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Experiments to Evaluate a Statistical Stemming Algorithm

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Stemming Process

- To design a stemming algorithm it is possible to follow at least two approaches:
  - Based on a-priori linguistic knowledge
  - Based on statistical methods which infer knowledge

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SPLIT: Key Concepts

- Suffix stripping paradigm.
- We build a collection of substrings extracted from words.
- We use a graph notation to represent the collection of substrings: nodes are substrings and an edge exists between 2 nodes only if these 2 substrings form a word.
- Mutual Reinforcing Relationship among prefixes which are stems and suffixes which are derivations.

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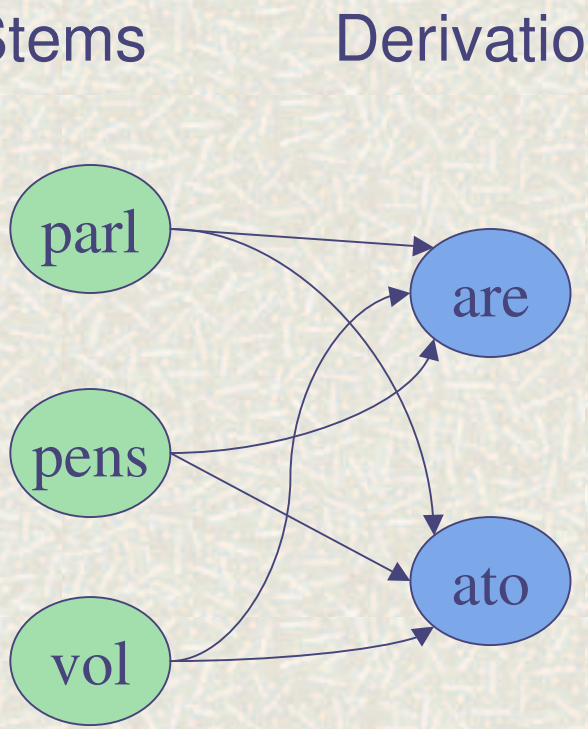
Words Graph Notation

Word	Stem	Derivation
parlare	parl	are
parlato	parl	ato
pensare	pens	are
pensato	pens	ato
volare	vol	are
volato	vol	ato



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The Probabilistic Approach

- We are interested in looking for the prefix x^* such that:

$$x^* = \arg\max_x \; P(x \in S \mid w \in W) = \arg\max_x \frac{P(w \in W \mid x \in S) \cdot P(x \in S)}{P(w \in W)}$$

  - The first term is estimated by the reciprocal of the number of words starting by the substring x
  - The second term is estimated using an iterative algorithm which discloses the mutual reinforcing relationship between stems and derivations (HITS)

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Disclosing Mutual Reinforcing Relationship

- HITS (Hyperlink Induced Topic Search) was originally proposed by J. Kleinberg to discover authoritative web pages.
- In this context, we assign each substring z two scores:

$$s_z^n = \sum_{\forall\, x \text{ prefix of } z} p_x^{n-1} \qquad p_z^n = \sum_{\forall\, y \text{ suffix of } z} s_y^n$$

- We estimated $P(x \in S)$ by the prefix score p_x

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Experiments to Evaluate SPLIT

- SPLIT can perform as effectively as an algorithm developed on the basis of a-priori linguistic knowledge?
- We developed a prototype IR system, called IRON. It is based on the top of an open-source java library, called LUCENE. It implements a vector-spacel model and a *tf·idf* weighting scheme.
- The stemming algorithm was implemented with a set of tools called SPLIT, which carries out the HITS estimation of the probabilities we are interested in.

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Experiments: Runs

- We compared the performances of IRON changing only the stemming algorithm for different runs, all other things being equal.
- We tested four different stemming algorithms:
  - NoStem: No stemming algorithm was applied.
  - Porter-like: An algorithm for the Italian language which applies a list of rules based on a-priori linguistic knowledge.
  - SPLIT: our statistical and graph-based stemming algorithm.
  - SPLIT-L3: the previous algorithm with a little ignition of linguistic knowledge (heuristic rule forcing the stem length to be at least 3).

