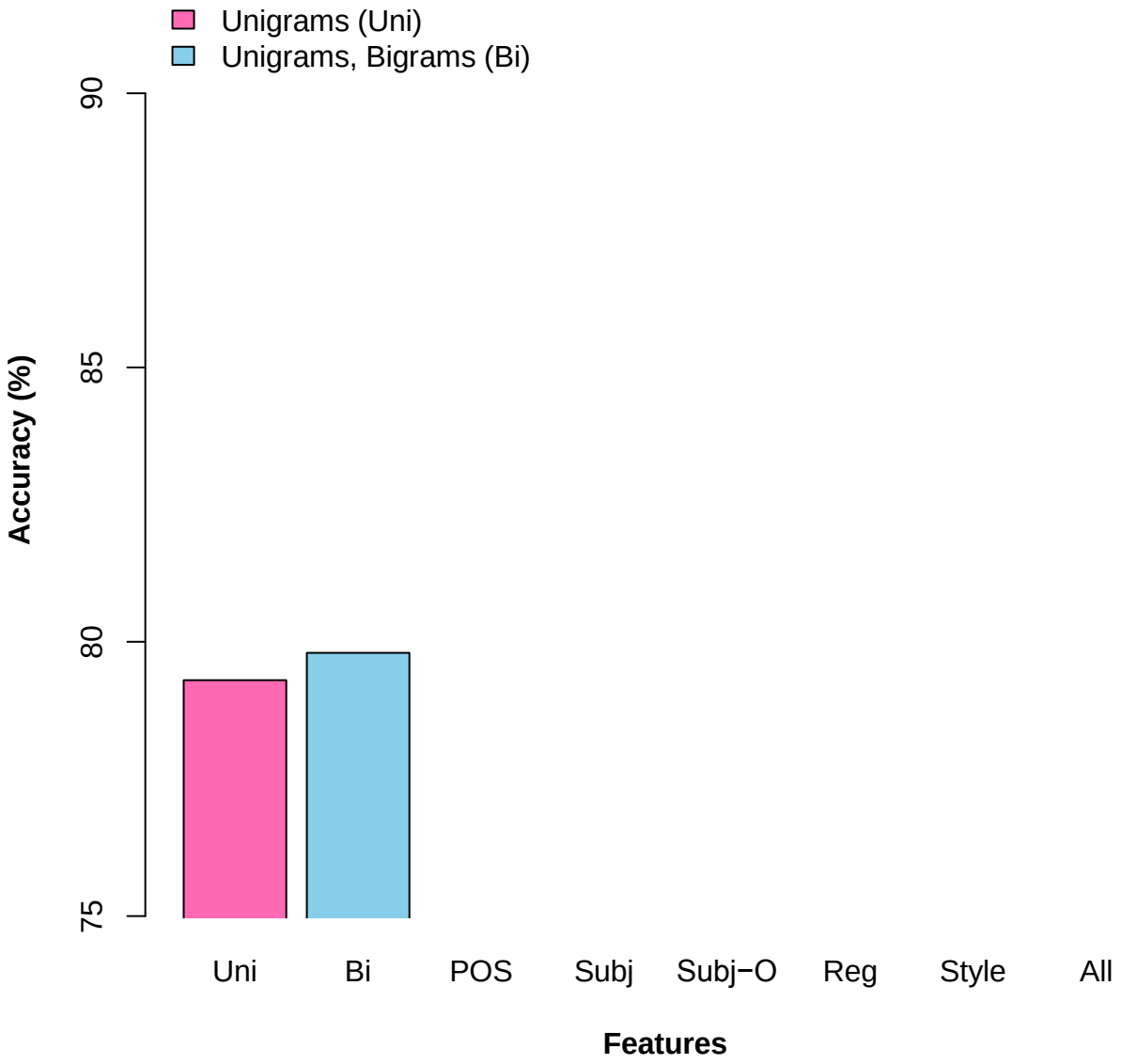
500 non-SA Tweets

All Events

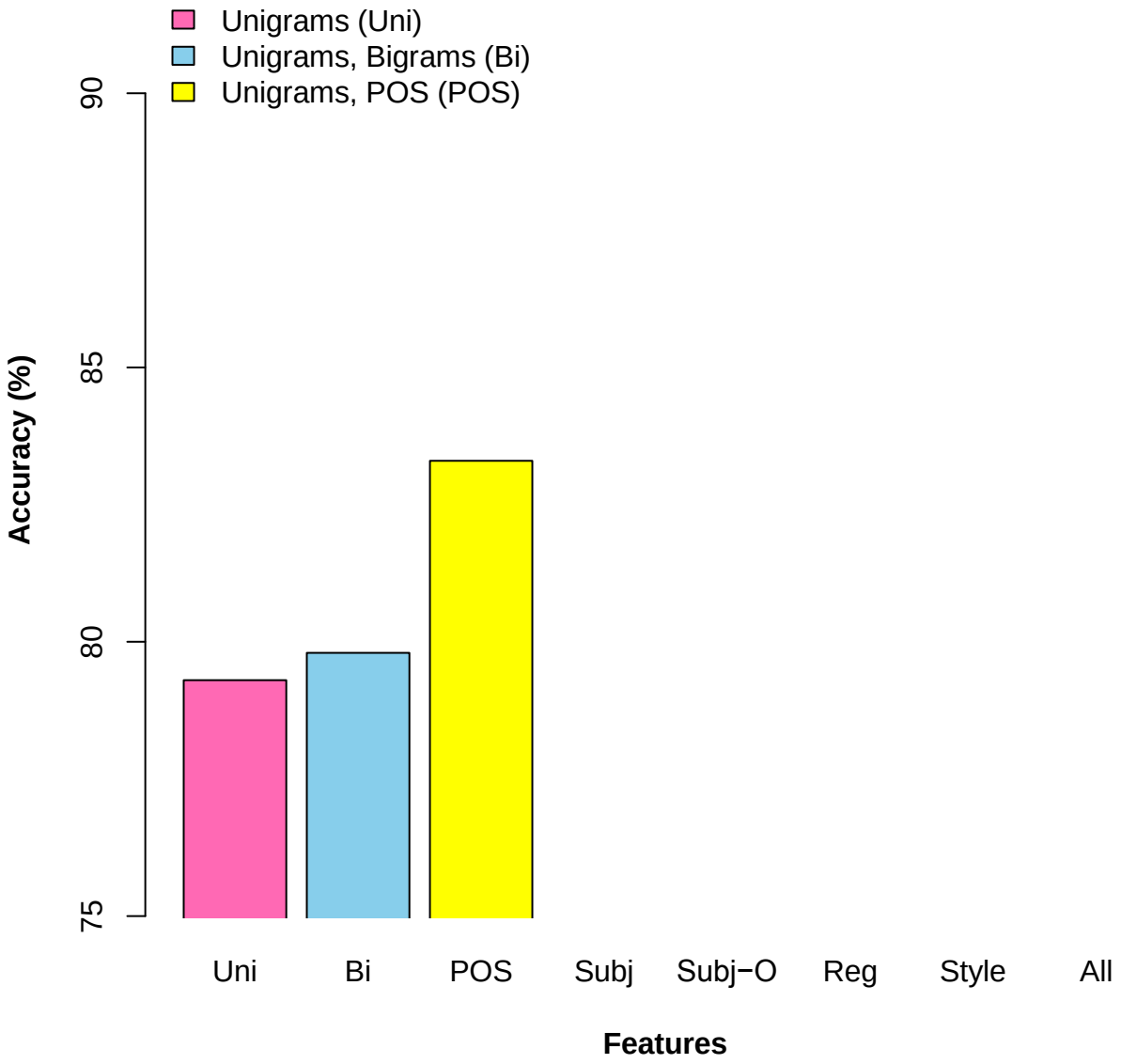
MaxEnt Results on Balanced Dataset



