# Semantic annotation of unstructured and ungrammatical text

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# Ungrammatical & Unstructured Text

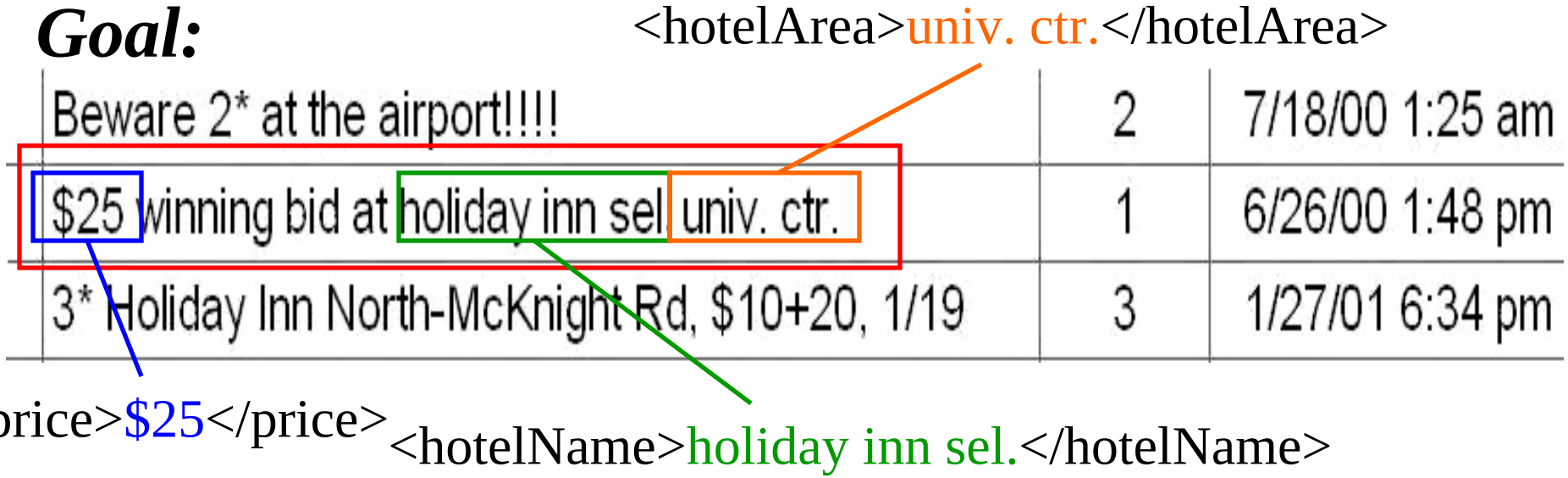
Page **1** 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

| | Topic | Replies | Last Comment | Started E |
|---|---|---|---|---|
| | SACRAMENTO HOTEL LIST | 0 | 11/21/04 9:56 pm | westcoastma |
| | 3* Rancho Cordova Holiday Inn $35, 1 nite (12/11) | 1 | 12/9/04 12:37 am | future canadi |
| | 3* Doubletree Sacto Arden 12/11 1 Night $34 | 1 | 12/7/04 4:46 pm | OCTraveler |
| | 4* Sacramento Failed Bid $85 12/7 | 1 | 12/6/04 6:29 pm | Sheryl |
| | Failed bid Sacramento Downtown 12/6 for 1 night, 4* | 13 | 12/6/04 6:25 pm | emaij |
| | 2.5* Wingate Inn Rancho Cordova 5/10-5/13/05 $32 | 0 | 12/4/04 7:11 pm | ego68 |
| | 3* DoubleTree Sacramento $35 (12/04/04) | 0 | 11/30/04 11:34 pm | shizzolator |
| | 2.5* Rancho Cordova Wingate Inn $32 (11/23-25) | 1 | 11/27/04 12:19 pm | Profiler |
| | 4* DT Hyatt 11/21 $60 11/23 $60; Sheraton Grand 11/25 $55 | 0 | 11/22/04 1:22 pm | bonish |
| | 3* Doubletree Arden/Sacramento $37 11/19 | 1 | 11/20/04 1:53 am | ahallez |
| | 2.5* Wingate Inn Rancho Cordova $33 11/13 | 2 | 11/19/04 1:44 am | cykick42 |
| | 2.5* DT Hawthorne Suites $40 (11/18-20) | 0 | 11/18/04 10:08 pm | Colfax30 |
| | Roseville 2.5*Larkspur $72(11/22-24) 2* Fairfield $80(11/24) | 2 | 11/17/04 4:38 pm | mcrinca |
| | 3* Rancho Cordova Holiday Inn $32 (11/17) | 0 | 11/16/04 10:20 pm | Colfax30 |
| | 3* Doubletree Sacramento $40 (11/11) | 2 | 11/16/04 11:05 am | OCTraveler |
| | 3* Doubletree Sacramento Arden $36 11/24 | 0 | 11/15/04 1:04 am | bomawin |