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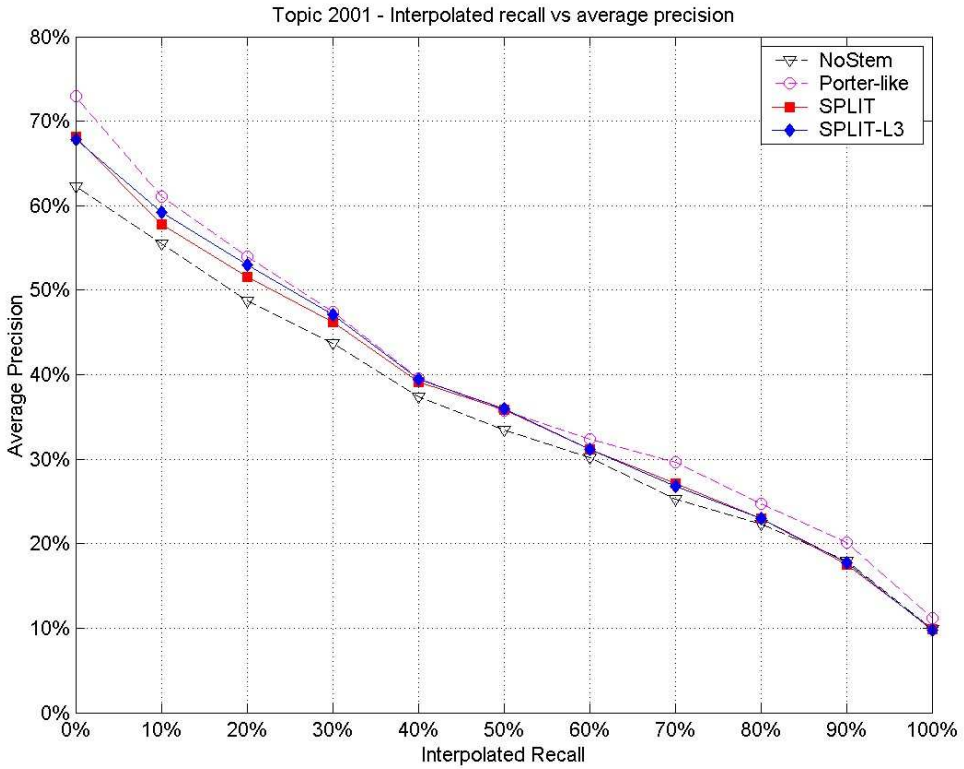
Experiments: 2001 Results



- For Avg-Prec e R-Prec all four methods are statistically equivalent.
- For Precision computed at 10, 20, 30 documents cut off values, stemming improves the performances, and SPLIT performs as effectively as Porter-like.

Algorithm	Avg-Prec
NoStem	0.3387
Porter	0.3753
SPLIT	0.3519
SPLIT-L3	0.3589

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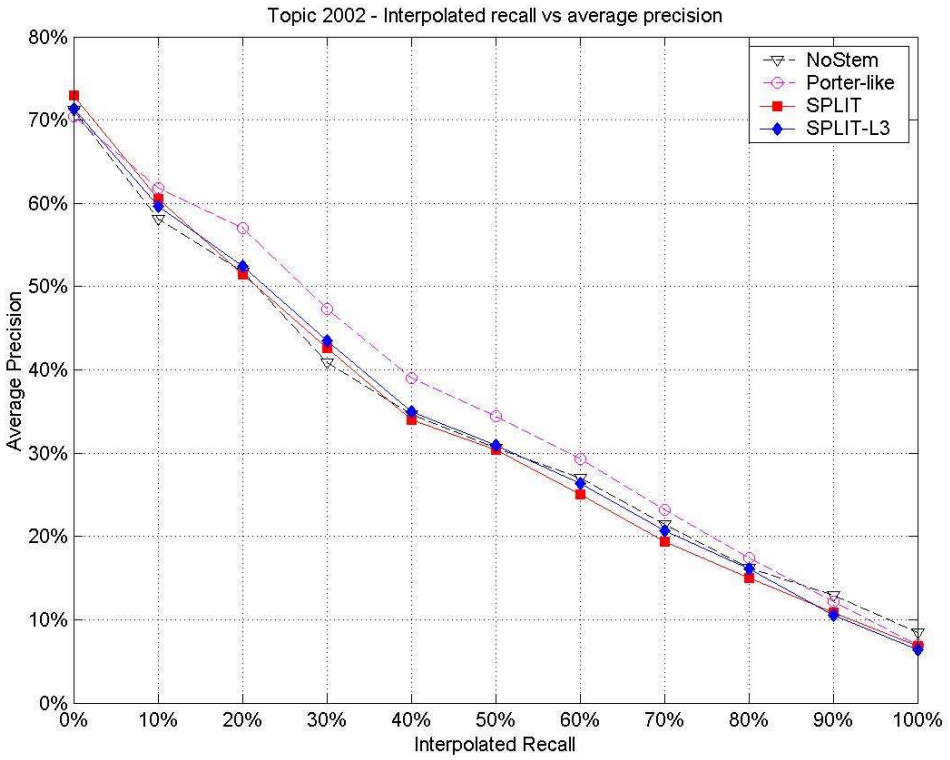
Experiments: 2002 Results



- For R-Prec all four methods are again equivalent. For Avg-Prec there is a moderate statistical indication that Porter algorithm performs better than SPLIT.
- For Precision computed at 10, 20, 30 documents cut off values, all the methods are comparable.

Algorithm	Avg-Prec
NoStem	0.3193
Porter	0.3419
SPLIT	0.3173
SPLIT-L3	0.3200

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Conclusions and Future Work

- Objective: to investigate a stemming algorithm based on a link analysis procedure.
- The results are encouraging because the effectiveness level of SPLIT is comparable at least to that of an algorithm based on a-priori linguistic knowledge.
- Future work:
  - Further experiments with other languages, in order to test if it is a language-independent stemming algorithm.
  - To improve the probabilistic decision criterion.
  - To use a weighted graph model.

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Thank you