Chapter 9:

Topic Detection and Tracking

(TDT)

Some slides from “Overview NIST Topic Detection and Tracking
-Introduction and Overview” by G. Doddington
-http://www.itl.nist.gov/iaui/894.01/tests/tdt/tdt99/presentations/index.htm

TDT Task Overview

- 5 R&D Challenges:
  - Story Segmentation
  - Topic Tracking
  - Topic Detection
  - First-Story Detection
  - Link Detection

- TDT3 Corpus Characteristics:†
  - Two Types of Sources:
    - Text
    - Speech
  - Two Languages:
    - English stories 30,000
    - Mandarin stories 10,000
  - 11 Different Sources:
    - _8 English__ 3 Mandarin

8 English		3 Mandarin
ABC	CNN	VOA
PRI	VOA	XIN
NBC	MNB	ZBN
APW	NYT	

* see http://www.itl.nist.gov/iaui/894.01/tdt3/tdt3.htm for details

† see http://morph.ldc.upenn.edu/Projects/TDT3/ for details

Preliminaries

A **topic** is …

a seminal **event** or activity, along with all directly related events and activities.

A **story** is …

a topically cohesive segment of news that includes two or more DECLARATIVE independent clauses about
a single event.

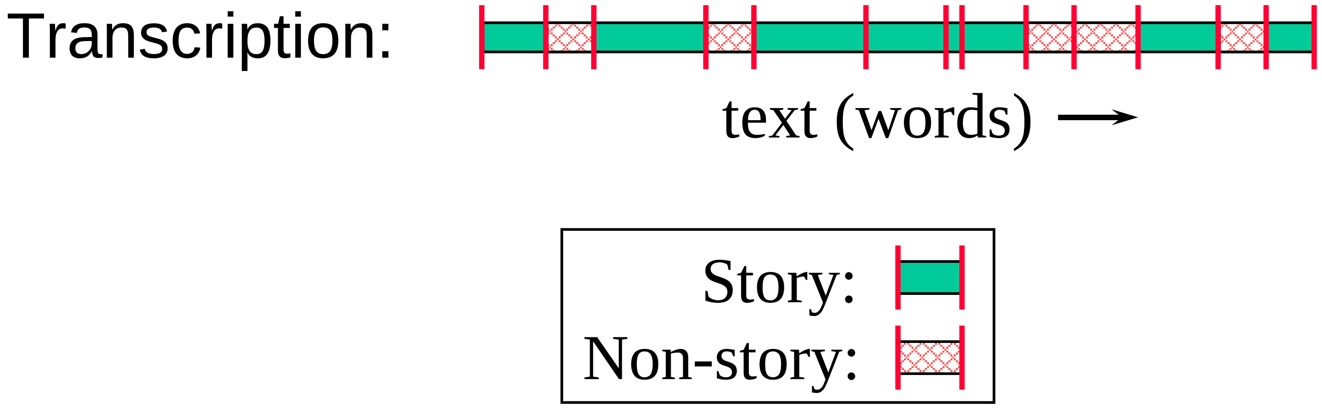
Example Topic

Title: Mountain Hikers Lost

- WHAT: 35 or 40 young Mountain Hikers were lost in an avalanche in France around the 20th of January.
- WHERE: Orres, France
- WHEN: January 1998
- RULES OF INTERPRETATION: 5. Accidents

The Segmentation Task:

To segment the source stream into its constituent stories, for all audio sources.

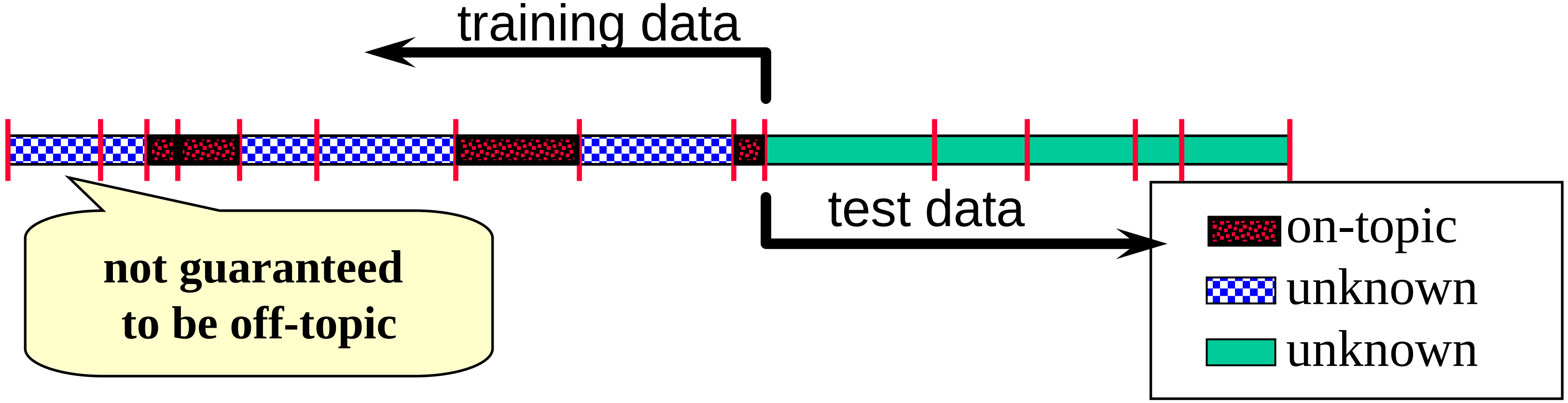


(for Radio and TV only)

The Topic Tracking Task:

To detect stories that discuss the target topic, in multiple source streams.

- Find all the stories that discuss a given target topic
  - *Training:* Given N_t sample stories that discuss a given target topic,
  - *Test:* Find all subsequent stories that discuss the target topic.

