Analysis and performance of morphological query expansion and language-filtering words on Basque web searching

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Contents

- Introduction
- Current study
- Morphological query expansion
- Language-filtering words
- Conclusions

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Basque IR problems

- Looking for conjugations and inflections
  - Basque is an agglutinative language
  - A given lemma makes many different surface forms: *lan* ("work"), *lana* ("the work"), *lanak* ("the works"), *lanari* ("to the work"), *lanei* ("to the works"), *lanaren* ("of the work")...
  - Looking only for the exact given word, or the word plus an "s" for the plural, is not enough
  - Wildcards are not an appropriate solution: looking for lan* would also return forms of the words *lanabes* ("tool"), *lanbro* ("fog")...

Basque IR problems

- Language discrimination
  - No search engine offers the possibility of returning only pages in Basque
  - Big problem when looking for technical words that exist also in other languages (*anorexia*, *sulfuroso*, *byte*, *allegro*, *sistema*, *energia*...), short words (*katu*, *ur*...) or proper nouns (*Egipto*, *Newton*, *Pluton*...)
  - Many non-Basque results are returned, often no Basque results at all

Our approach

- API based
  - We use APIs of major search engines
  - Cost-effective solution
  - NLP techniques applied to obtain better results

Our approach

- Morphological query expansion or MQE (I)
  - We use a morphological generator for Basque created by the IXA Group of the University of the Basque Country
  - We obtain all the forms of a given lemma
  - We ask the search engine for all of them using an OR operator
  - etxe => etxe OR etxea OR etxeak OR etxeari OR etxeei OR etxeek OR…

Our approach

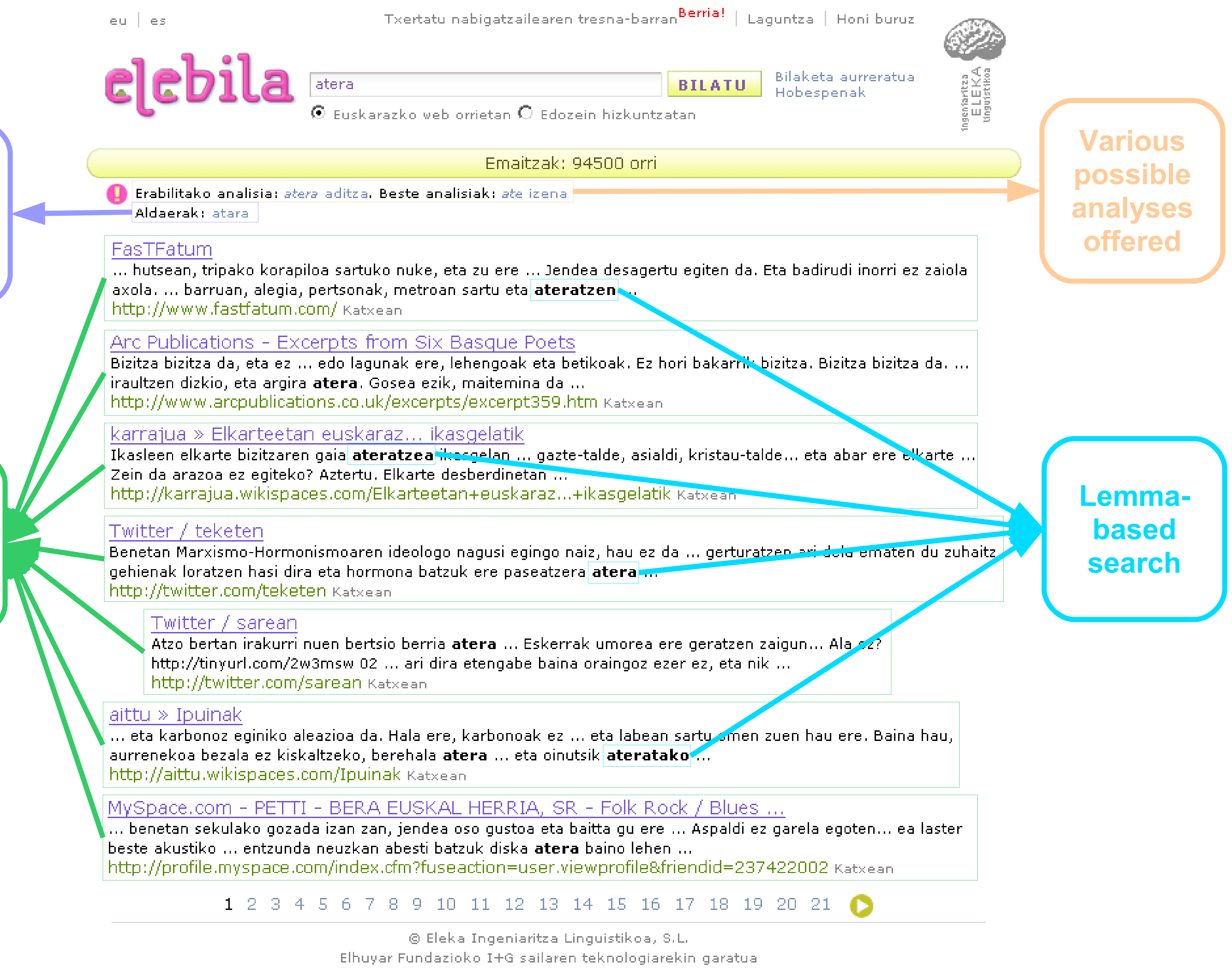
- Morphological query expansion or MQE (II)
  - The APIs of the search engines have each a limit in number of words of the queries
  - This makes real lemma-based search impossible
  - But good results can be obtained if the forms sent in the query are the most frequent ones