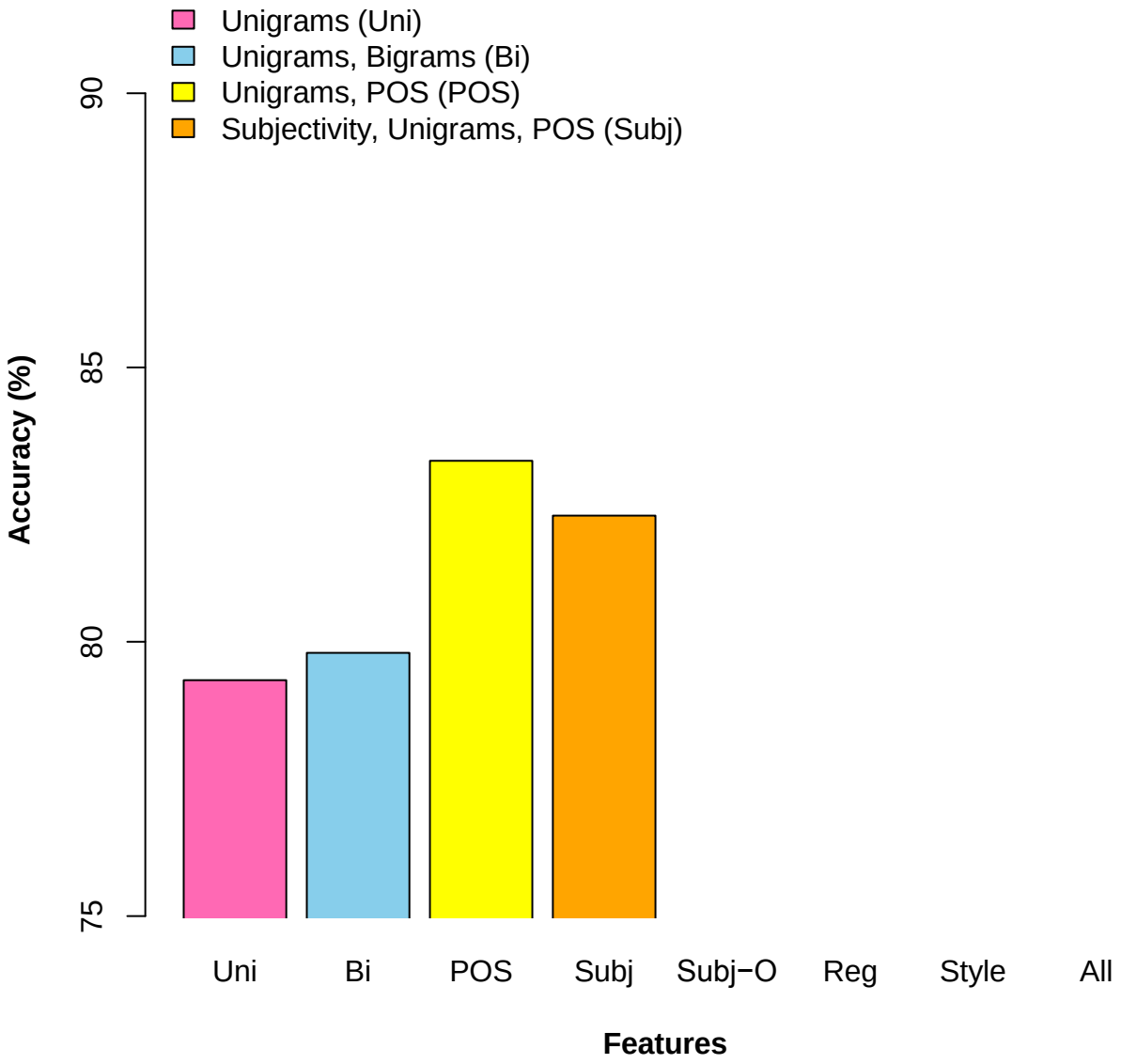
MaxEnt Results on Balanced Dataset



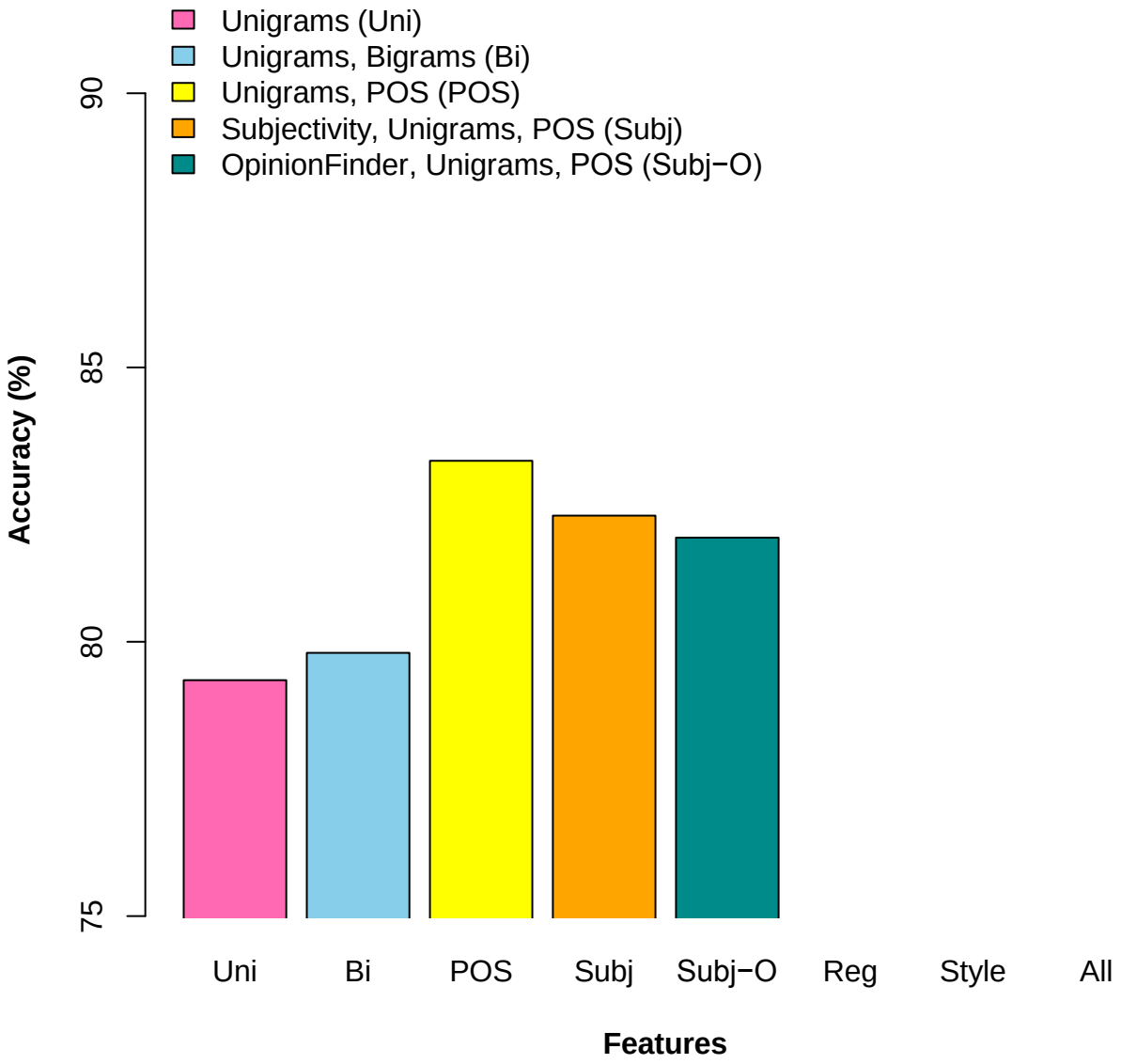
MaxEnt Results on Balanced Dataset



