# Sense-level Subjectivity Analysis

# What is Subjectivity?

The linguistic expression of somebody's opinions, sentiments, emotions, evaluations, beliefs, speculations ***(private states)***

**Private state:** state that is not open to objective observation or verification Quirk, Greenbaum, Leech, Svartvik (1985)

Note that this particular use of subjectivity is adapted from literary theory E.G. Banfield 1982, Fludernik 1993; Wiebe PhD Dissertation 1990.

# Examples of Subjective Expressions

- References to private states
  - She was enthusiastic about the plan
  - He was boiling with anger
- References to speech or writing events expressing private states
  - Leaders rounding condemned his verbal assault on Israel
- Expressive subjective elements
  - That would lead to disastrous consequences
  - What a freak show

# Subjectivity Analysis

- Automatic extraction of subjectivity from text or dialog (newspapers, blogs, conversations etc.)
- Classification of text as
  - Subjective/Objective
  - Positive/Negative/Neutral (Polarity)

# Subjectivity Analysis: Applications

- ***Product* review mining:** What features of the iPhone 5 do customers like and which do they dislike?
- **Opinion-oriented question answering:** How do the Chinese regard the human rights record of the United States?
- **Review classification:** Is a review positive or negative toward the movie?
- **Tracking sentiments toward topics over time:** Is anger ratcheting up or cooling down?
- **Etc.**

# Manually (human) Annotated News Data

## Wilson PhD Dissertation 2008

**I think people are happy because Chavez has fallen**

**direct subjective**
span: think
source: <writer, I>
attitude:

**attitude**
span: think
type: positive arguing
intensity: medium
target:

**target**
span: people are happy because Chavez has fallen

**direct subjective**
span: are happy
source: <writer, I, People>
attitude:

**attitude**
span: are happy
type: pos sentiment
intensity: medium
target:

**target**
span: Chavez has fallen

**inferred attitude**
span: are happy because Chavez has fallen
type: neg sentiment
intensity: medium
target:

**target**
span: Chavez



MPQA corpus: http://www.cs.pitt.edu/mpqa

# Focus

- Our focus is linguistic disambiguation; how should language be <u>interpreted</u>?
  - *Is it subjective in the first place? If so, is it positive or negative? What is it about? Etc.*
- *Subjective language is highly ambiguous*

# Outline

- Introduction
- Subjectivity Lexicons and Sense Ambiguity
- Subjectivity Sense Labeling
- Sense Aware Analysis
- Data Acquisition

# Subjectivity Lexicons

- Many approaches to subjectivity and sentiment analysis exploit subjectivity lexicons
  - Lists of keywords that have been gathered together because they have subjective uses

# Subjectivity Lexicons

| Lexicon |
| --- |
| … |
| cold − |
| pain − |
| headache − |
| … |
| … |

The concert left me cold.

That guy is such a pain.

Converting to SMF is a headache.

# Creating Subjectivity Lexicons

- Much work on recognizing subjectivity bearing words

E.g. Hatzivassiloglou & McKeown 1997; Wiebe 2000; Turney 2002; Kamps & Marx 2002; Wiebe, Riloff, Wilson 2003; Kim & Hovy 2005; Esuli & Sebastiani 2006; Williams & Anand 2009; Velikovich, Goldensohn, Hannan, McDonald 2010, Hassan & Radev 2010; Peng & Park 2011

# Our Lexicon

- In this talk, we use the subjectivity lexicon by Wilson et al., (2005)
  - A collection of over 8,000 single-word subjectivity clues
  - Entries from several sources (e.g. our own work, General Inquirer)
  - Entries are annotated with reliability class and prior polarity
  - Available at http://www.cs.pitt.edu/mpqa

# Our Lexicon

- Our lexicon covers 67.1% of the subjective expressions in the MPQA corpus
- The high coverage of the lexicon demonstrates its potential usefulness for subjectivity and sentiment analysis

# However There Is Significant Sense Ambiguity

| Lexicon |
| --- |
| … |
| cold |
| pain |
| headache |
| … |
| … |

Early symptoms of the disease include severe headaches, red eyes, fevers and cold chills, body pain, and vomiting.

# Subjectivity Sense Ambiguity

The concert left me cold. *"feeling or showing no enthusiasm"*

That guy is such a pain.

Converting to SMF is a headache.

Early symptoms of the disease include severe headaches, red eyes, fevers and cold chills, body pain, and vomiting.

*"having a low or inadequate temperature or feeling a sensation of coldness"*

# Subjectivity Sense Ambiguity

The concert left me cold.

That guy is such a pain. *"a bothersome annoying person"*

Converting to SMF is a headache.

Early symptoms of the disease include severe headaches, red eyes, fevers and cold chills, body pain, and vomiting.

*"a symptom of some physical hurt or disorder"*

# Subjectivity Sense Ambiguity

The concert left me cold.

That guy is such a pain.

Converting to SMF is a headache.

"something or someone that causes anxiety; a source of unhappiness"

Early symptoms of the disease include severe headaches, red eyes, fevers and cold chills, body pain, and vomiting.

*"pain in the head caused by dilation of cerebral arteries or muscle contractions or a reaction to drugs"*

# Evidence of Subjectivity Sense Ambiguity

- Gyamfi et al., (2009) gives evidence that subjectivity sense ambiguity is prevalent
  - Manually annotated 2875 senses of 882 lexicon clues
  - Only 1383 (48%) of the senses are subjective

# Outline

- Introduction
- Subjectivity Lexicons and Sense Ambiguity
- Subjectivity Sense Labeling
  - Annotation Schemes
  - Automatic Methods
- Sense Aware Analysis
- Data Acquisition

# Subjectivity Sense Labeling

- Is the task of assigning subjectivity labels to word senses in a dictionary

# Subjectivity Labels on Senses

S

Alarm, dismay, consternation – (fear resulting from the awareness of danger)

O

Alarm, warning device, alarm system – (a device that signals the occurrence of some undesirable event)

# Subjectivity Labels on Senses

S

Interest, involvement -- (a sense of concern with and curiosity about someone or something; "an interest in music")

O

Interest -- (a fixed charge for borrowing money; usually a percentage of the amount borrowed; "how much interest do you pay on your mortgage?")

# Our Annotation Schema

- Assigning subjectivity labels to dictionary senses
  - **S:** subjective
  - **O:** objective
  - **B:** both

# Annotators are given the synset and its hypernym

S

Alarm, dismay, consternation – (fear resulting from the awareness of danger)

- Fear, fearfulness, fright – (an emotion experiences in anticipation of some specific pain or danger (usually accompanied by a desire to flee or fight))

# Subjective Sense Definition

- When the sense is used in a text or conversation, we expect it to express subjectivity, **and** we **expect** the phrase/sentence containing it **to be subjective**.

# Objective Senses: Observation

- We **don't** necessarily expect phrases/sentences containing objective senses to be objective
  - **Would you actually be stupid enough to pay that rate of interest?**
  - **Will someone shut that darn alarm off?**

- Subjective, but **not** due to **interest or alarm**

# Objective Sense Definition

- When the sense is used in a text or conversation, we don't expect it to express subjectivity and, **if** the phrase/sentence containing it **is subjective**, the subjectivity is **due to something else**

# Senses that are Both

- Covers both subjective and objective usages
- Example:

  absorb, suck, imbibe, soak up, sop up, suck up, draw, take in, take up – (take in, also metaphorically; "The sponge absorbs water well"; "She drew strength from the Minister's Words")

# Annotation Study
## (Wiebe and Mihalcea 2006)

- 64 words; 354 senses
  - Balanced subset [32 words; 138 senses]; 2 judges
  - The ambiguous nouns of the SENSEVAL-3 English Lexical Task [20 words; 117 senses]
  - Others [12 words; 99 senses]; 1 judge

# Annotated Study

- 64 words; 354 senses
  - Balanced subset [32 words; 138 senses]; 2 judges
    - 16 words have both S and O senses
    - 16 words do not (8 only S and 8 only O)
    - All subsets balanced between nouns and verbs
    - Uncertain tags also permitted