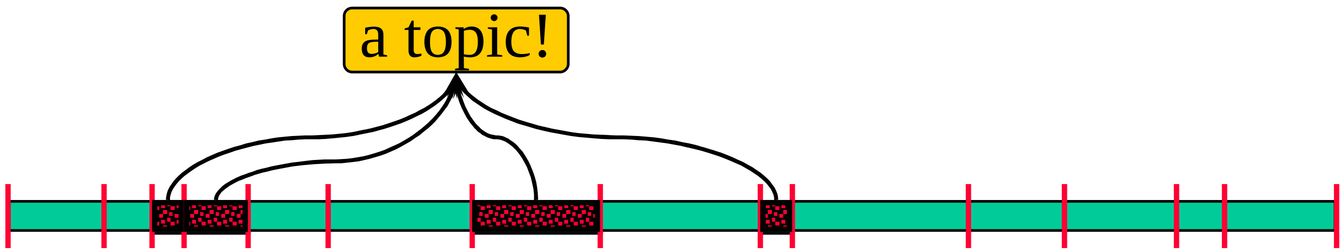


Topic Tracking Conditions

- 3 Source Conditions:
  - text sources and manual transcription of the audio sources
  - text sources and ASR transcription of the audio sources
  - text sources and the sampled data signal for audio sources
- 2 Story Boundary Conditions:
  - Reference story boundaries provided
  - No story boundaries provided

The Topic Detection Task:

To detect topics in terms of the (clusters of) stories that discuss them.



- Unsupervised topic training
- New topics must be detected as the incoming stories are processed.
- Input stories are then associated with one of the topics.

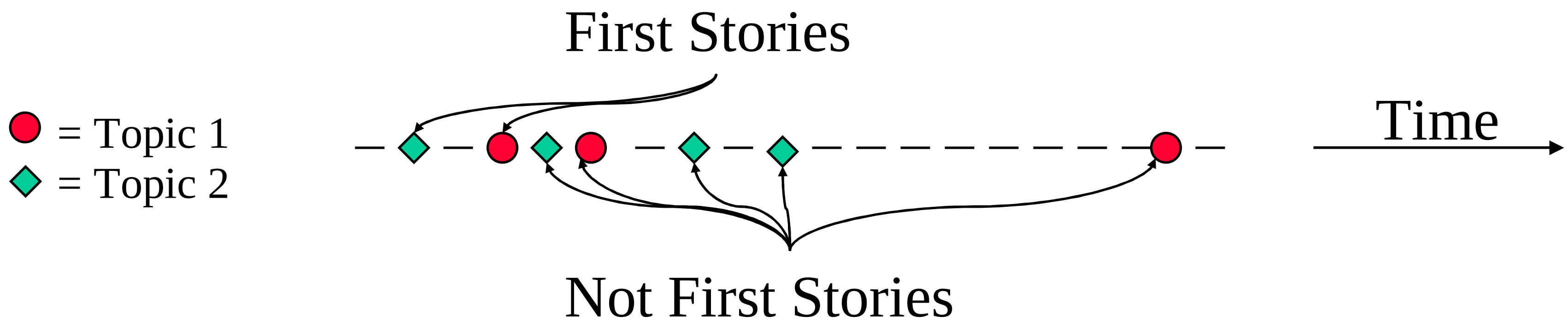
Topic Detection Conditions

- Decision Deferral Conditions:

Maximum decision deferral period in # of source files
1
10
100

The First-Story Detection Task:

To detect the first story that discusses a topic, for all topics.

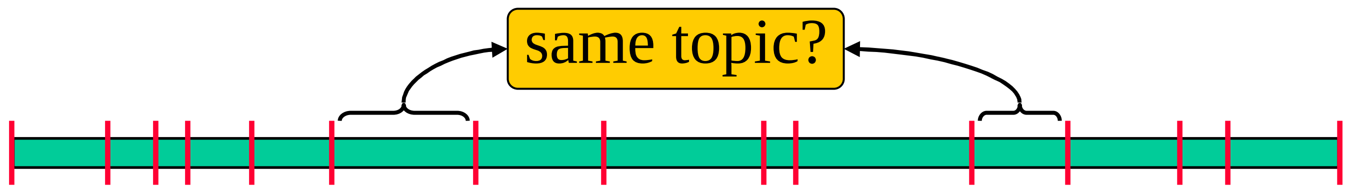


- There is no supervised topic training

  (like Topic Detection)

The Link Detection Task

To detect whether a pair of stories discuss the same topic.



- The topic discussed is a free variable.
- Topic definition and annotation is unnecessary.
- The link detection task represents a basic functionality, needed to support all applications (including the TDT applications of topic detection and tracking).
- The link detection task is related to the topic tracking task, with Nt = 1.

TDT3 Evaluation Methodology

- All TDT3 tasks are cast as statistical detection (***yes*-*no***) tasks.
  - Story Segmentation: ***Is there a story boundary here?***
  - Topic Tracking: ***Is this story on the given topic?***
  - Topic Detection: ***Is this story in the correct topic-clustered set?***
  - First-story Detection: ***Is this the first story on a topic?***
  - Link Detection: ***Do these two stories discuss the same topic?***
- Performance is measured in terms of detection cost, which is a weighted sum of ***miss*** and ***false alarm*** probabilities:

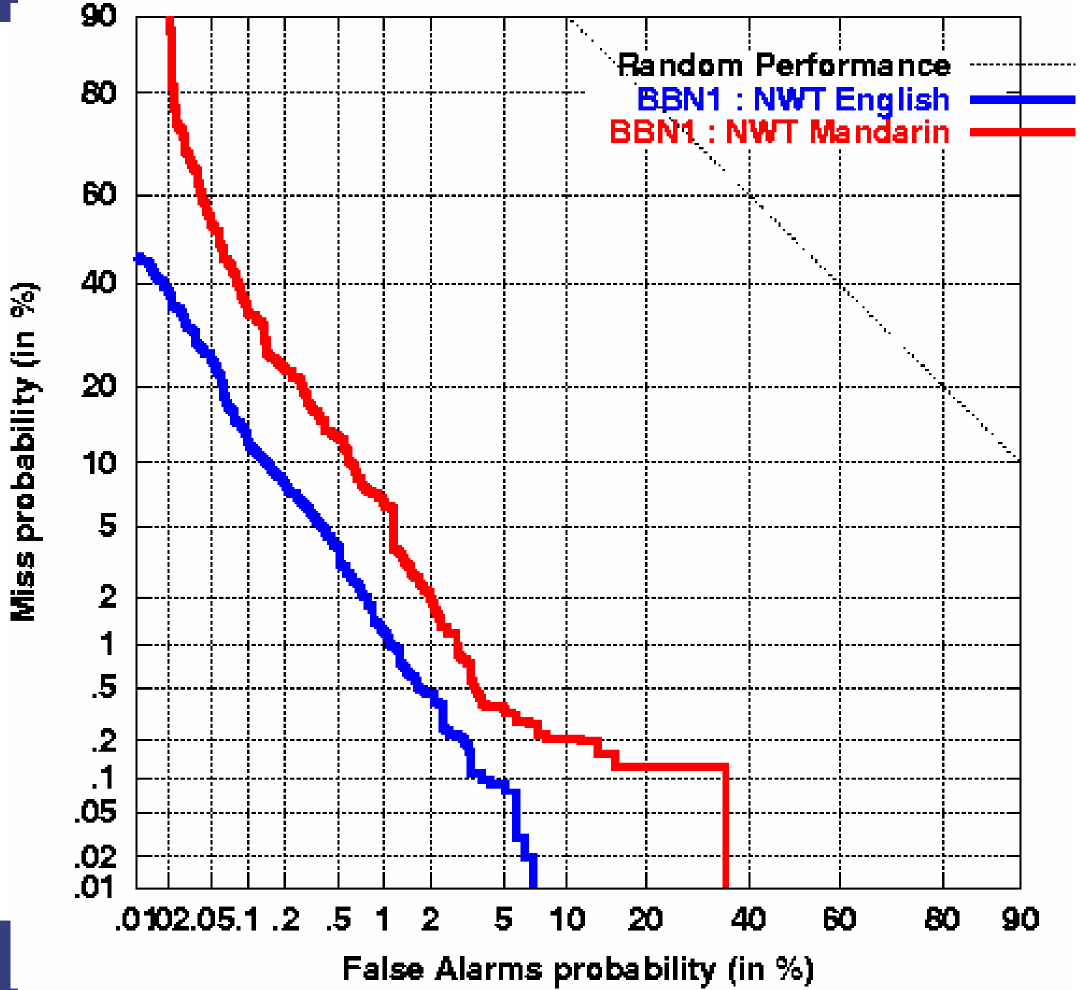
  $$\mathbf{C_{Det}} = C_{Miss} \bullet P_{Miss} + C_{FA} \bullet P_{FA}$$

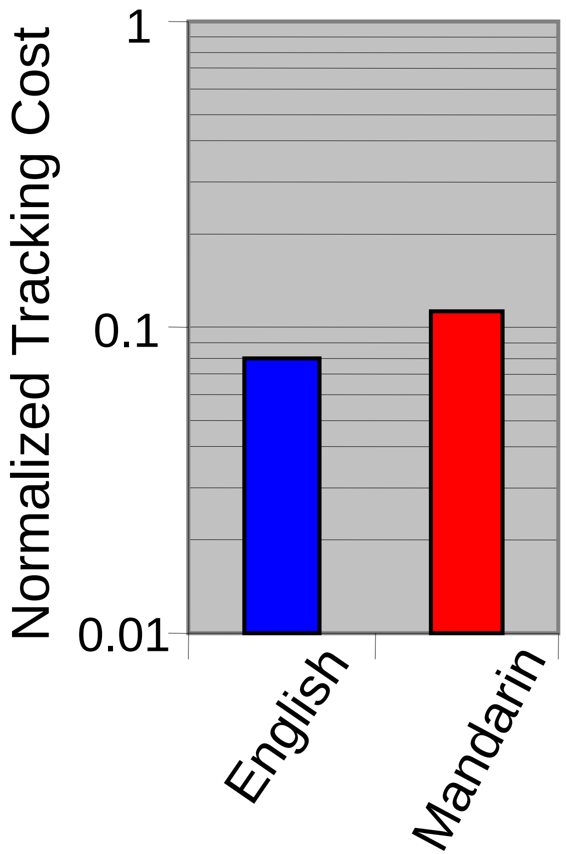
  (e.g. $C_{Miss}=0.2$, $C_{FA} = 0.98$)
- Detection Cost is normalized to lie between 0 and 1:

  $$\mathbf{(C_{Det})_{Norm}} = \mathbf{C_{Det}} \,/\, \min\{C_{Miss},\ C_{FA}\}$$

Example Performance Measures:

Tracking Results on Newswire Text (BBN)