# Ungrammatical & Unstructured Text

For simplicity → "posts"

***Goal:***




***Wrapper based IE does not apply (e.g. Stalker, RoadRunner)***

***NLP based IE does not apply (e.g. Rapier)***

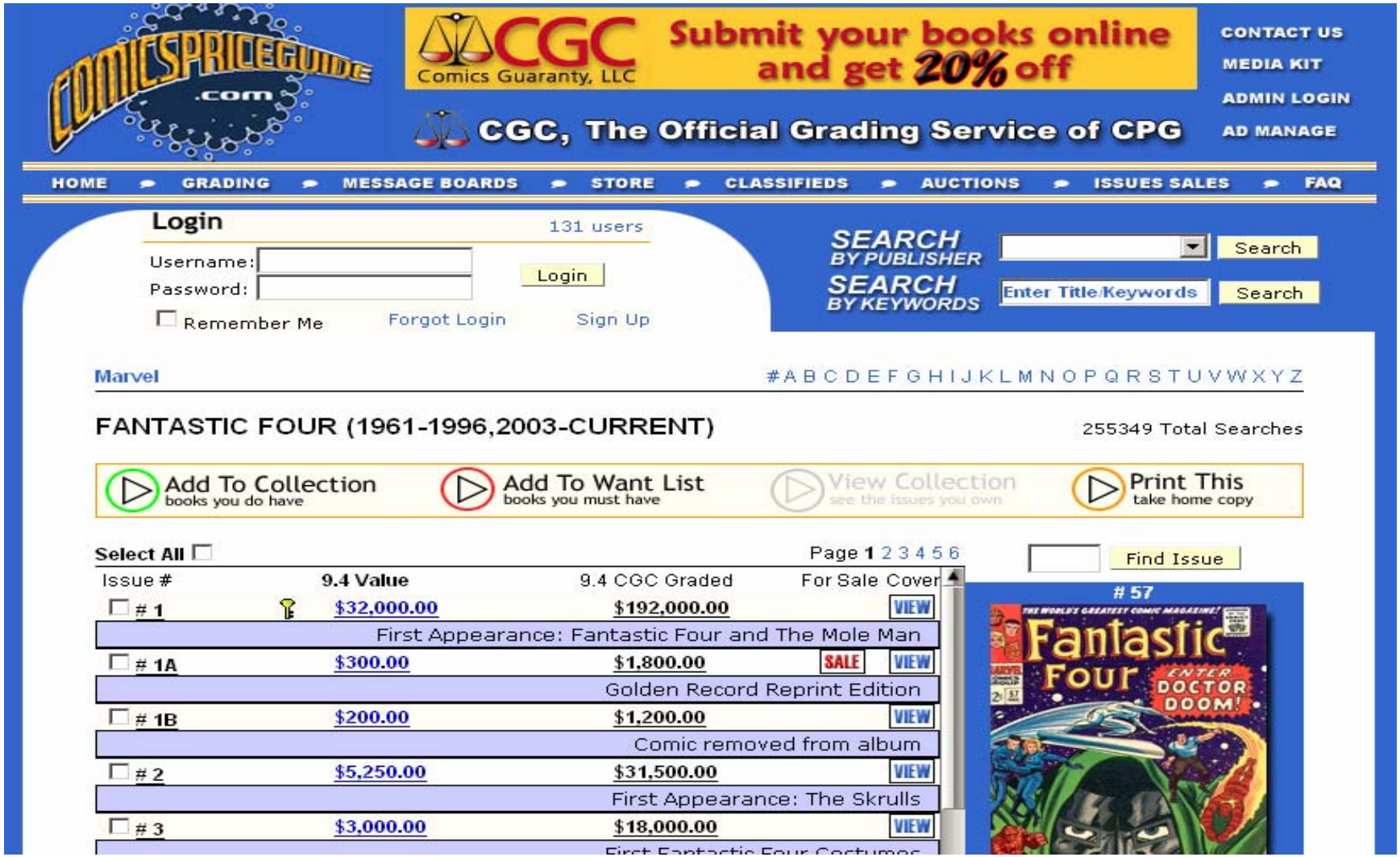
# Reference Sets

***IE infused with outside knowledge***

***"Reference Sets"***

- Collections of known entities and the associated attributes
- Online (offline) set of docs
  - CIA World Fact Book
- Online (offline) database
  - Comics Price Guide, Edmunds, etc.
- Build from ontologies on Semantic Web