Our approach

- Language-filtering words or LFW
  - Some of the most frequent Basque words are added to the query using an AND operator
  - Several LFWs have to be used, since the most frequent words in Basque exist in other languages too
  - The more LFWs used, the better language-precision we obtain, but with loss in recall

Tools built

- Elebila
  - Search service for Basque
  - API based
  - Lemma-based search (MQE)
  - Returns pages in Basque alone (LFWs)
  - Optional search for variants of words
  - Optional lemma-based search for whole noun phrases or terms (including them in double quotes)
  - http://www.elebila.eu



eu | es

Txertatu nabigatzailearen tresna-barran Berria! | Laguntza | Honi buruz

elebila

atera BILATU

Bilaketa aurreratua
Hobespenak

● Euskarazko web orrietan ○ Edozein hizkuntzatan

Emaitzak: 94500 orri

Erabilitako analisia: atera aditza. Beste analisiak: ate izena
Aldaerak: atara

FasTFatum
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http://www.fastfatum.com/ Katxean

Arc Publications - Excerpts from Six Basque Poets
Bizitza bizitza da, eta ez ... edo lagunak ere, lehengoak eta betikoak. Ez hori bakarrik bizitza. Bizitza bizitza da. ... iraultzen dizkio, eta argira **atera**. Gosea ezik, maitemina da ...
http://www.arcpublications.co.uk/excerpts/excerpt359.htm Katxean

karrajua » Elkarteetan euskaraz... ikasgelatik
Ikasleen elkarte bizitzaren gaia **ateratzea** ikasgelan ... gazte-talde, asialdi, kristau-talde... eta abar ere elkarte ... Zein da arazoa ez egiteko? Aztertu. Elkarte desberdinetan ...
http://karrajua.wikispaces.com/Elkarteetan+euskaraz...+ikasgelatik Katxean

Twitter / teketen
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http://twitter.com/teketen Katxean

Twitter / sarean
Atzo bertan irakurri nuen bertsio berria **atera** ... Eskerrak umorea ere geratzen zaigun... Ala ez? http://tinyurl.com/2w3msw 02 ... ari dira etengabe baina oraingoz ezer ez, eta nik ...
http://twitter.com/sarean Katxean

aittu » Ipuinak
... eta karbonoz eginiko aleazioa da. Hala ere, karbonoak ez ... eta labean sartu omen zuen hau ere. Baina hau, aurrenekoa bezala ez kiskaltzeko, berehala **atera** ... eta oinutsik **ateratako** ...
http://aittu.wikispaces.com/Ipuinak Katxean

MySpace.com - PETTI - BERA EUSKAL HERRIA, SR - Folk Rock / Blues ...
... benetan sekulako gozada izan zan, jendea oso gustoa eta baitta gu ere ... Aspaldi ez garela egoten... ea laster beste akustiko ... entzunda neuzkan abesti batzuk diska **atera** baino lehen ...
http://profile.myspace.com/index.cfm?fuseaction=user.viewprofile&friendid=237422002 Katxean

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

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Elhuyar Fundazioko I+G sailaren teknologiarekin garatua