# Inter-Annotator Agreement Results

- Overall:
  - Kappa=0.74
  - Percent Agreement=85.5%

# Inter-Annotator Agreement Results

- Overall:
  - Kappa=0.74
  - Percent Agreement=85.5%

- Without the 12.3% cases when a judge is U:
  - Kappa=0.90
  - Percent Agreement=95.0%

# Inter-Annotator Agreement Results

- Overall:
  - Kappa=0.74
  - Percent Agreement=85.5%

- 16 words with S and O senses: Kappa=0.75
- 16 words with only S or O: Kappa=0.73

Comparable difficulty

# Inter-Annotator Agreement Results

- 64 words; 354 senses
  - The ambiguous nouns of the SENSEVAL-3 English Lexical Task [20 words; 117 senses] 2 judges
    - U tags not permitted
    - Even so, Kappa=0.71

# Su and Markert, 2008

- The authors conduct subjectivity and polarity annotations
- Two stage

Subjectivity Annotations : Subjective, Objective, Both

Polarity Annotations : Positive Negative Varying  Positive Negative NoPolarity

# Su and Markert, 2008

- Agreement study on 496 synsets from WordNet
- Overall :
  - Kappa=0.77
  - Percent Agreement=84.9%

Only Subjectivity Annotations : Subjective, Objective, Both

Kappa=0.79
Agreement=90.1%

Only Polarity Annotations : Positive Negative Varying NoPolarity

Kappa=0.83
Agreement=89.1%

# Other definitions

- WordNet-Affect (Strapparava & Valitutti, 2004)
  - Affective labels (e.g. emotion, mood, sensation) on WordNet synsets
- SentiWordNet (Esuli & Sebastiani, 2006) and Micro-WNOp (Cerini, Compagnoni, Demontis, Formentelli, and Gandini, 2007)
  - Triplet of numerical scores on WordNet synsets representing the strength of positivity, negativity, and neutrality/objectivity
- Andreevskaia & Bergler, 2006
  - Fuzzy polarity categories on WordNet

# Automatic Methods

- SentiWordNet (Esuli & Sebastiani, 2006)
  - Semi-supervised approach
  - Assign polarity scores via bootstrapping from a small seed set making use of glosses and lexical relations in WordNet (e.g. synonym, antonym)
- Wiebe & Mihalcea, 2006
  - Unsupervised (wrt sense labels) corpus-based approach
  - Assign subjectivity labels to word senses based on a set of distributionally similar words found in MPQA
- WordNet-Affect (Strapparava & Valitutti, 2004)
  - Automatically expand a list of affective words via lexical relations in WordNet

# Automatic Methods

- Andreevskaia & Bergler, 2006
  - Automatically expand a seed set of positive and negative words via glosses and lexical relations in WordNet
- Gyamfi, Wiebe, Mihalcea, Akkaya, 2009
  - Supervised approach
  - Novel machine learning features defined on WordNet
- Su & Markert, 2009
  - Semi-supervised approach
  - Min-cut framework making use of WordNet glosses and its relation structure

# Senses

- Sense#1 : "There are many differences between African and Asian elephants." **O**
- Sense#2 : "… dividing by the absolute value of the difference from the mean…" **O**
- Sense#3 : "Their differences only grew as they spent more time together …" **S**
- Sense#4 : "Her support really made a difference in my life" **S**
- Sense#5 : "The difference after subtracting X from Y…" **O**

# Outline

- Introduction
- Subjectivity Lexicons and Sense Ambiguity
- Subjectivity Sense Labeling
- Sense Aware Analysis
  - Ambiguity in Text
  - Subjectivity Word Sense Disambiguation (SWSD)
  - Application to Subjectivity Analysis
- Data Acquisition

# Ambiguity in Text

- The ambiguity is also prevalent in text
- Subjectivity clues used with objective senses (False Hits) are a significant source of error in subjectivity and sentiment analysis

# Evidence of Ambiguity in Text

- Akkaya et al., (2009) shows that
  - at least 43% of the clue instances in MPQA corpus are used with objective senses

# A Possible Solution – Sense-aware Analysis

- To have lexicons listing word senses instead of simple keywords
- Exploit Word Sense Disambiguation (WSD) to avoid false hits
  - By determining which sense of a keyword is activated in context according to a sense inventory

# Contextual Subjectivity Analysis

"There are many differences between African and Asian elephants."

*Does the sentence contain subjectivity?*

*Is the expression containing a keyword subjective?*

*What is the polarity of the expression?*

"Their differences only grew as they spent more time together …"

# Contextual Subjectivity Analysis

S or O ?

Classifier

S or O ?

"There are many differences between African and Asian elephants."

*Is the expression containing a keyword subjective?*

"Their differences only grew as they spent more time together …"

# Contextual Subjectivity Analysis Using WSD

S or O ?

Classifier

S or O ?

"There are many differences between African and Asian elephants."

O Sense#1 : the quality of being unlike or dissimilar

S Sense#3 : a disagreement or argument about something important

Sense#1

↑

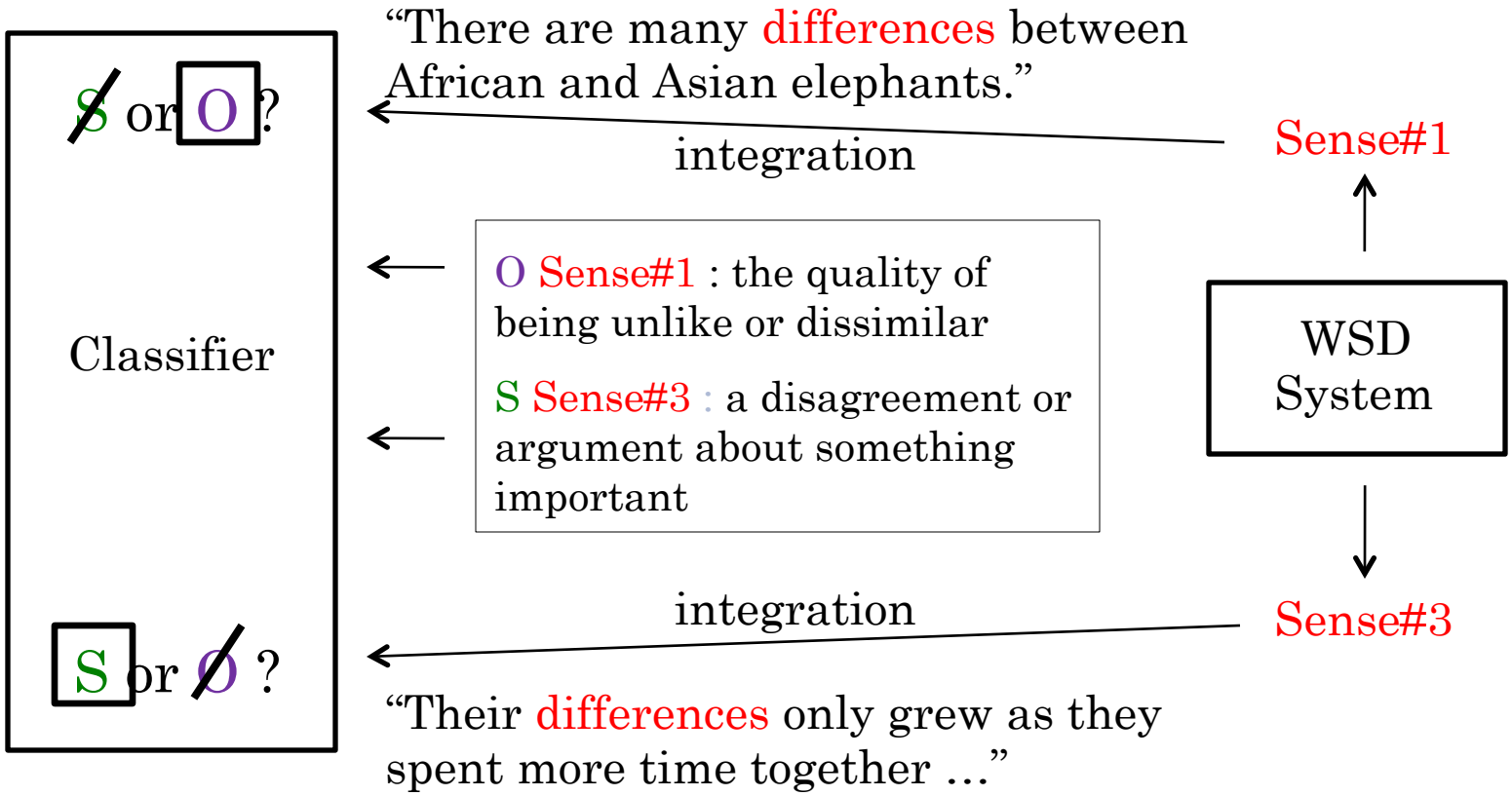
WSD System

↓

Sense#3

"Their differences only grew as they spent more time together …"