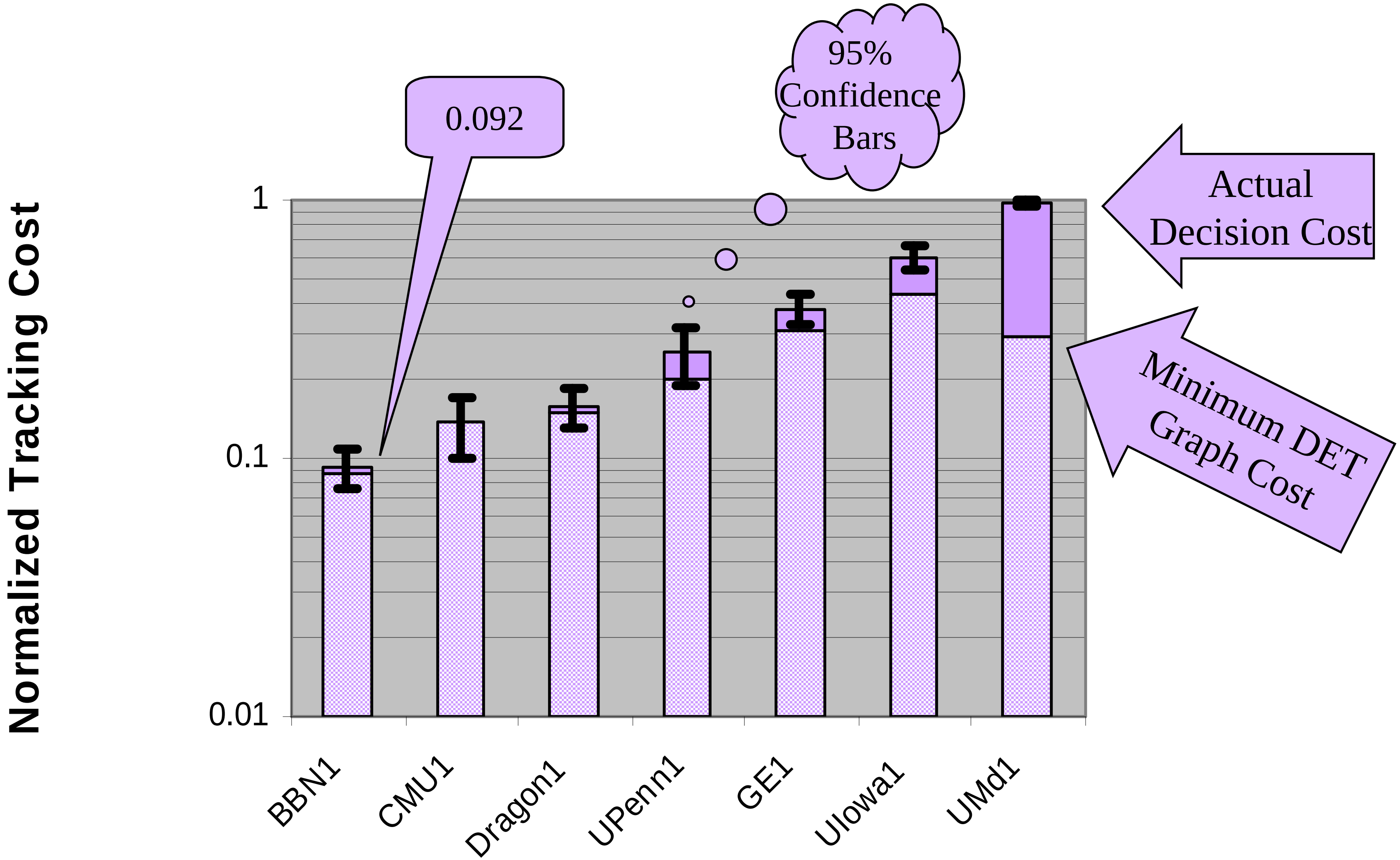




1999 TDT3 Tracking Results

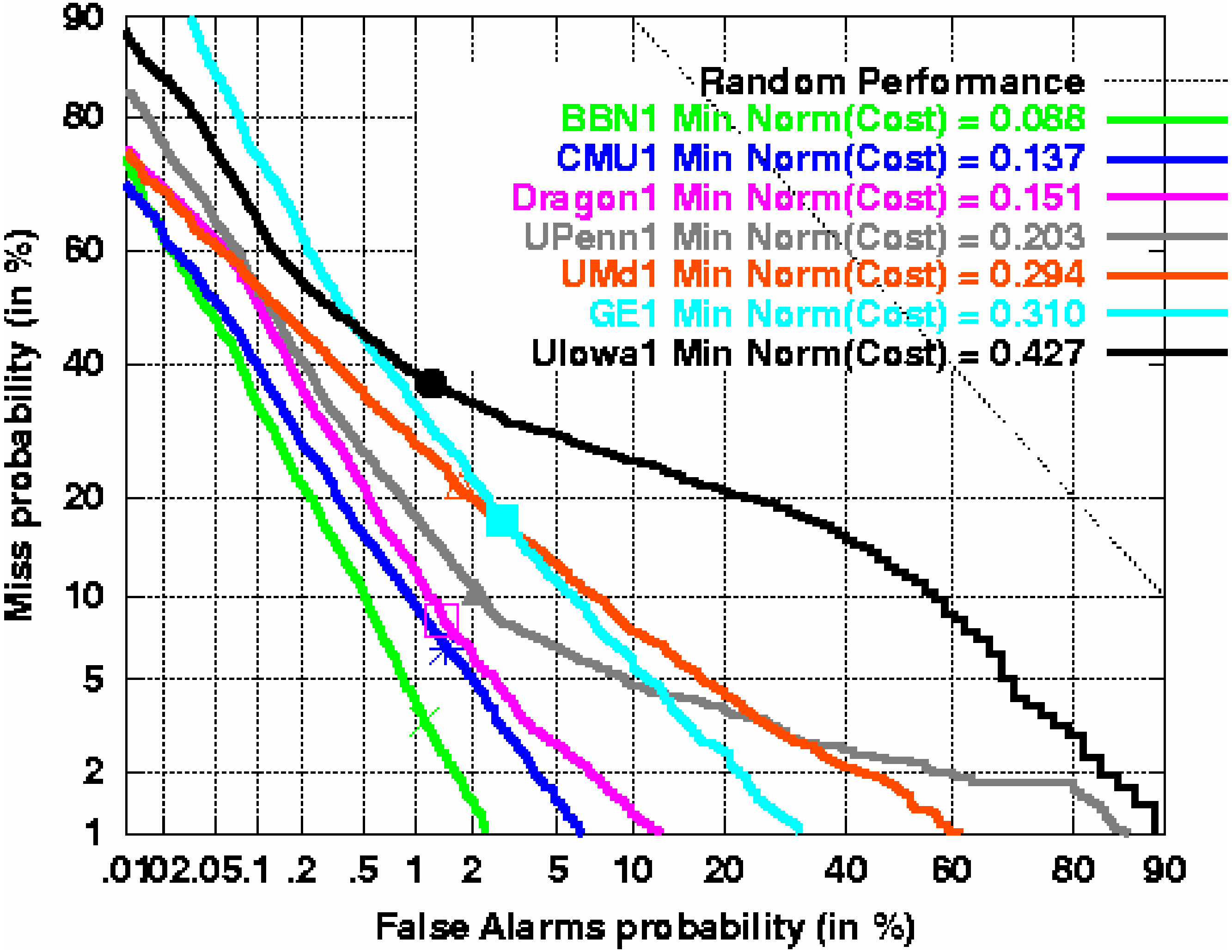
Required Evaluation Condition

4 English Training Stories, Multilingual Test Texts,
Newswire Text+Broadcast News ASR, Given ASR Boundaries

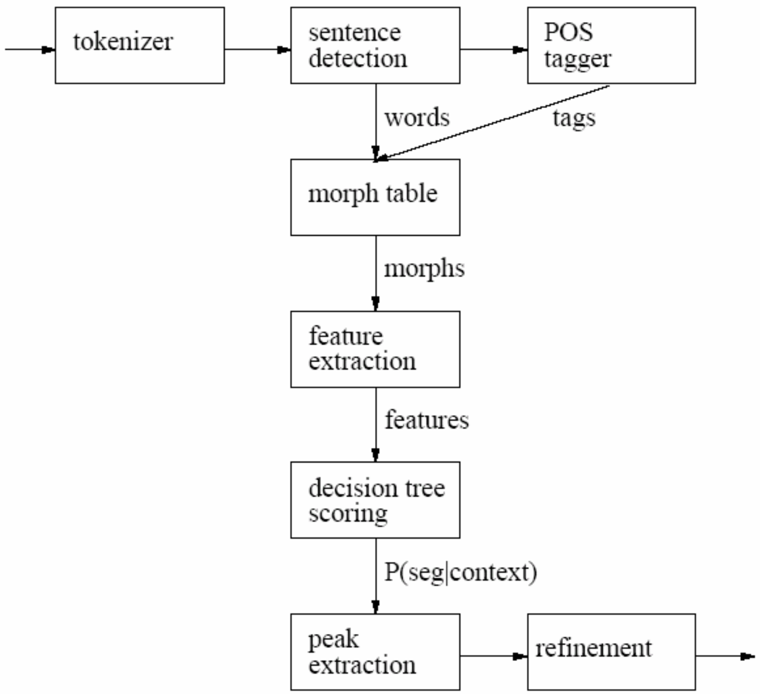


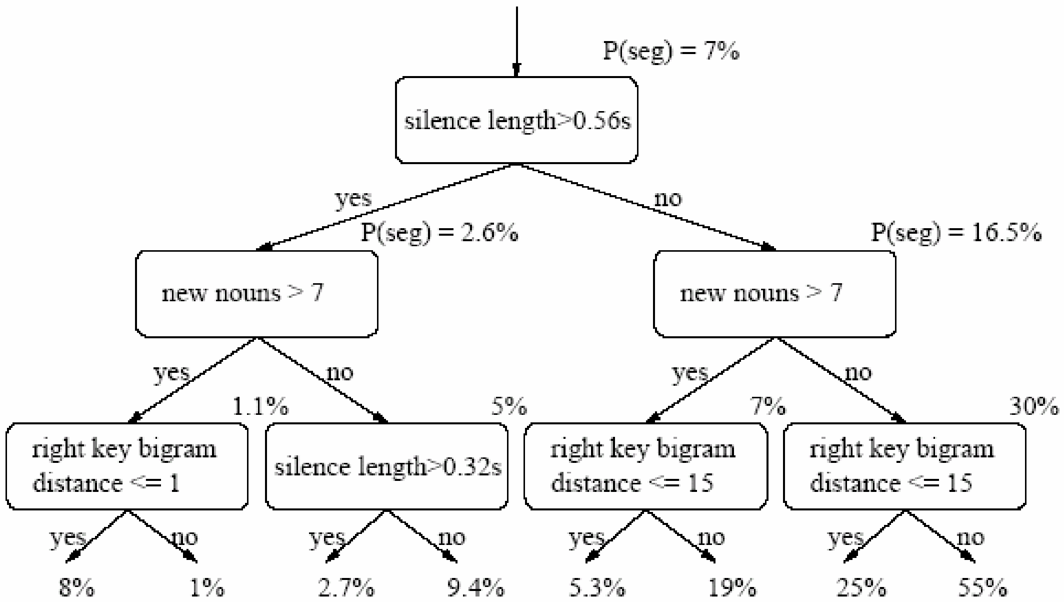