# Comics Price Guide Reference Set

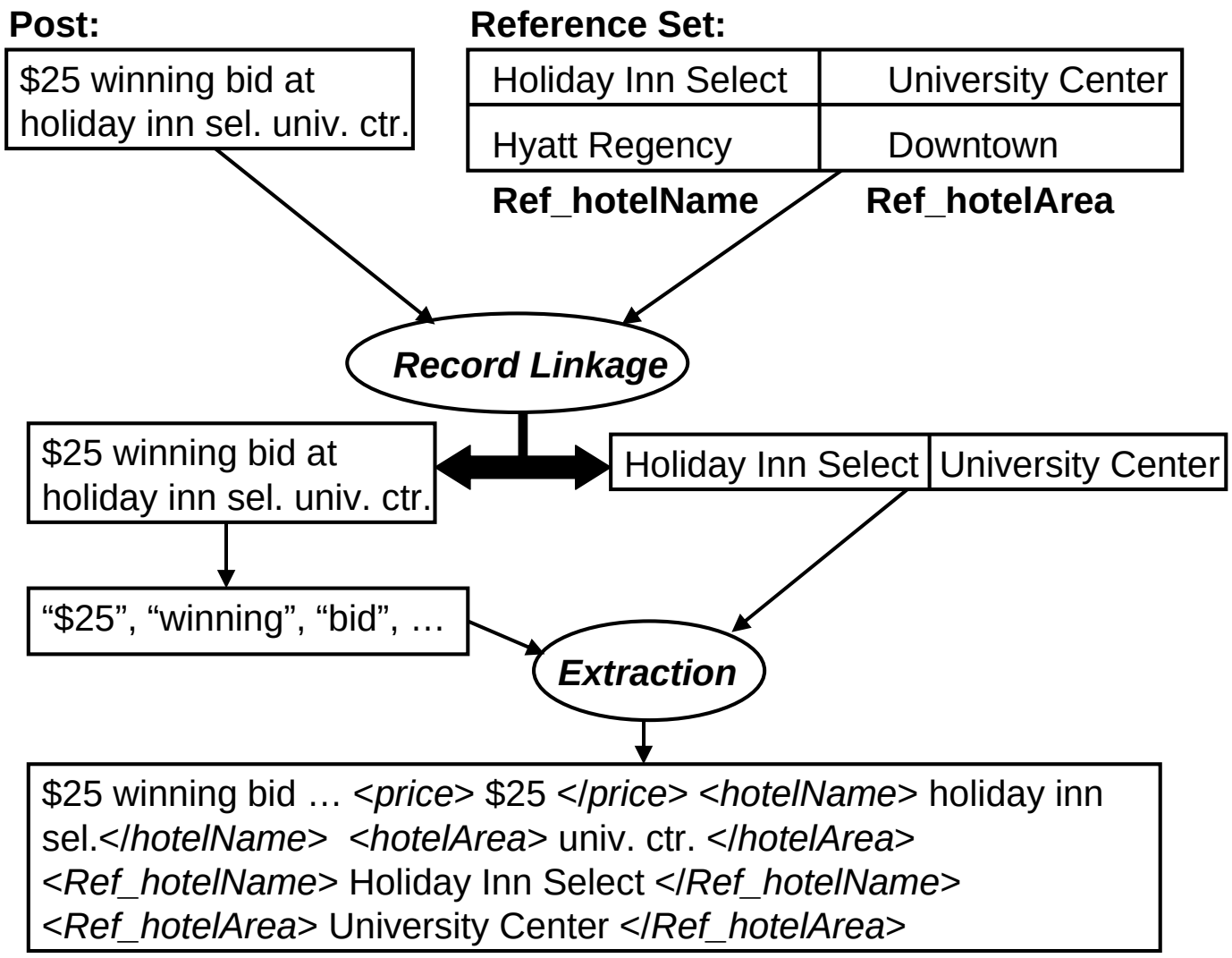


# 2 Step Approach to Annotation

1. Align post to a member of the reference set

2. Exploit the matching member of reference set for extraction/annotation

# Algorithm Overview – Use of Ref Sets



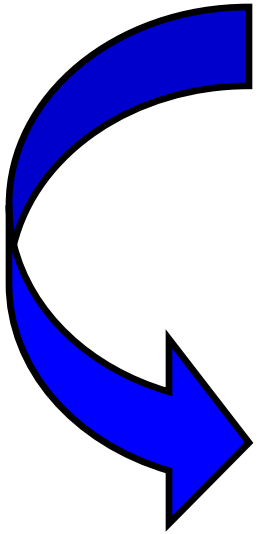
# Our Record Linkage Problem

- ***Posts not yet decomposed attributes.***
- ***Extra tokens that match nothing in Ref Set.***

Post:

"$25 winning bid at holiday inn sel. univ. ctr."