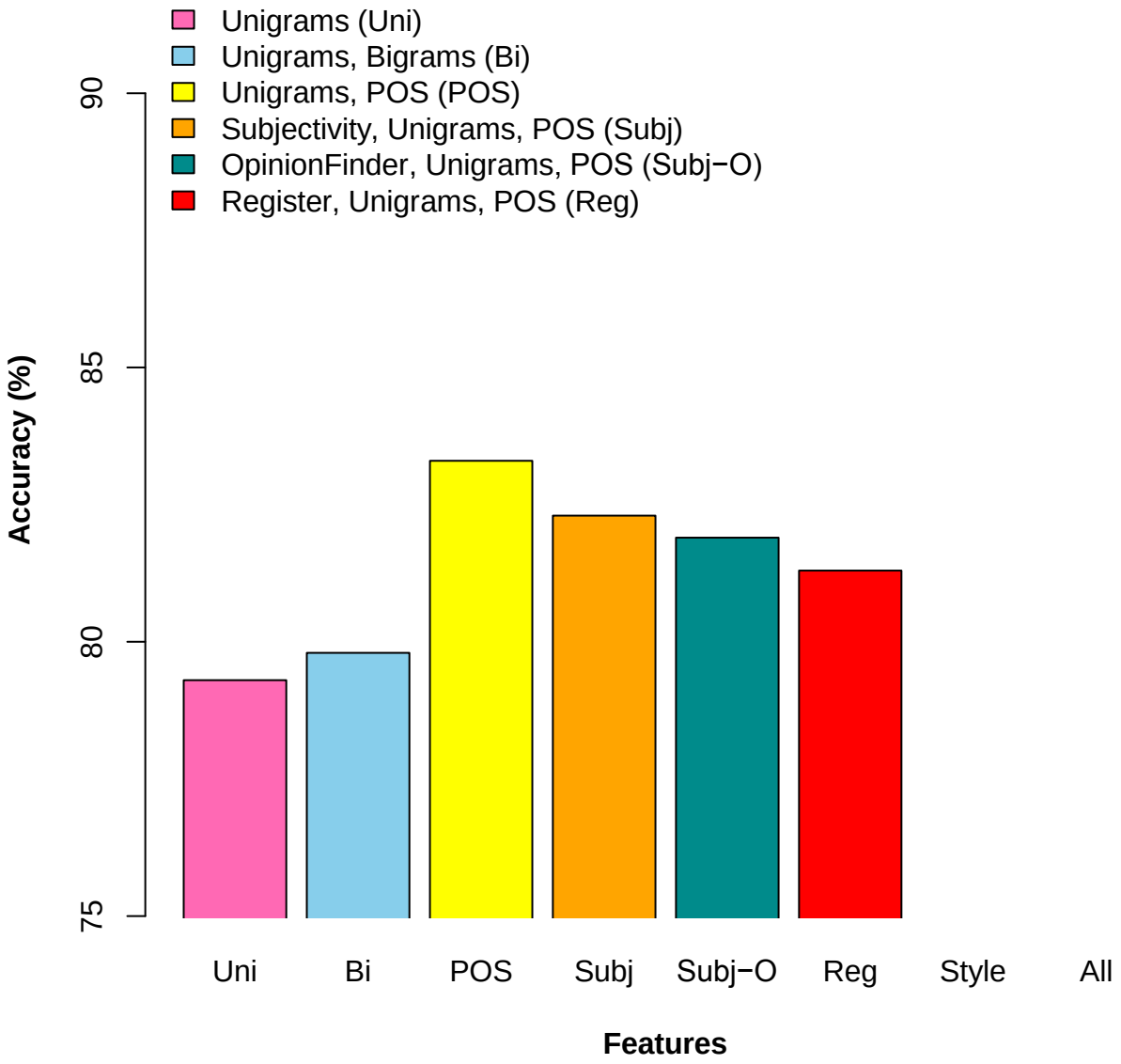
MaxEnt Results on Balanced Dataset



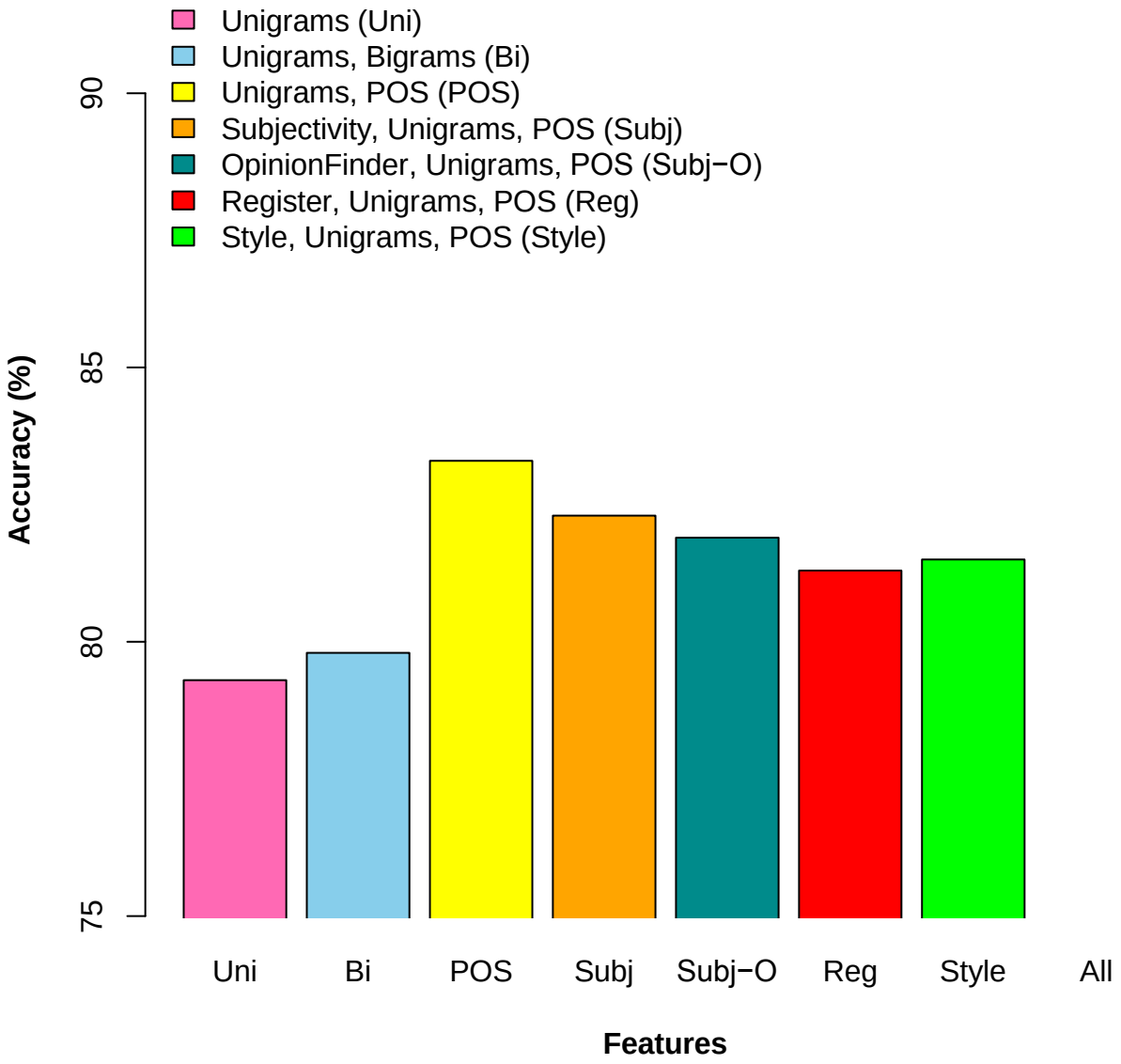
MaxEnt Results on Balanced Dataset



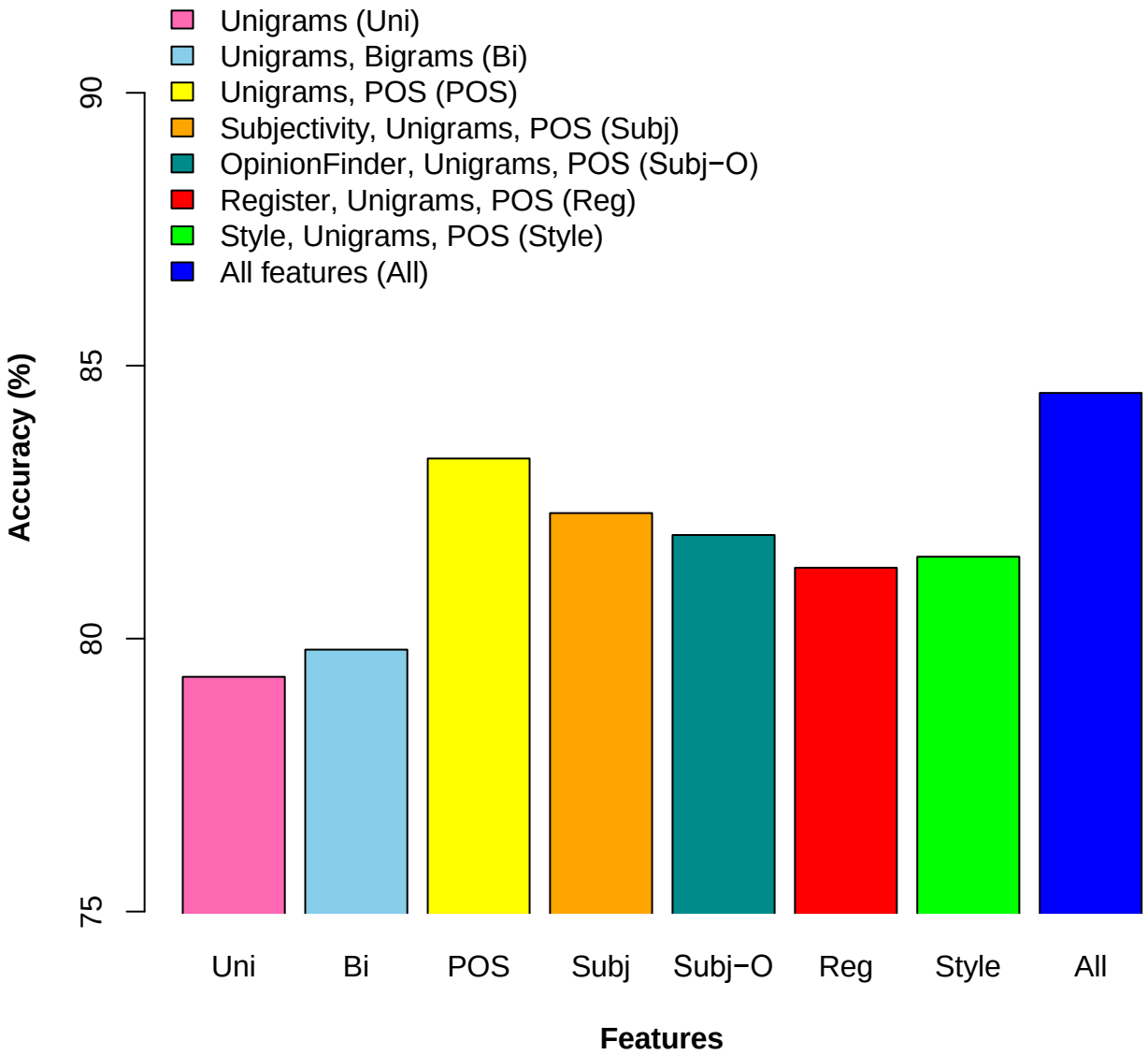