# Contextual Subjectivity Analysis Using WSD



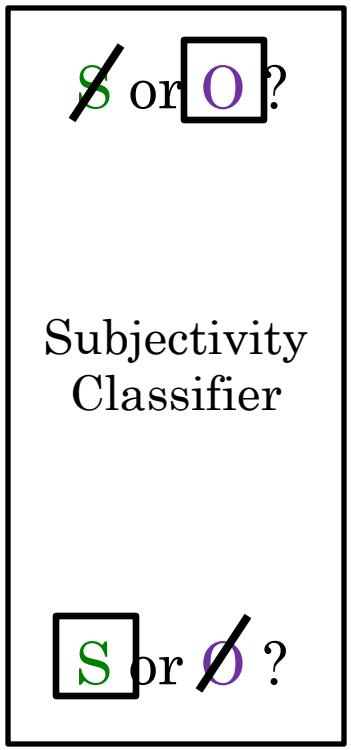
# Senses

- Sense#1 : "There are many differences between African and Asian elephants." **O**
- Sense#2 : "… dividing by the absolute value of the difference from the mean…" **O** ← **Is it one of these ?**
- Sense#3 : "Their differences only grew as they spent more time together …" **S**
- Sense#4 : "Her support really made a difference in my life" **S**
- Sense#5 : "The difference after subtracting X from Y…" **O**

# Senses

- Sense#1 : "There are many differences between African and Asian elephants." **O**
- Sense#2 : "… dividing by the absolute value of the difference from the mean…" **O**
- Sense#3 : "Their differences only grew as they spent more time together …" **S** ← **Or one of these ?**
- Sense#4 : "Her support really made a difference in my life" **S**
- Sense#5 : "The difference after subtracting X from Y…" **O**

# Contextual Subjectivity Analysis Using SWSD




"There are many differences between African and Asian elephants."

Sense O {#1, #2, #5}

Difference :
Sense#1 → O
Sense#2 → O
Sense#3 → S
Sense#4 → S
Sense#5 → O

SWSD System

Sense S {#3, #4}

"Their differences only grew as they spent more time together …"

# Subjectivity Word Sense Disambiguation (Akkaya, Wiebe, And Mihalcea 2009)

- Automatically determining if a word instance in context is used with a subjective sense or with an objective senses

"There are many differences between African and Asian elephants." Sense O

"Their differences only grew as they spent more time together …" Sense S

- Coarse-grained application-specific WSD

# Subjectivity Word Sense Disambiguation : Hypotheses

- SWSD is more feasible than conventional fine-grained WSD
  - In vivo evaluation
- SWSD can be exploited to improve the performance of contextual subjectivity analysis systems
  - In vitro evaluation

# Subjectivity Word Sense Disambiguation : Method

- Targeted approach – one classifier per word
- Supervised SVM classifiers

# Subjectivity Word Sense Disambiguation : Method

- Features borrowed from WSD research

CW: the target word itself
CP : POS of the target word
CF : surrounding context of 3 words and their POS
HNP : the head of the noun phrase to which the target word belongs
NB : the first noun before the target word
VB : the first verb before the target word
NA : the first noun after the target word
VB : the first verb before the target word
VA : the first verb after the target word
SK : at most 10 keywords occurring at least 5 times; determined for each sense

# Subjectivity Word Sense Disambiguation : Evaluation

- Training and Test data for SWSD consists of target word instances in a corpus labeled as S or O

**Sense-tagged corpus:**

Lexical sample corpora from SENSEVAL I,II, and III

as they spent more time together …
…

- We annotated SENSEVAL words that are in our lexicon
- Annotation Schema from Wiebe & Mihalcea 2006

- This gives us a S/O-tagged corpus for 39 keywords (senSWSD Corpus)

# Subjectivity Word Sense Disambiguation : Evaluation

| | Base | Acc. | ER% |
|---|---|---|---|
| All | 79.9 | 88.3 | 41.8 |
| S1 | 57.9 | 80.7 | 54.2 |
| S2 | 81.1 | 87.3 | 32.8 |
| S3 | 95 | 96.4 | 28 |

S1 (10 words) : [50%,70%)
S2 (18 words) : [70%,90%)
S3 (11 words) : [90%,100%)

SWSD is a feasible variant of WSD

The overall accuracy of WSD on the same set of words is 67.2

The overall accuracy of WSD on the same set of words is natural (18.9% error reduction)

# Application to Opinion Analysis

- We apply SWSD to two contextual classifiers
  - Contextual S/O Classifier
  - Contextual Polarity Classifier
- The SWSD system trained on the senSWSD
  - 39 target words
  - 723 instances in the MPQA Corpus.
- We call this subset of the MPQA Corpus senMPQA

# Contextual S/O Classifier

S or O ?

Contextual S/O Classifier

S or O ?

"There are many differences between African and Asian elephants."

*Is the expression containing a keyword subjective?*

"Their differences only grew as they spent more time together …"

# Contextual Polarity Classifier

Neg, Pos, Neutral?

Contextual Polarity Classifier

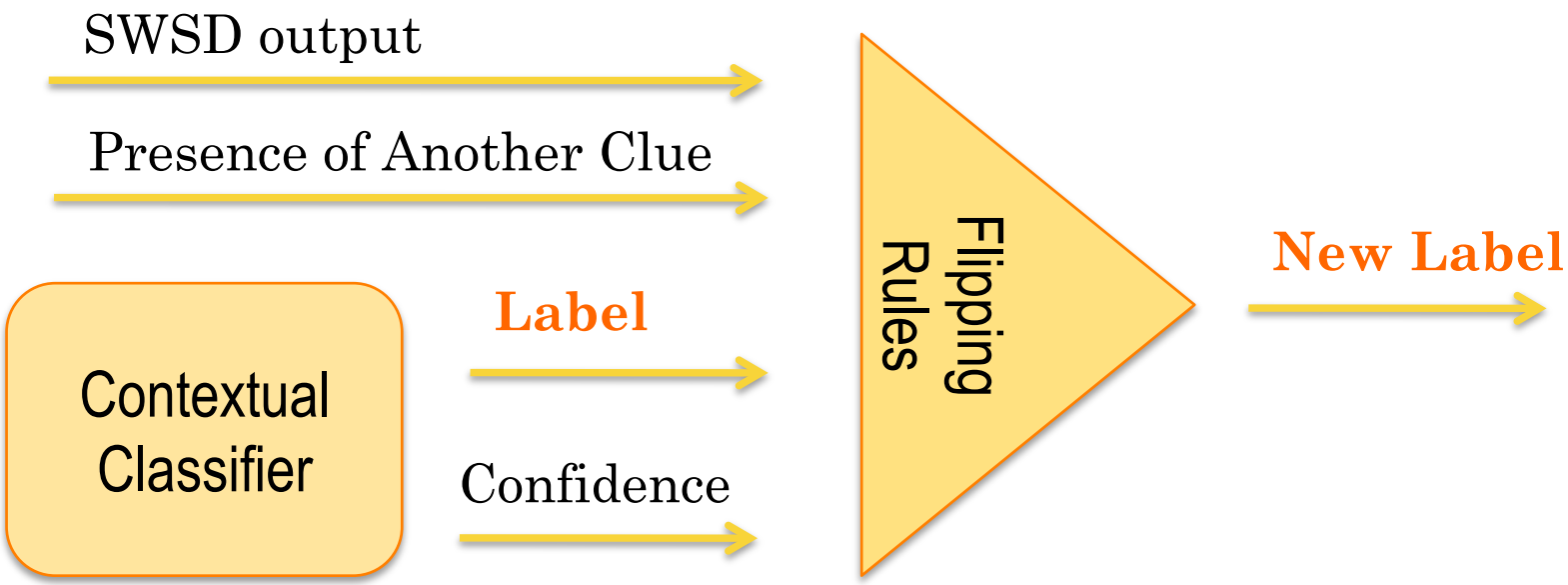
Neg, Pos, Neutral?