1999 TDT3 Tracking Results

Required Evaluation Condition



Story Segmentation using Decision Trees





Story Segmentation and Topic Detection in the Broadcast News Domain

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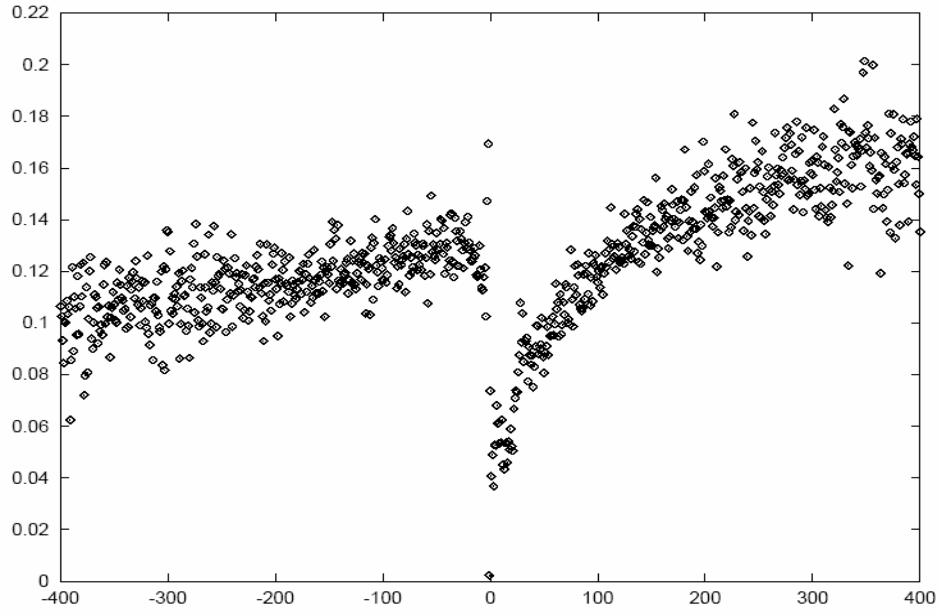
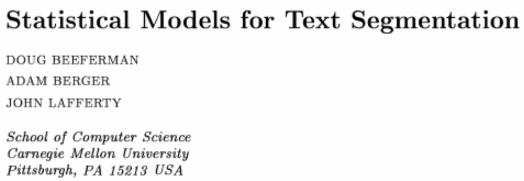
Using Maximum Entropy Language Models