*hotel name* *hotel area*



Reference Set:

| Holiday Inn | Greentree |
|---|---|
| Holiday Inn Select | University Center |
| Hyatt Regency | Downtown |

*hotel name* *hotel area*

# Our Record Linkage Solution

***P = "$25 winning bid at holiday inn sel. univ. ctr."***

***Record Level Similarity + Field Level Similarities***

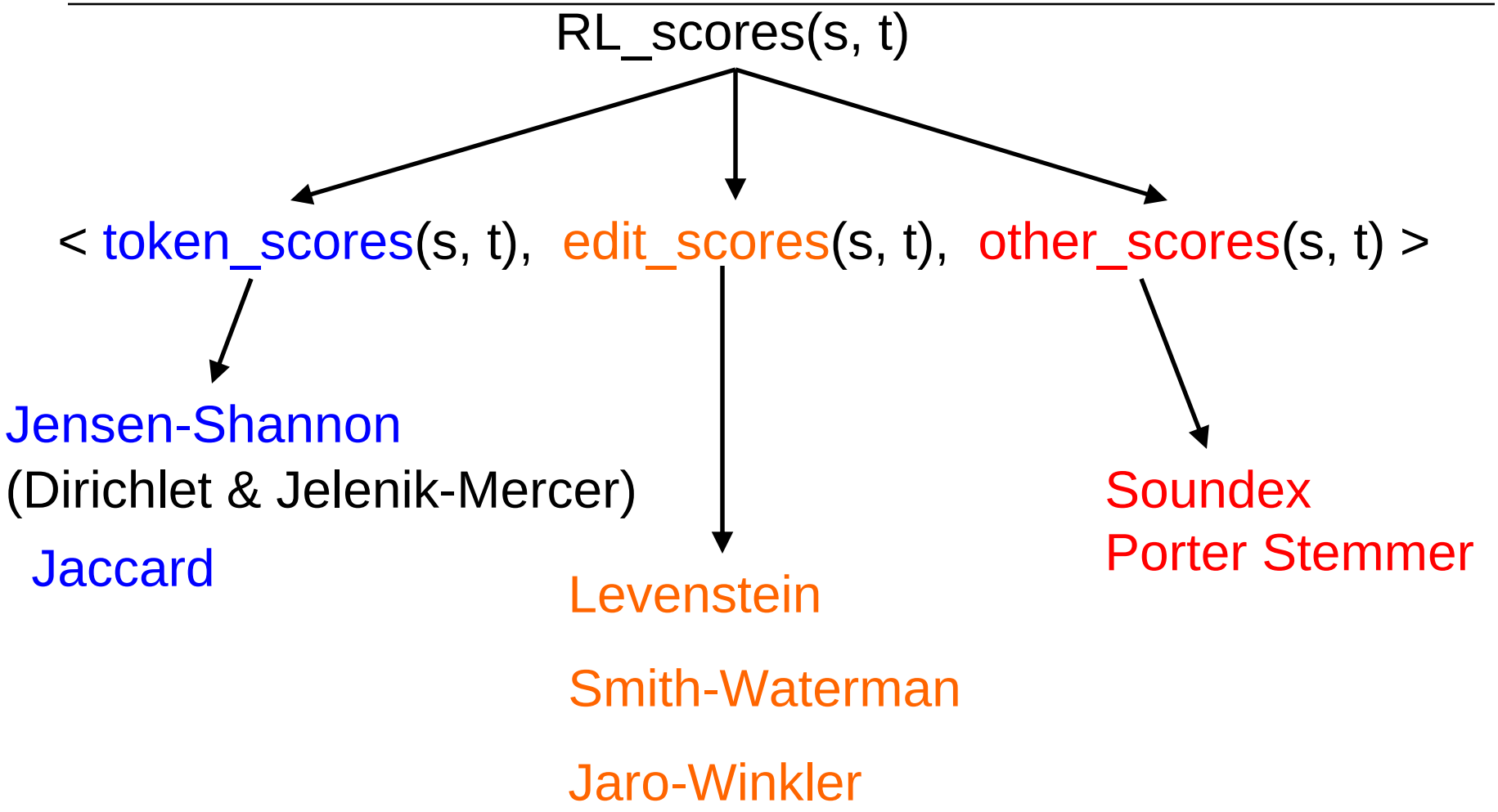
$V_{RL}$ = < ***RL_scores***(***P***, ***"Hyatt Regency Downtown"***),
***RL_scores***(***P***, ***"Hyatt Regency"***),
***RL_scores***(***P***, ***"Downtown"***)>