"There are many differences between African and Asian elephants."

*What is the polarity of the expression?*

"Their differences only grew as they spent more time together …"

# Rule Based Integration



# Contextual S/O Classifier Evaluation

| | Acc | Objective F-measure | Subjective F-measure |
|---|---|---|---|
| Orig | 75.4 | 65.4 | 80.9 |
| Orig+SWSD | 81.3 | 75.9 | 84.8 |

5.9 point improvement (24% error reduction)
significant at $p < 0.01$

# Contextual Polarity Classifier Evaluation

| | | Neutral | | Positive | | Negative | |
|---|---|---|---|---|---|---|---|
| | Accuracy | Prec. | Recall | Prec. | Recall | Prec. | Recall |
| $O_{rig}$ | 77.6 | 80.9 | 94.6 | 60.4 | 29.4 | 52.2 | 32.4 |
| Orig+SWSD | 80.6 | 81.2 | 98.7 | 82.1 | 29.4 | 68.6 | 32.4 |

3 points improvement (13.4% error reduction)
significant at $p < 0.01$

# Application to Opinion Analysis

- SWSD captures the appropriate semantic granularity specific to subjectivity analysis
- Both contextual subjectivity and sentiment analysis  benefits from SWSD

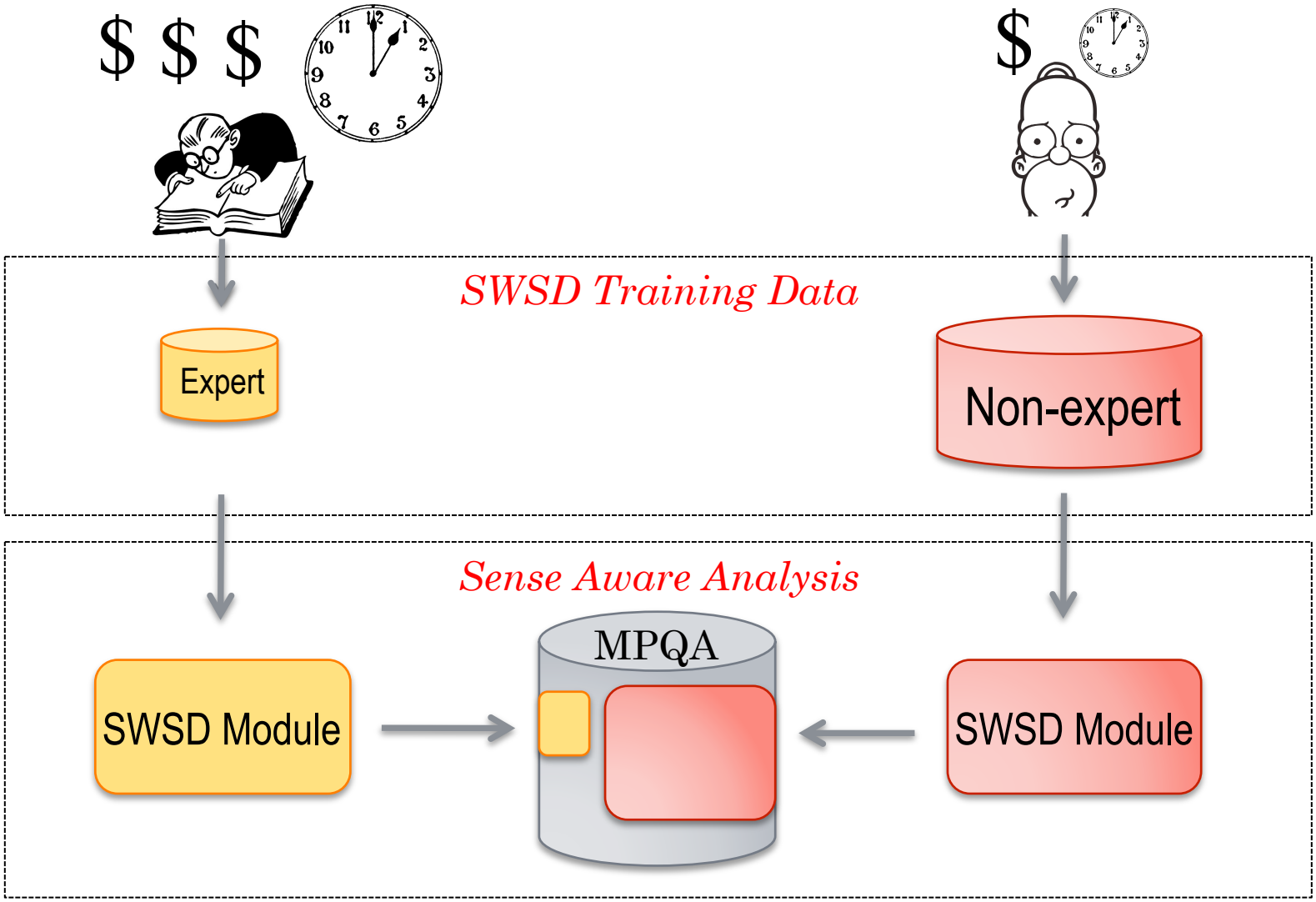
# Outline

- Introduction
- Subjectivity Lexicons and Sense Ambiguity
- Subjectivity Sense Labeling
- Sense Aware Analysis
- Data Acquisition
  - Non-Expert Annotations
  - Token-based Context Discrimination

# SWSD on Non-Expert Annotations
(Akkaya, Wiebe, Conrad and Mihalcea 2010)
(Akkaya, Wiebe, Conrad and Mihalcea 2011)

- We utilize Amazon Mechanical Turk (MTurk) to acquire training data for SWSD

# More Words – Better Coverage



# Annotation Task

- Determining if a target word instance is being used with a subjective sense or an objective sense in text

"There are many differences between African and Asian elephants." — Sense O

"Their differences only grew as they spent more time together …" — Sense S

# Annotation Task

- Keep the annotation task as simple as possible
  - We do not directly ask them if the target instance has a subjective or an objective sense
  - We cast the underlying annotation task as some sort of word sense annotation task

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All HITs | HITs Available To You | HITs Assigned To You

Search for HITs containing that pay at least $ 0.00 for which you are qualified GO

Timer: 00:00:00 of 7 minutes

Want to work on this HIT? Accept HIT

Want to see other HITs? Skip HIT

Total Earned: $4.77
Total HITs Submitted: 93

Tag a word in a sentence with the appropriate dictionary sense.

**Requester:** ISP Research **Reward:** $0.07 per HIT **HITs Available:** 0 **Duration:** 7 minutes

**Qualifications Required:** HIT approval rate (%) is greater than 96, Location is US, Total approved HITs is greater than 50

## Disambiguate the sense of the verb "appear"

Words often have multiple meanings, or senses. For example, the word "bat" can refer to either a small flying mammal or a wooden stick used in the game of baseball. In this task, you are given two lists of senses for a specific target word and several sentences in which the target word appears. Your job is to select the set of senses that best reflects the meaning of the target word in each sentence. The following link demonstrates how to correctly solve this type of problem.