Idea: compare perplexities of adaptive trigram with general English trigram



Relative position in segment



Results

segmentation model	P_k	*miss probability*	*false alarm probability*
exponential model	13.2%	16.0%	10.9%
decision tree	15.2%	19.3%	11.9%
interpolated (exp + dtree) models	11.8%	14.2%	9.8%
cue-word and $s = t$ trigger features	13.4%	16.9%	10.5%
cue-word and $s \neq t$ trigger features	13.6%	17.8%	10.1%
cue-word features only	18.3%	21.6%	15.5%
topicality features only	37.3%	42.1%	33.3%
TextTiling	34.6%	57.1%	18.6%

Relevance Models and Link Detection

- Given two stories A and B
  - Determine if topic(A)=topic(B)
- Estimate topics models of A and B
  - e.g. language models
- Measure distance between the models
  - e.g. Kullback-Leibler

Relevance Models for Topic Detection and Tracking

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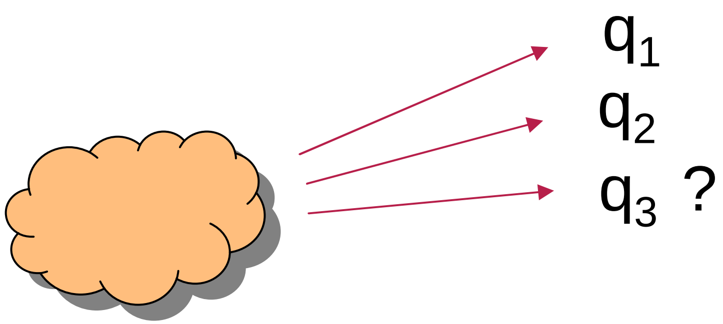
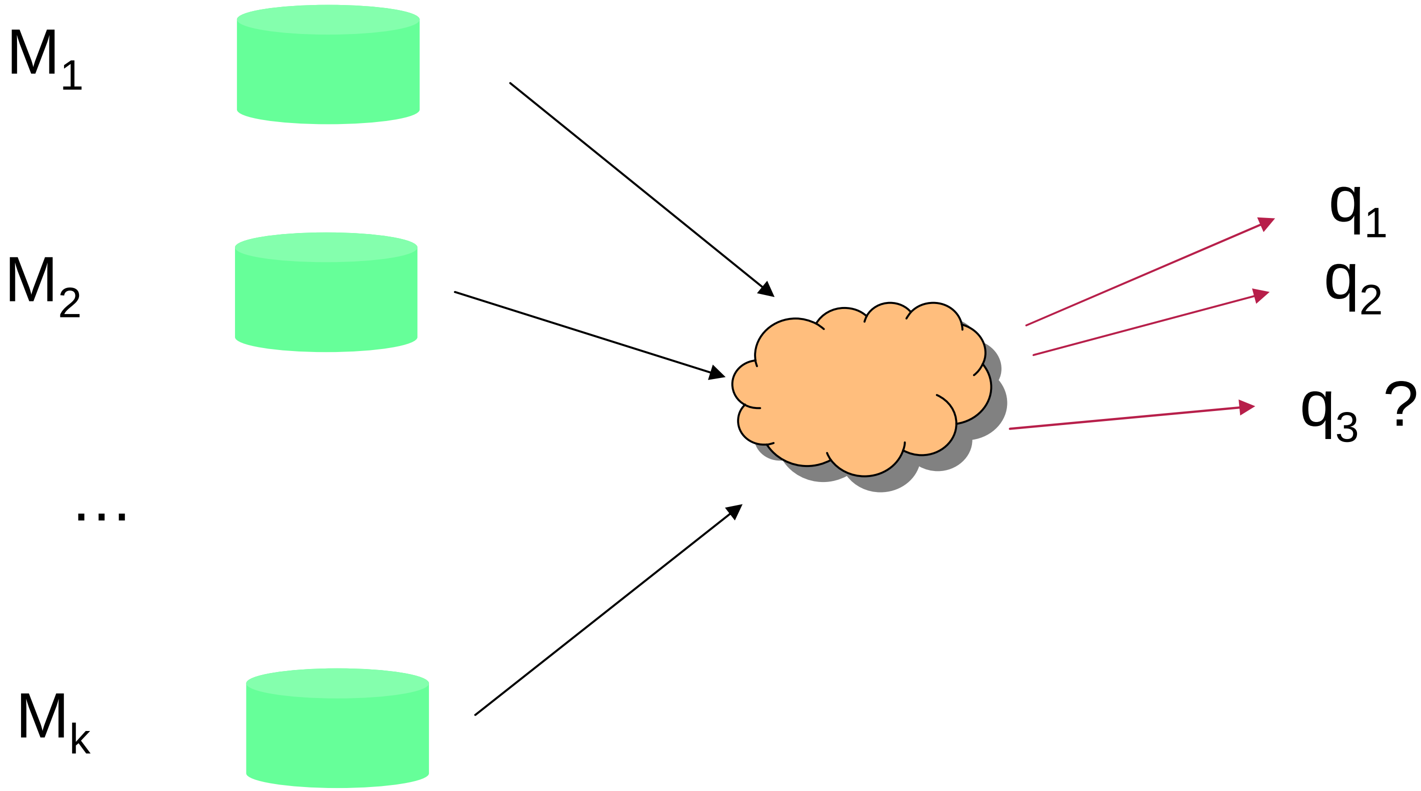
Generating Queries

- Suppose you have some source of queries
- You have generated several queries $q_1 \ldots q_n$ from this source
- What is

$$P(q_{N+1} \mid q_1 \ldots q_{N-1})$$



Universe of Models



$$P(q_{N+1} \mid q_1 \ldots q_N) = \sum_{i=1}^{k} P(q_{N+1} \mid M_i) P(M_i \mid q_1 \ldots q_N)$$

Using Relevance Models in Link Detection

- Question:
  - Are stories S_1 and S_2 linked?
- Approach
  - Create are relevance model for S_1 and S_2
  - Measure the distance between the models