***Binary Rescoring***

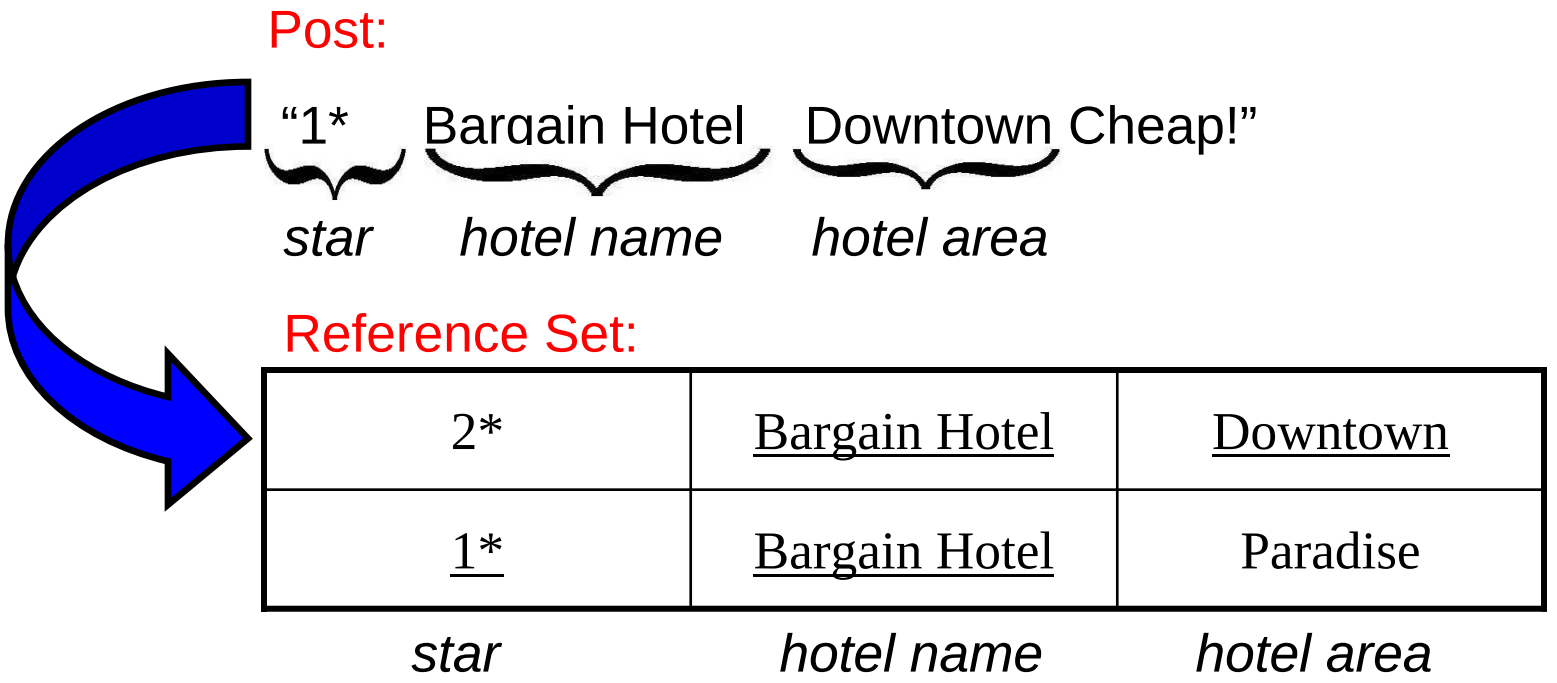
SVM

***Best matching member of the reference set for the post***

# RL_scores


RL_scores(s, t)
< token_scores(s, t), edit_scores(s, t), other_scores(s, t) >
Jensen-Shannon
(Dirichlet & Jelenik-Mercer)
Jaccard
Levenstein
Smith-Waterman
Jaro-Winkler
Soundex
Porter Stemmer

# Record Level Similarity Problem




What if equal ***RLS*** but different attributes? Many more hotels share **Star** than share **Hotel Area** → need to reflect **Hotel Area** similarity more discriminative…

# Binary Rescoring

***Candidates*** = $< V_{RL1}, V_{RL2}, \ldots, V_{RLn} >$

$V_{RL}$(s) with max value at index i set that value to 1. All others set to 0.

$V_{RL1} = < 0.999, 1.2, \ldots, 0.45, 0.22 >$

$V_{RL2} = < 0.888, 0.0, \ldots, 0.65, 0.22 >$

$V_{RL1} = < 1, 1, \ldots, 0, 1 >$

$V_{RL2} = < 0, 0, \ldots, 1, 1 >$

Emphasize best match → similarly close values but only one is best match

# SVM Classification

Support Vector Machine (SVM)

- Trained to classify matches/ non-matches
- Returns score from decision function
- Best Match: Candidate that is a match & max. score from decision function
  - 1-1 mapping: If more than one cand. with max. score → throw them all away
  - 1-N mapping: If more than one cand. with max. score → keep first one or keep random one w/in set of max.

# Last Alignment Step

***Return reference set attributes as annotation for the post***

Post:

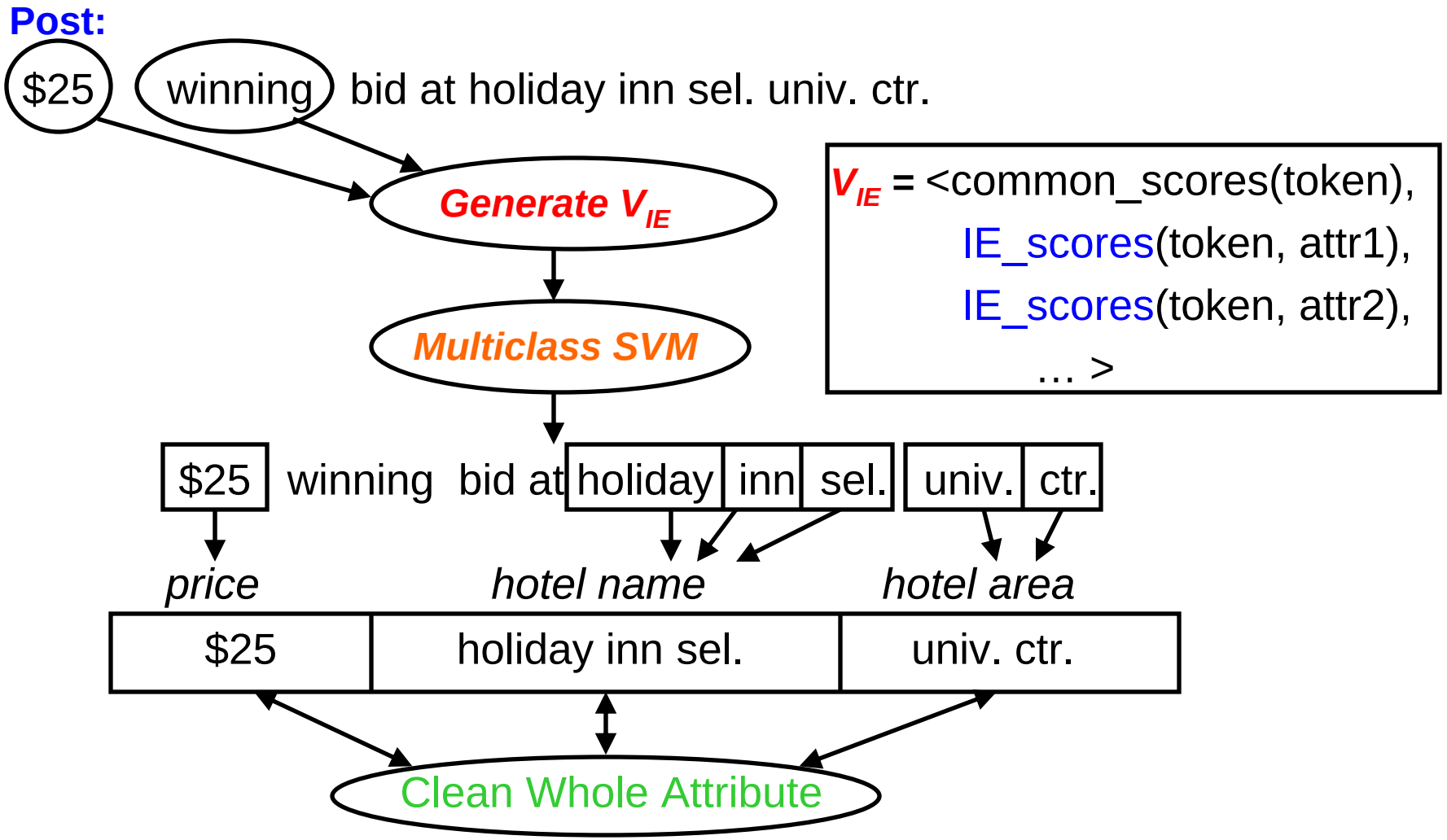
$25 winning bid at holiday inn sel. univ. ctr.