Guidelines:

- Before reading the text passages, take a look at the list of dictionary senses. Each sense entry has the following format : {possible synonyms} -- sense definition; "example usages"
- There are four text passages. The target word will appear with vertical bars on either side, as in |target_word|.
- Use surrounding context to determine the meaning of the target word, and select the sense set that either contains that meaning or contains the most similar meanings.

Sense Inventory for the verb "appear":

Sense_Set-1

- { look, appear, seem } -- give a certain impression or have a certain outward aspect; "She seems to be sleeping"; "This appears to be a very difficult problem"; "This project looks fishy"; "They appeared like people who had not eaten or slept for a long time"
- { appear, seem } -- seem to be true, probable, or apparent; "It seems that he is very gifted"; "It appears that the weather in California is very bad"

Sense_Set-2

- { appear } -- come into sight or view; "He suddenly appeared at the wedding"; "A new star appeared on the horizon"
- { appear, come_out } -- be issued or published, as of news in a paper, a book, or a movie; "Did your latest book appear yet?"; "The new Woody Allen film hasn't come out yet"
- { appear, come_along } -- come into being or existence, or appear on the scene; "Then the computer came along and changed our lives"; "Homo sapiens appeared millions of years ago"
- { appear } -- appear as a character on stage or appear in a play, etc.; "Gielgud appears briefly in this movie"; "She appeared in `Hamlet' on the London stage"
- { appear } -- present oneself formally, as before a (judicial) authority; "He had to appear in court last month"; "She appeared on several charges of theft"

This is a time of abundance when bird , beast and insect gather to share the cornucopia . Hedgehogs |target| appear |target| as twilight deepens and robins become pugnaciously territorial . Young martins and swallows form chattering groups on eaves and telephone wires .

- Sense_Set-1
- Sense_Set-2

And He will stretch forth His arms to us , and we shall fall down before Him ad weep , and we shall understand all things . So the swine swine in God 's eyes too will |target| appear |target| on judgment Day immortal souls capable of penitence and knowledge . This tirade , carried on vodka - laden breath , is a classic instance of Dostoevsky 's apocalyptic naturalism working on two levels at once .

- Sense_Set-1
- Sense_Set-2

Being gripped by a narrative is an altogether wider notion than what is presaged by the two - in - one of being outside yet inside Raskolnikov 's strange smile : the rehearsal of the murder , the murder sequence itself , the three long duels with the detective Porfiry , the suffering , the hesitation , the final climb up the police - station stairs . Dostoevsky 's own attempt to suggest how he disposes his reader in relation to these events goes as follows : Narration by the author , a sort of invisible but omniscient being who nevertheless does n't leave him meaning his hero ' for a moment So , after |target| appearing |target| to settle for third - person narrative , he doubles back on himself and leaves us to make what we can of an omniscient author who is bound hand and foot to a far from omniscient protagonist . That he succeeds in having it both ways is our experience of reading his novel in its dominant and thriller aspect .

- Sense_Set-1
- Sense_Set-2

It does n't follow that the cap\/name link disappears but that it becomes so to say transpersonalized . Kartuz itself is pinned to a Captain Kartuzov who |target| appears |target| just once in The Possessed , and then only by name . We learn not a thing about him .

- Sense_Set-1
- Sense_Set-2

# Study -- Annotation Quality

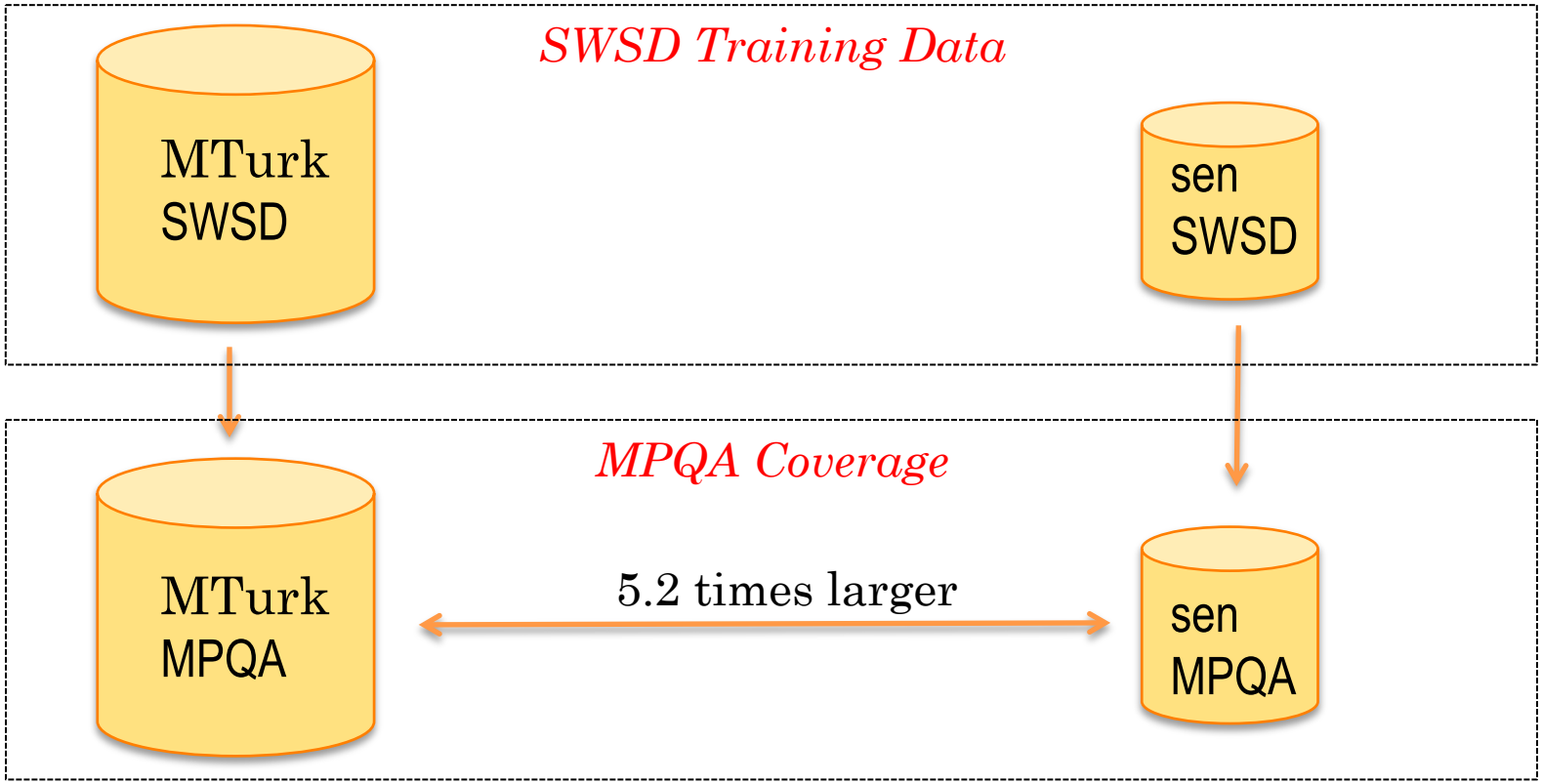
- We collect non-expert annotations for 8 random words available in senSWSD
  - 88.4% agreement with the gold standard (baseline agreement 62.2%)
  - The average kappa score of workers is .77

# Study -- Annotation Quality

- Two SWSD systems
  - the one trained on expert annotations
  - The other one on non-expert annotations
- We test them both on the same gold-standard data (expert)
  - Expert system: 79.2% accuracy
  - Non-expert system: 78.8% accuracy