Building Relevance Models as Topic Models

- S_1 :
  - Generate queries from it
  - Retrieve documents from the collection
  - Estimate

$$P(w \mid D) = \lambda \frac{tf_{w,D}}{|D|} + (1-\lambda)\frac{cf_w}{Coll.Size}$$

$$P(w \mid S_1) = P(w \mid q_1 \ldots q_N)$$

$$= \sum_{D \in R} P(w \mid D) P(D \mid q_1 \ldots q_N)$$

Measuring Distances

Kullback-Leibler Distance

$$D(S_1 \| S_2) = \sum_w P(w|S_1) \log \frac{P(w|S_1)}{P(w|S_2)}$$

Symmetric Kullback-Leibler Distance

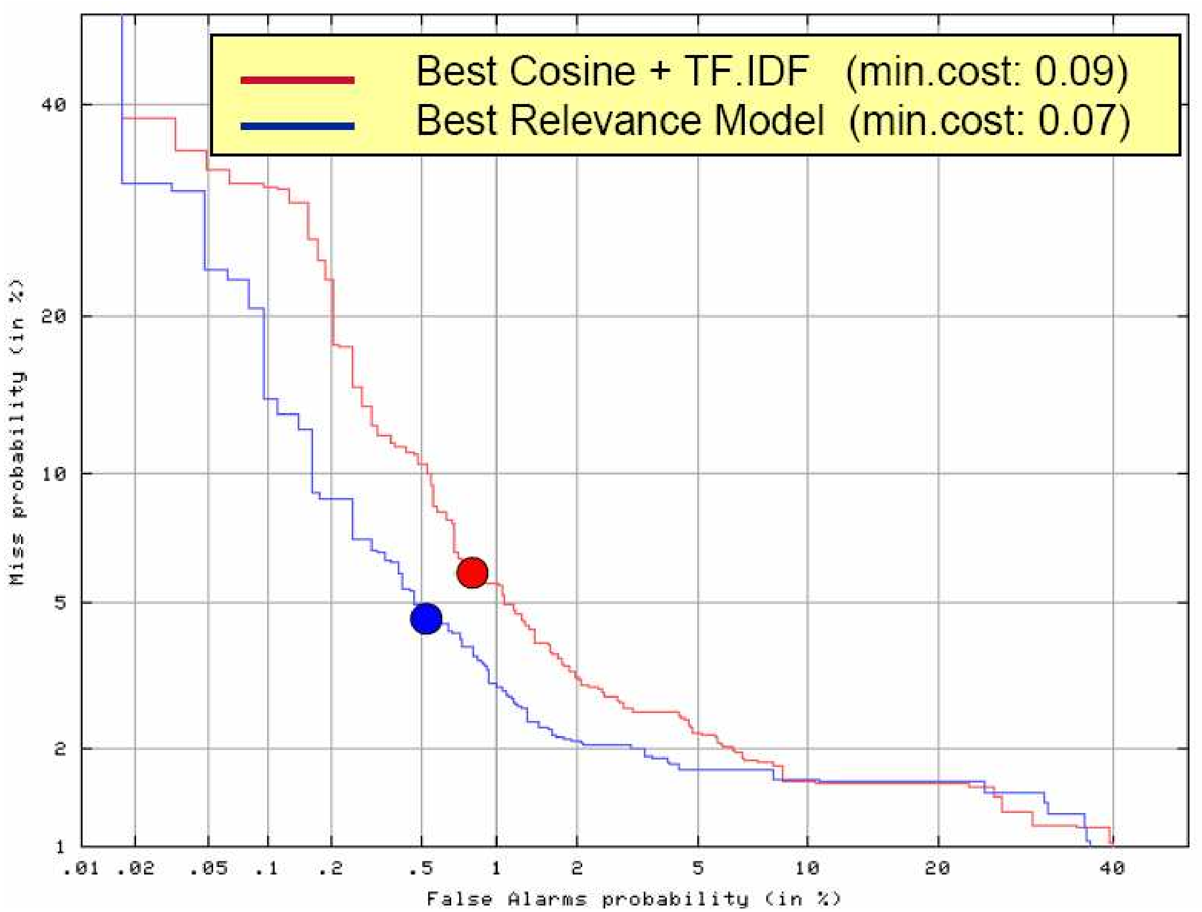
$$D_{sym}(S_1 \| S_2) = \frac{1}{2}\left(D(S_1 \| S_2) + D(S_2 \| S_1)\right)$$

Kullback-Leibler Distance with "Clarity"

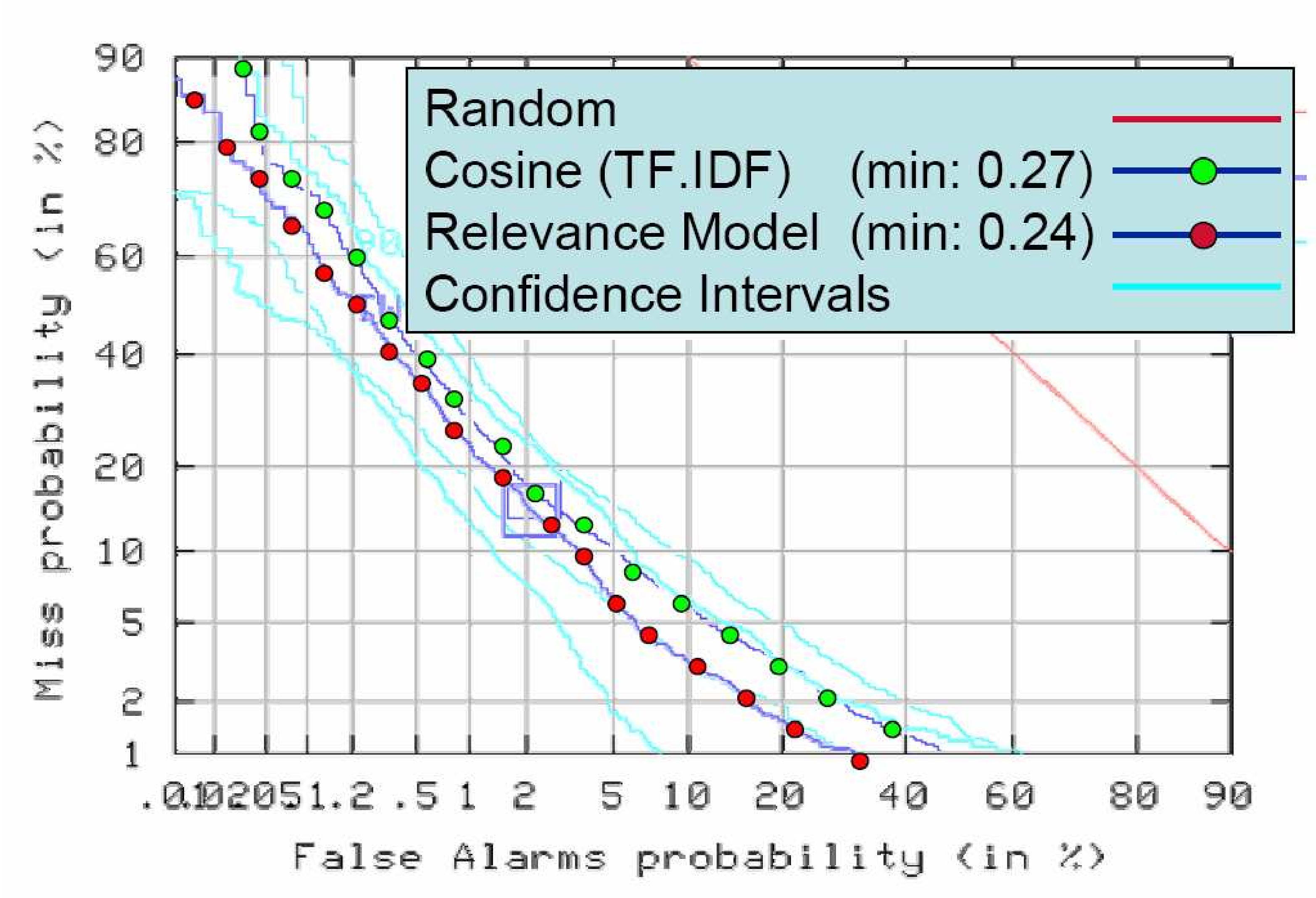
$$D_{Cl}(S_1 \| S_2) = \sum_w P(w|S_1) \log \frac{P(w|S_2)}{P(w|GE)}$$