<Ref_hotelName>Holiday Inn Select</Ref_hotelName>

<Ref_hotelArea>University Center</Ref_hotelArea>

***… discuss implications a little later…***

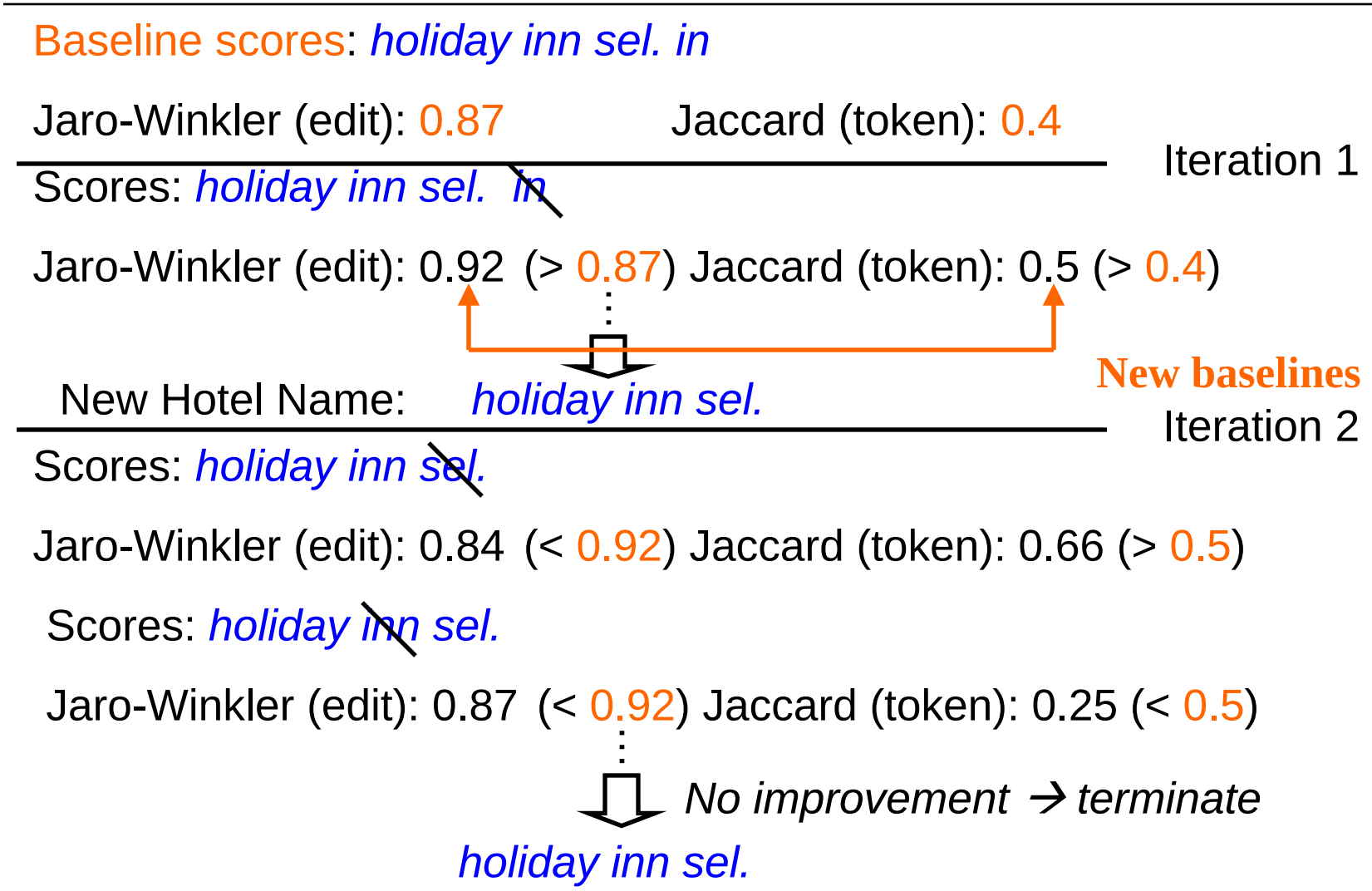
# Extraction Algorithm



# Common Scores

- Some attributes not in reference set
  - Reliable characteristics
  - Infeasible to represent in reference set
  - E.g. prices, dates
- Can use characteristics to extract/annotate these attributes
  - Regular expressions, for example
- These types of scores are what compose ***common_scores***

# Cleaning an attribute: Example



# Experimental Data Sets

***Hotels***

- ***Posts***
  - 1125 posts from www.biddingfortravel.com
    - Pittsburgh, Sacramento, San Diego
    - Star rating, hotel area, hotel name, price, date booked
- ***Reference Set***
  - 132 records
  - Special posts on BFT site.
    - Per area – list any hotels ever bid on in that area
    - Star rating, hotel area, hotel name

# Experimental Data Sets

***Comics***

- ***Posts***
  - 776 posts from EBay
    - "Incredible Hulk" and "Fantastic Four" in comics
    - Title, issue number, price, condition, publisher, publication year, description (1st appearance the Rhino)
- ***Reference Sets***
  - 918 comics, 49 condition ratings
  - Both come from ComicsPriceGuide.com
    - For FF and IH
    - Title, issue number, description, publisher

# Comparison to Existing Systems

***Our Implementation***

- Phoebus

***Record Linkage***

- WHIRL
  - RL allows non-decomposed attributes

***Information Extraction***

- Simple Tagger (CRF)
  - State-of-the-art IE
- Amilcare
  - NLP based IE

# Record linkage results

| | Prec. | Recall | F-Measure |
|---|---|---|---|
| **Hotel** | | | |
| Phoebus | 93.60 | 91.79 | **92.68** |
| WHIRL | 83.52 | 83.61 | 83.13 |
| **Comic** | | | |
| Phoebus | 93.24 | 84.48 | **88.64** |
| WHIRL | 73.89 | 81.63 | 77.57 |

10 trials – 30% train, 70% test

# Token level Extraction results: Hotel domain

| | | Prec. | Recall | F-Measure | Freq |
|---|---|---|---|---|---|
| *Area* | Phoebus | 89.25 | 87.50 | **88.28** | 809.7 |
| | Simple Tagger | 92.28 | 81.24 | 86.39 | |
| | Amilcare | 74.2 | 78.16 | 76.04 | |
| Date | Phoebus | 87.45 | 90.62 | **88.99** | 751.9 |
| | Simple Tagger | 70.23 | 81.58 | 75.47 | |
| | Amilcare | 93.27 | 81.74 | 86.94 | |
| *Name* | Phoebus | 94.23 | 91.85 | 93.02 | 1873.9 |
| | Simple Tagger | 93.28 | 93.82 | **93.54** | |
| | Amilcare | 83.61 | 90.49 | 86.90 | |
| Price | Phoebus | 98.68 | 92.58 | **95.53** | 850.1 |
| | Simple Tagger | 75.93 | 85.93 | 80.61 | |
| | Amilcare | 89.66 | 82.68 | 85.86 | |
| *Star* | Phoebus | 97.94 | 96.61 | **97.84** | 766.4 |
| | Simple Tagger | 97.16 | 97.52 | 97.34 | |
| | Amilcare | 96.50 | 92.26 | 94.27 | |