# Sense-aware Analysis on Non-expert Annotations

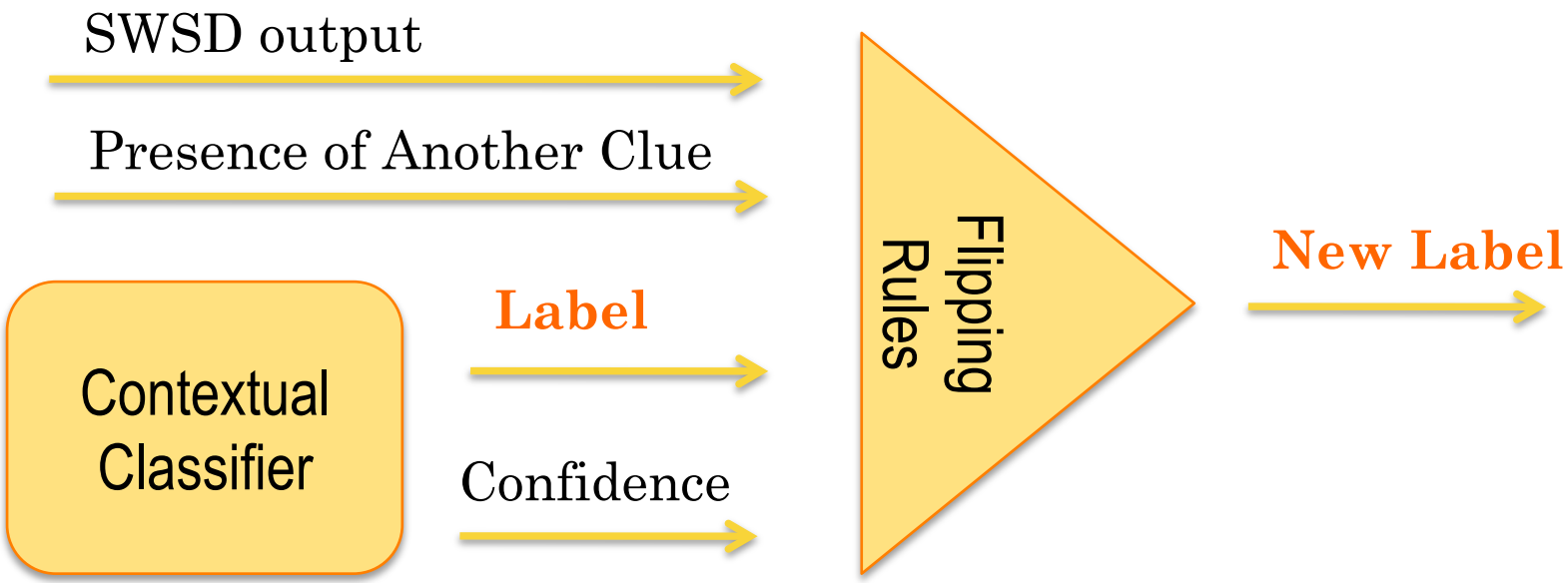
- We collect non-expert annotations for 90 words different from the ones in senSWSD
  - MTurkSWSD



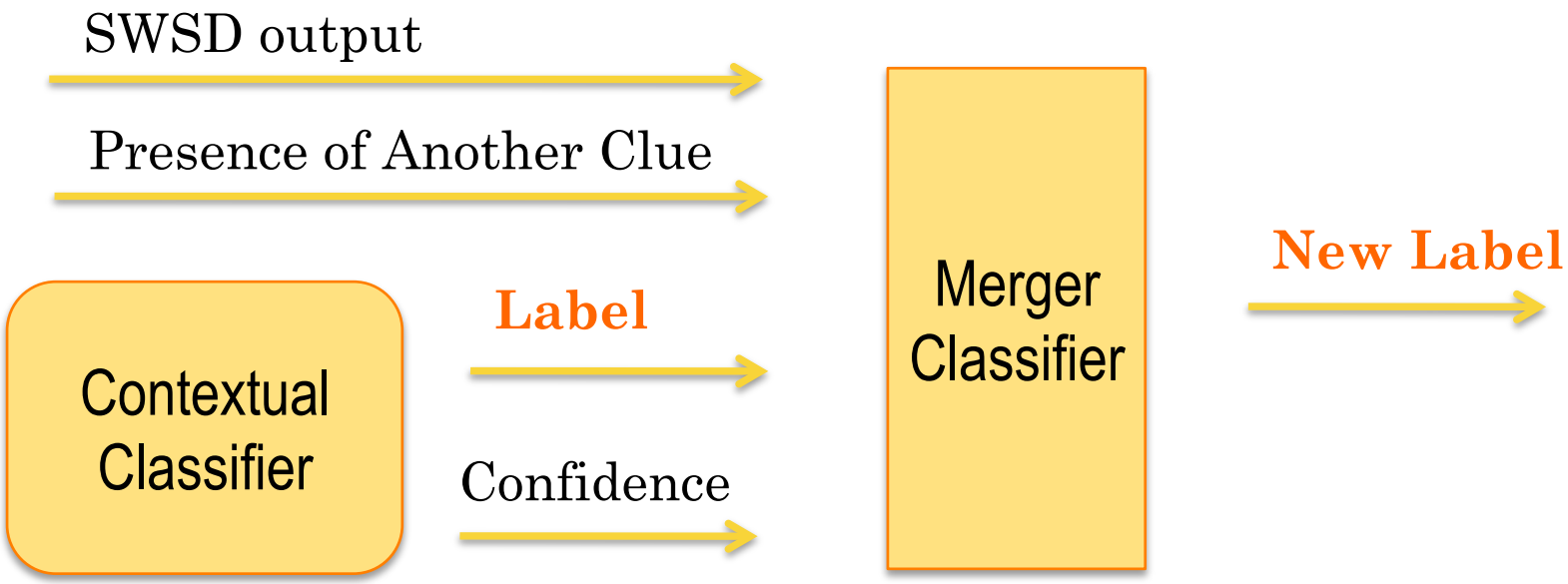
# Learning-based Integration

- More Training data allows us to experiment with learning based integration

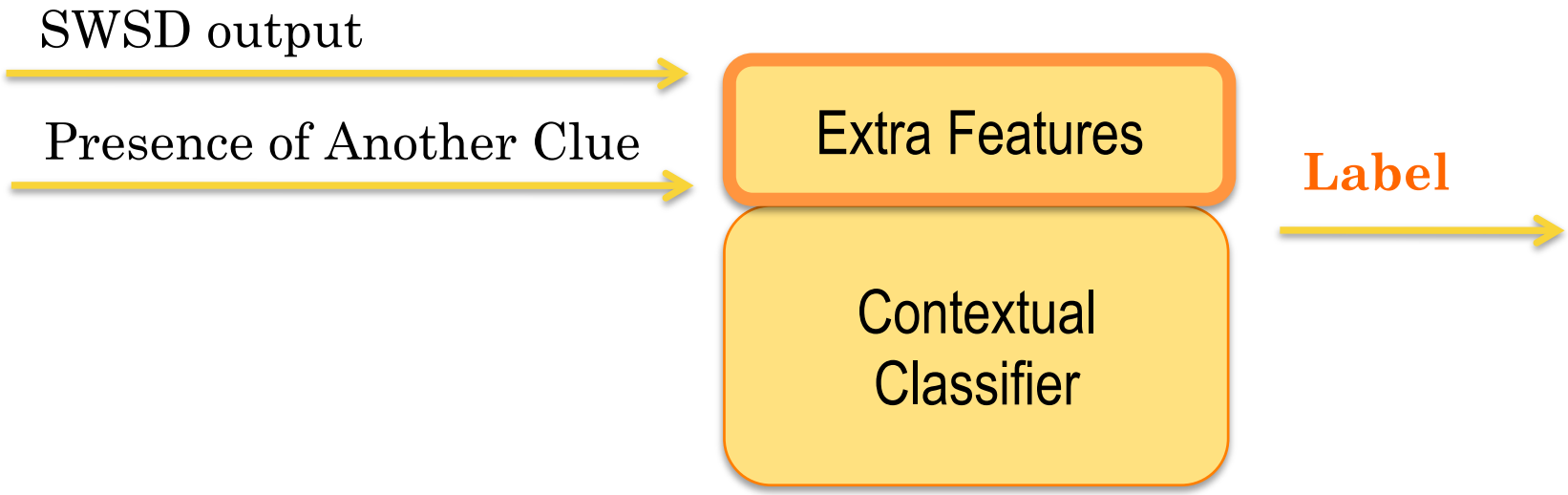
# Rule-Based Integration



# Learning-based Integration (Merger)



# Learning-based Integration (Extra)



# Contextual S/O Classifier

S or O ?