$$(\mathrm{GE} : \mathrm{general\ english})$$

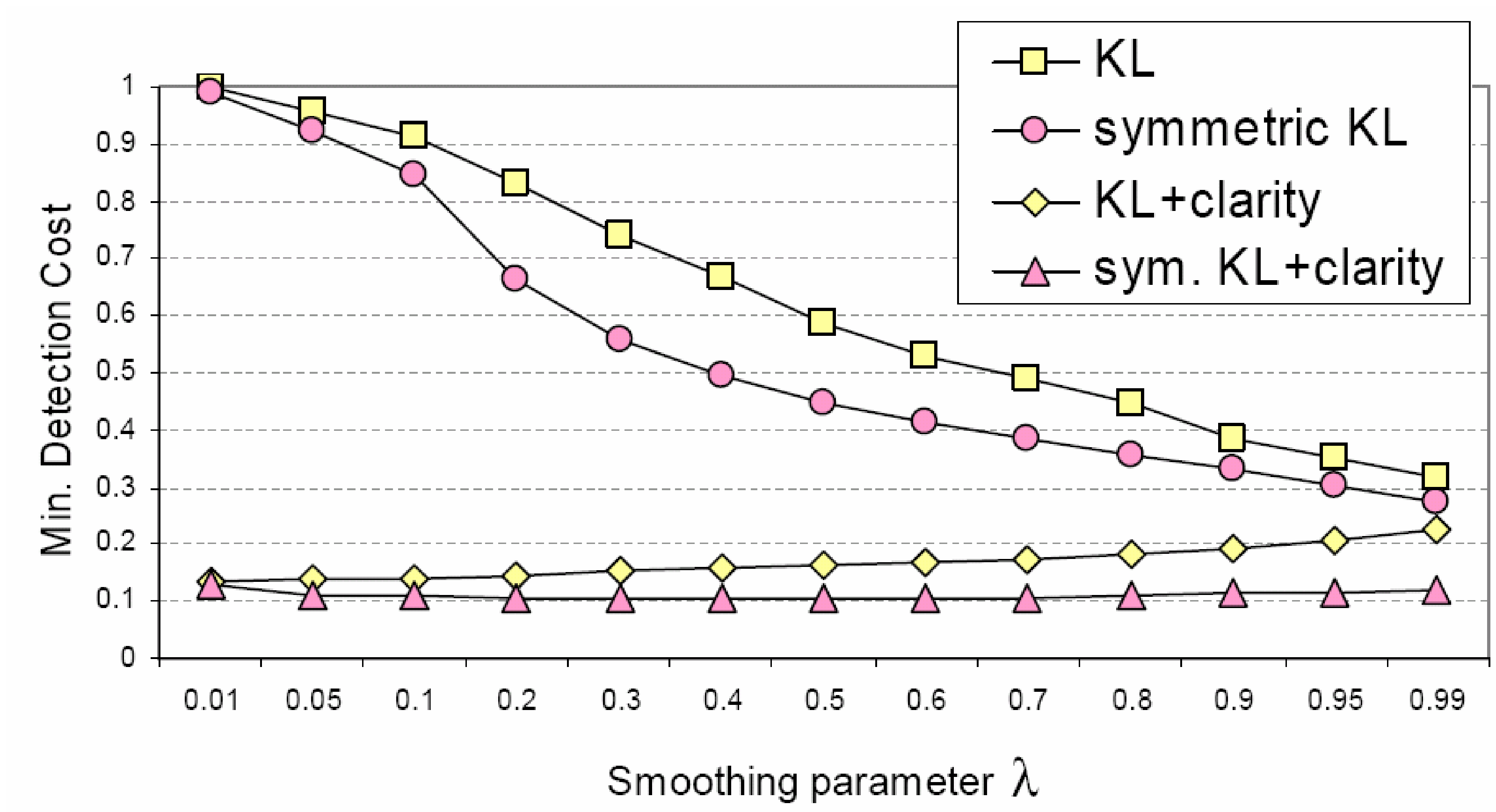
Comparison on Training Data



Comparison on Evaluation Data



Distance Metric /Smoothing



Sym. KL distance + clarity is not only the best method but also is robust against changes in the smoothing

Summary

- TDT:
  - International Benchmark
  - Various sub tasks
- Link detection