**Not Significant**

# Token level Extraction results: Comic domain

| | | Prec. | Recall | F-Measure | Freq |
|---|---|---|---|---|---|
| *Condition* | Phoebus | 91.8 | 84.56 | **88.01** | 410.3 |
| | Simple Tagger | 78.11 | 77.76 | 77.80 | |
| | Amilcare | 79.18 | 67.74 | 72.80 | |
| *Descript.* | Phoebus | 69.21 | 51.50 | 59.00 | 504.0 |
| | Simple Tagger | 62.25 | 79.85 | **69.86** | |
| | Amilcare | 55.14 | 58.46 | 56.39 | |
| *Issue* | Phoebus | 93.73 | 86.18 | **89.79** | 669.9 |
| | Simple Tagger | 86.97 | 85.99 | 86.43 | |
| | Amilcare | 88.58 | 77.68 | 82.67 | |
| Price | Phoebus | 80.00 | 60.27 | **68.46** | 10.7 |
| | Simple Tagger | 84.44 | 44.24 | 55.77 | |
| | Amilcare | 60.00 | 34.75 | 43.54 | |

# Token level Extraction results: Comic domain (cont.)

| | | Prec. | Recall | F-Measure | Freq |
|---|---|---|---|---|---|
| *Publisher* | Phoebus | 83.81 | 95.08 | **89.07** | 61.1 |
| | Simple Tagger | 88.54 | 78.31 | 82.83 | |
| | Amilcare | 90.82 | 70.48 | 79.73 | |
| *Title* | Phoebus | 97.06 | 89.90 | 93.34 | 1191.1 |
| | Simple Tagger | 97.54 | 96.63 | **97.07** | |
| | Amilcare | 96.32 | 93.77 | 94.98 | |
| Year | Phoebus | 98.81 | 77.60 | **84.92** | 120.9 |
| | Simple Tagger | 87.07 | 51.05 | 64.24 | |
| | Amilcare | 86.82 | 72.47 | 78.79 | |

# Summary extraction results

Expensive to label training data…

| | Prec. | Recall | F-Mes. | # Train. |
|---|---|---|---|---|
| Hotel (30%) | 93.6 | 91.79 | 92.68 | 338 |
| Hotel (10%) | 93.66 | 90.93 | 92.27 | 113 |
| Comic (30%) | 93.24 | 84.48 | 88.64 | 233 |
| Comic (10%) | 91.41 | 83.63 | 87.34 | 78 |

Token Level

| | | | |
|---|---|---|---|
| Hotel (30%) | 87.44 | 85.59 | 86.51 |
| Hotel (10%) | 86.52 | 84.54 | 85.52 |
| Comic (30%) | 81.73 | 80.84 | 81.28 |
| Comic (10%) | 79.94 | 76.71 | 78.29 |

Field Level

# Reference Set Attributes as Annotation

- Standard query values
- Include info not in post
  - If post leaves out “Star Rating” can still be returned in query on “Star Rating” using reference set annotation
- Perform better at annotation than extraction
  - Consider record linkage results as field level extraction
  - E.g., no system did well extracting comic desc.
    - +20% precision, +10% recall using record link

# Reference Set Attributes as Annotation

***Then why do extraction at all?***

- Want to see actual values
- Extraction can annotate when record linkage is wrong
  - Better in some cases at annotation than record linkage
  - If wrong record matched, usually close enough record to get some extraction parts right
- Learn what something is not
  - Helps to classify things not in reference set
  - Learn which tokens to ignore better

# Related Work

- Generate mark-up for Semantic Web
  - Rely on lexical info (e.g. S-CREAM, MnM) or structure (ADEL)
- Record Linkage
  - Require decomposed attributes
  - WHIRL is exception, used in experiments
- Data Cleaning
  - Tuple-to-tuple transformations (Fuzzy Match Similarity)
- Info. Extraction (for Annotation)
  - Conditional Random Fields (Simple Tagger)
  - Datamold / CRAM
    - Require all tokens to receive label / no junk
  - NER with Dictionary (Conditional Semi-Markov Model)
    - Whole segments receive same label – attributes can't be interrupted

# Conclusion

- Annotate unstructured and ungrammatical sources
  - Don’t involve users
  - Structured queries over data sources
- Future:
  - Automate entire process
    - Unsupervised RL and IE
    - Mediator gets Reference Sets
- More Info:
  - www.isi.edu/~michelso

Questions?