Contextual S/O Classifier

S or O ?

"There are many differences between African and Asian elephants."

*Is the expression containing a keyword subjective?*

"Their differences only grew as they spent more time together …"

# Contextual Polarity Classifier

Neg, Pos, Neutral?

Contextual Polarity Classifier

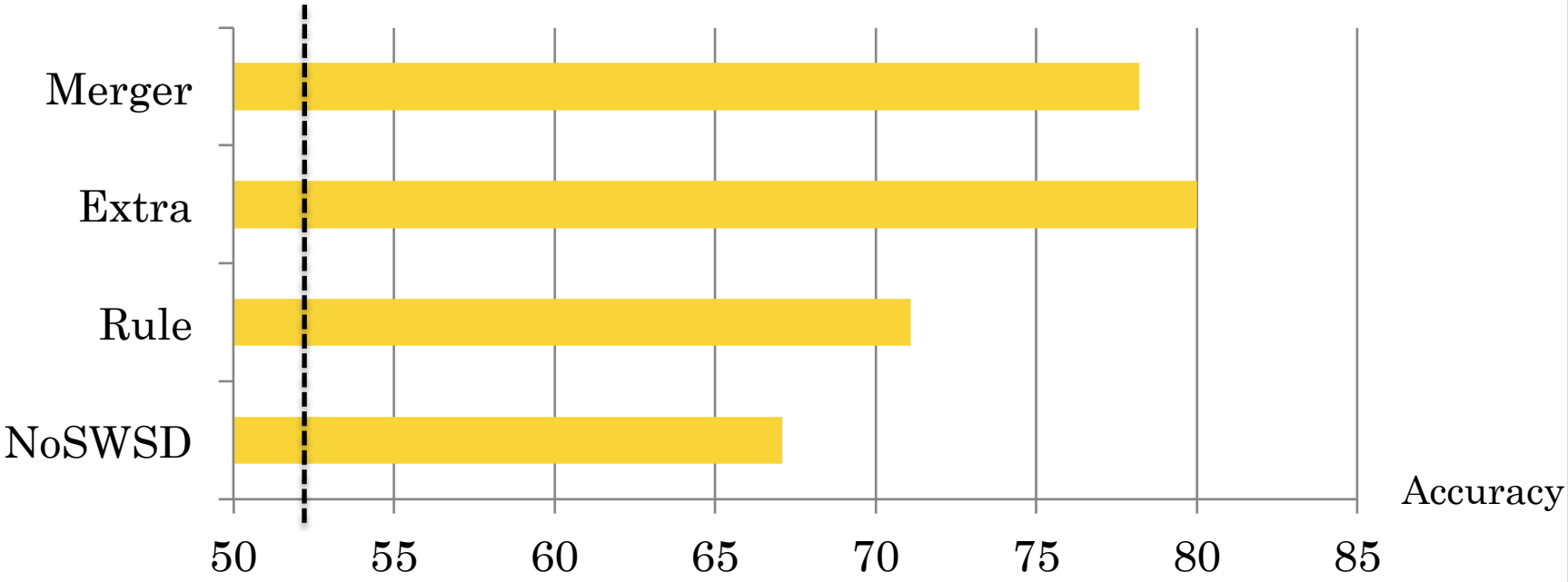
Neg, Pos, Neutral?

"There are many differences between African and Asian elephants."

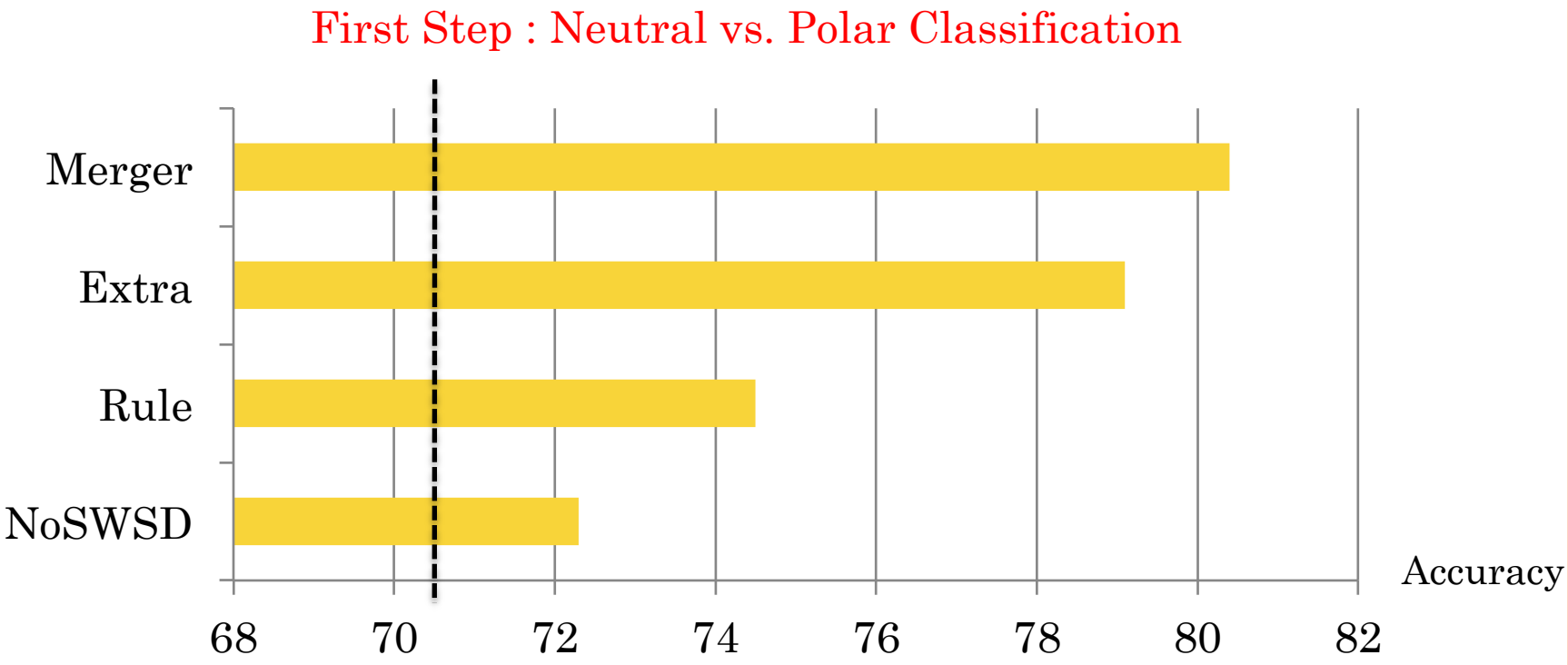
*What is the polarity of the expression?*

"Their differences only grew as they spent more time together …"