MaxEnt Results on Balanced Dataset



MaxEnt Results on Balanced Dataset



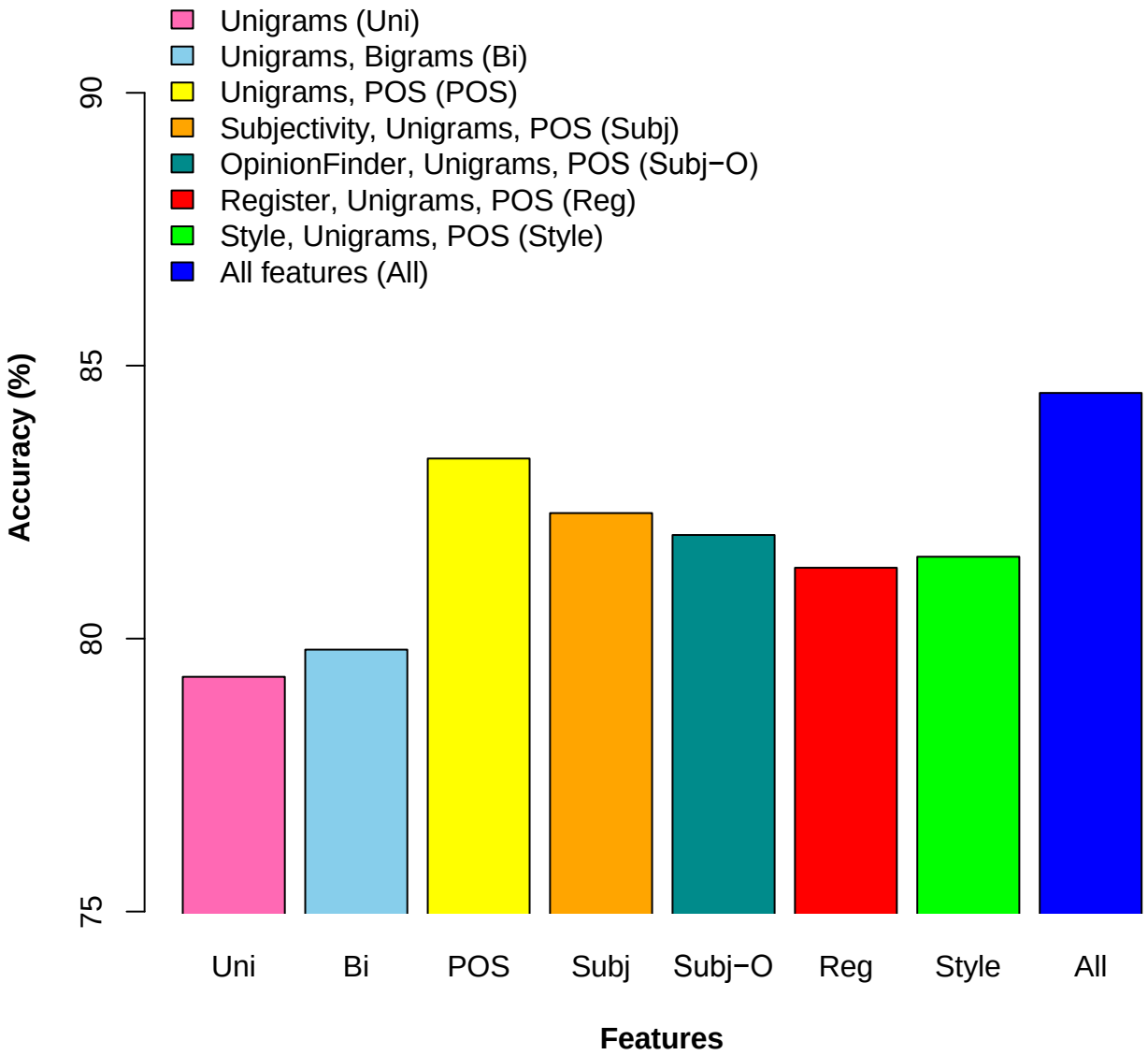
MaxEnt Results on Balanced Dataset