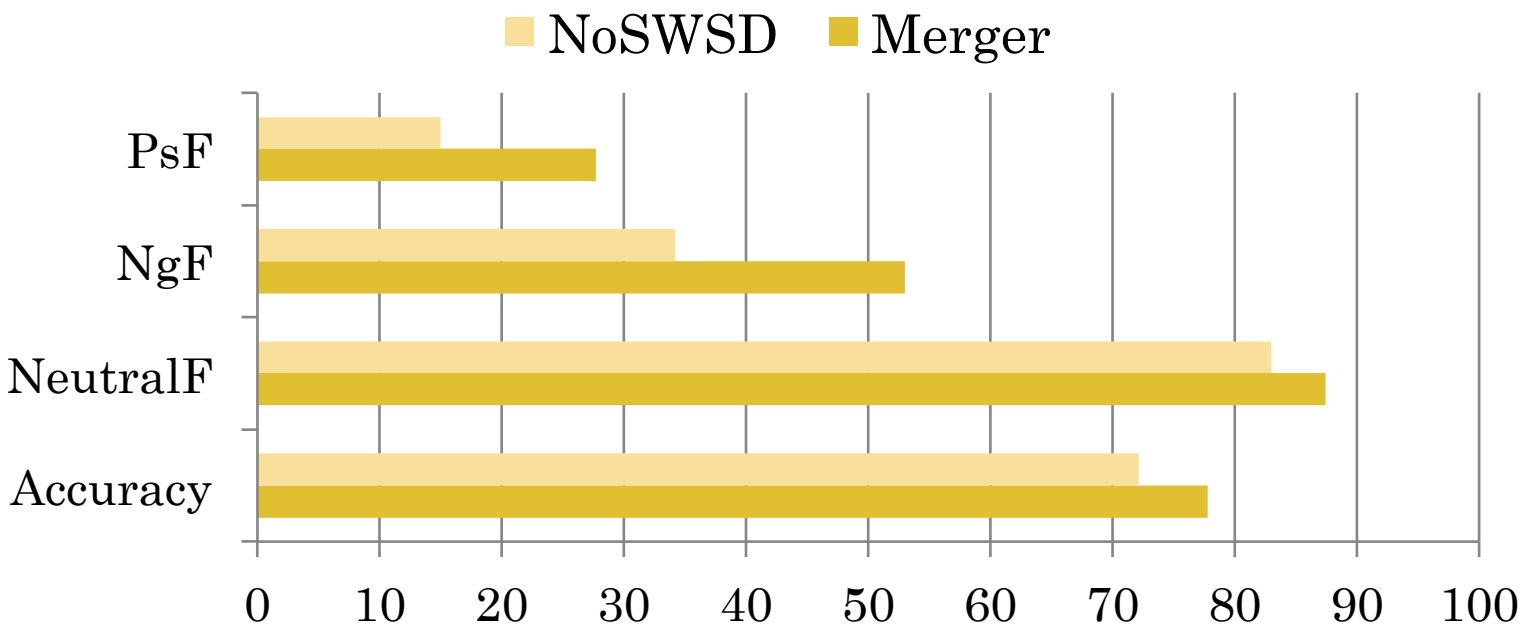
# Impact On Contextual S/O Classifier



# Impact On Contextual Polarity Classifier



# Impact On Contextual Polarity Classifier



# Sense-aware Analysis on Non-expert Annotations

SWSD relying on non-expert annotations improves contextual opinion analysis including sentiment classification

The improvement through SWSD holds on a larger scale, made possible by use of inexpensive and fast non-expert annotations

Learning-based strategies achieve greater benefits from SWSD than rule-based strategies

# Semi-automatic Data Acquisition

- Reduce the human annotation effort required to build a reliable SWSD system

Token based context discrimination (Schutze, 1998)

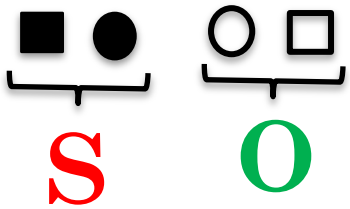
# Token-based Context Discrimination

- Clustering contexts in which a given target word occurs
  - Each cluster optimally contains target word instances used in the same sense

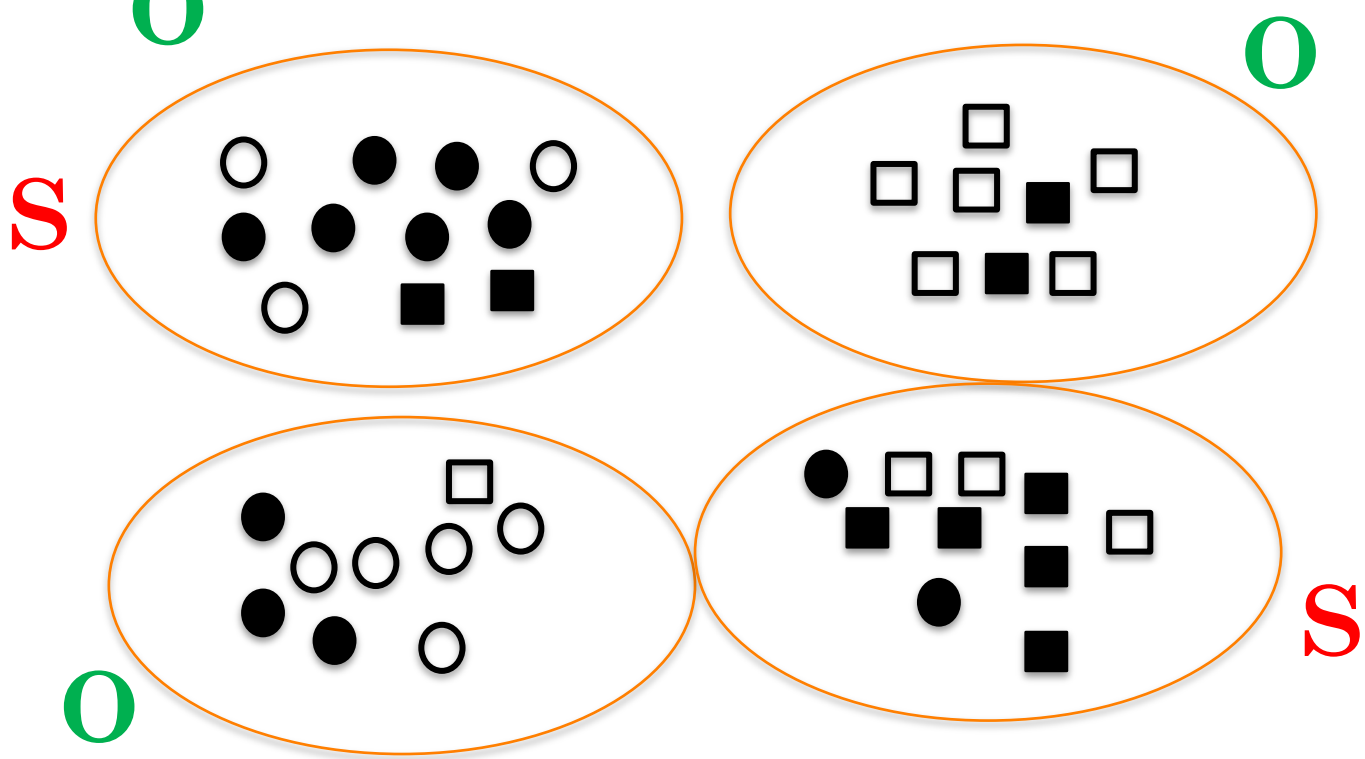
# Token-based Context Discrimination : Distributional Semantic Model

- Akkaya et al. 2012: DSM extensions to include arbitrary dependency relations; applications to WS disambiguation and discrimination
- Now: working to extend the representation to capture subjectivity information

# Reducing Annotation Effort




Label clusters instead of single instances



# Constrained Clustering

- A semi-supervised clustering algorithm
  - Supervision is provided in terms of cannot and must links
  - For our task: from the annotations performed so far
- The constraints act as a guide for the clustering algorithm

# Conclusions

- Many approaches to subjectivity and sentiment analysis exploit subjectivity lexicons
- However, there is significant sense ambiguity, both in the lexicon and in context
- Subjectivity sense labeling assigns S/O labels to senses
- Enables SWSD
  - SWSD captures an appropriate semantic granularity specific to subjectivity analysis
  - Both contextual subjectivity and sentiment analysis benefits from SWSD

# Conclusions

- Larger scale via non-expert annotations
  - SWSD relying on non-expert annotations improves contextual opinion analysis including sentiment classification
  - The improvement through SWSD holds on a larger scale, made possible by use of inexpensive and fast non-expert annotations
  - Learning-based strategies achieve greater benefits from SWSD than rule-based strategies
- Efforts continue toward broad coverage via semi-supervised clustering
  - Once viability established, once again use Mturk workers
  - Annotations need not be tied to a fixed sense inventory: "usage" versus "sense" inventories

# Other Current Projects in Subjectivity

- Recognizing and tracking arguments at the paragraph level; matching text fragments to stance structures
- Attitude inferences (connotations + subjectivity + implicatures)