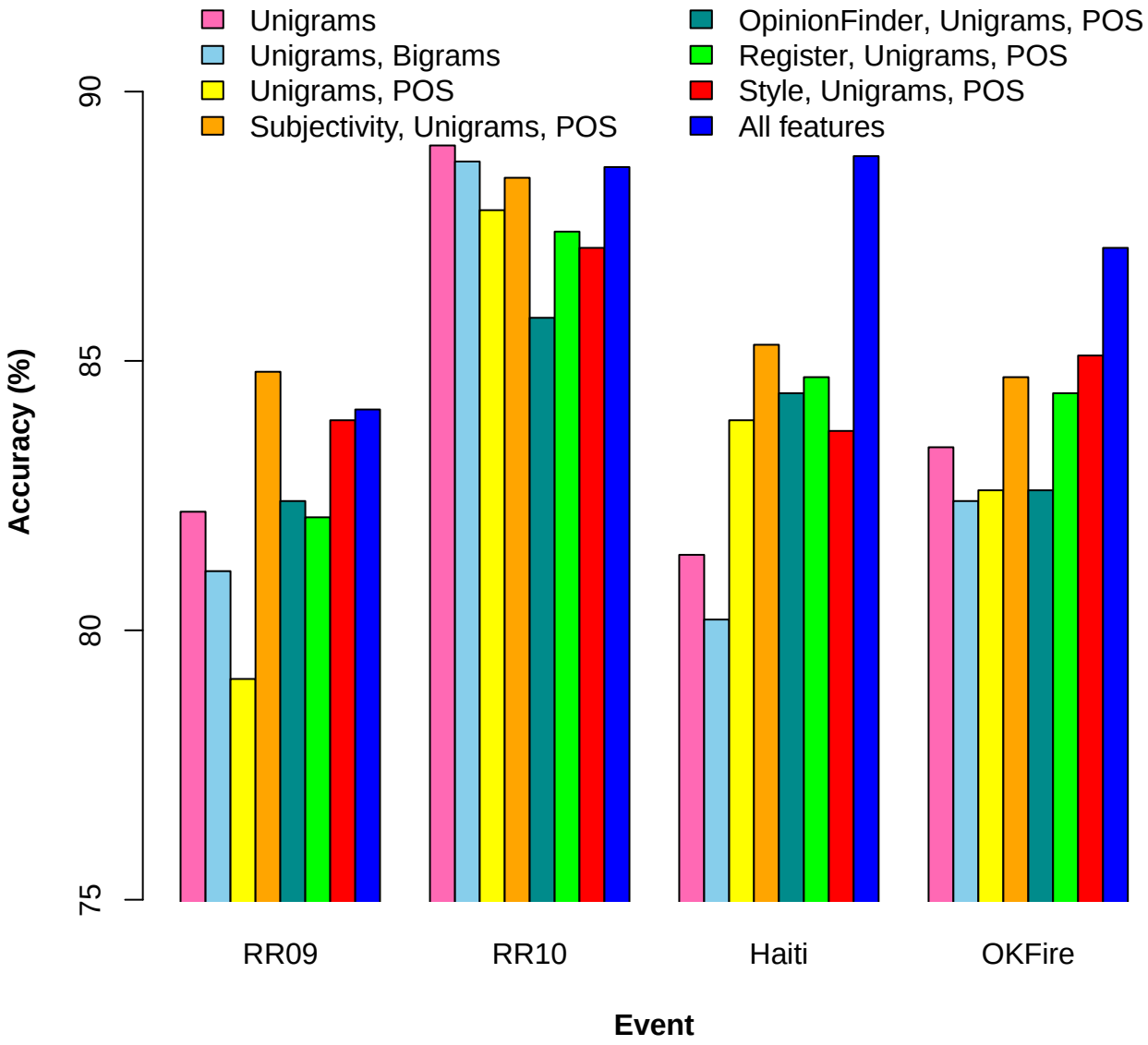
Classification Results

How well do the features perform across various events?

MaxEnt Results on Balanced Dataset



MaxEnt Results across all Events



Conclusions

Our results in classification of SA Tweets are promising

- SA tweets can be classified automatically with good accuracy
- Use of additional linguistic features help improve overall accuracy and reduce the error rate

Acknowledgements

- NSF Grants - IIS-0546315 and IIS-0910586
- http://epic.cs.colorado.edu

Photo Credits:

FEMA Photo Library, ESRI

EPIC

Empowering the Public with Information in Crisis

University of Colorado Boulder