Variant suggestion

Various possible analyses offered

All results in Basque

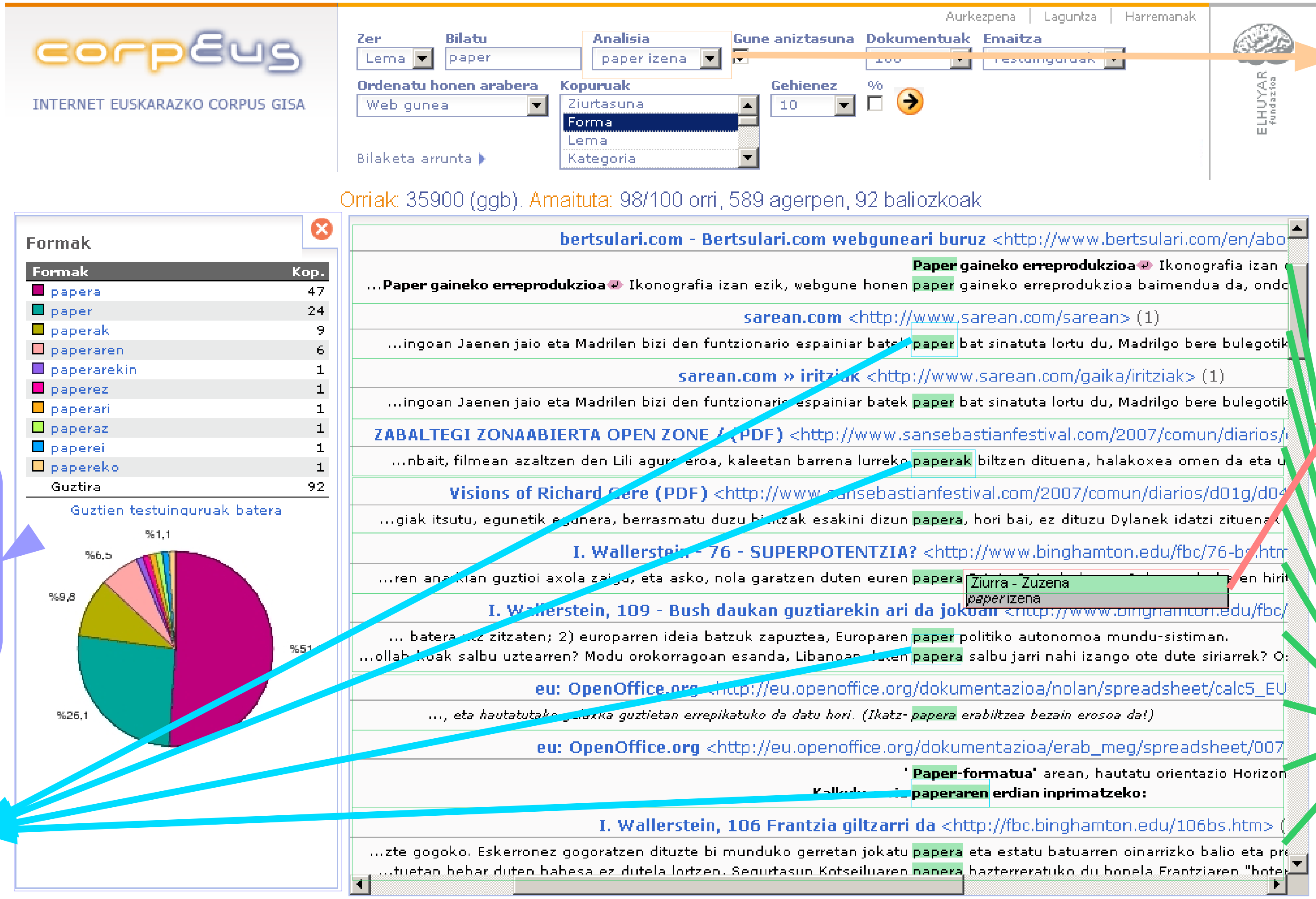
Lemma-based search

Tools built

- CorpEus (I)
  - Web-as-corpus tool for Basque
  - API based
  - Lemma-based search (MQE)
  - Returns occurrences in Basque alone (LFWs)
  - Optional search for variants of words
  - Optional lemma-based search for whole noun phrases or terms (including them in double quotes)

Tools built

- CorpEus (II)
  - Parallel downloading of pages
  - Analyses of the results
  - Different ordering criteria
  - Occurrence counts and charts
  - http://www.corpeus.org



corpEus

INTERNET EUSKARAZKO CORPUS GISA

Aurkezpena | Laguntza | Harremanak

Orriak: 35900 (ggb). Amaituta: 98/100 orri, 589 agerpen, 92 baliozkoak

Formak

Formak	Kop.
papera	47
paper	24
paperak	9
paperaren	6
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Guztira	92

Guztien testuinguruak batera

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Visions of Richard Gere (PDF) <http://www.sansebastianfestival.com/2007/comun/diarios/d01g/d04

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'**Paper-formatua**' arean, hautatu orientazio Horizon

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Various possible analyses offered

Analysis of the results

All results in Basque

Occurrence counts and charts

Lemma-based search

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Current study

- Analysis and performance measurement of MQE and LFWs
- Corpora based

Current study

- Implementation details of the methodology very important in its performance
    - Cases for MQE
    - Which and how many LFWs
- Previously
    - LFWs chosen based on a classic corpus
    - Cases for MQE quite intuitively
    - Improvement not measured quantitatively

Corpora used

- ZT Corpusa
  - Corpus of Science and Technology
  - 7.6 million words
- A web corpus
  - Downloaded all the pages of the Basque branch of Google Directory (+3,000) and recursively followed links of pages in Basque
  - 44,000 documents
  - 20 million words

Words used

- Some words needed to perform the various measurements
  - For observing the most frequent cases for MQE
  - For measuring the language-precision obtained by LFWs
- Most asked-for words of the Elebila logs
  - Four months, 400,000 queries, 800,000 words, 70,000 different words
  - Lemmatised and used the most frequent ones

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Most frequent cases

- Observed which are the most frequent cases
  - For each POS
  - Using the most frequently asked-for words of Elebila
  - Using both corpora
  - We have opted for the web corpus lists

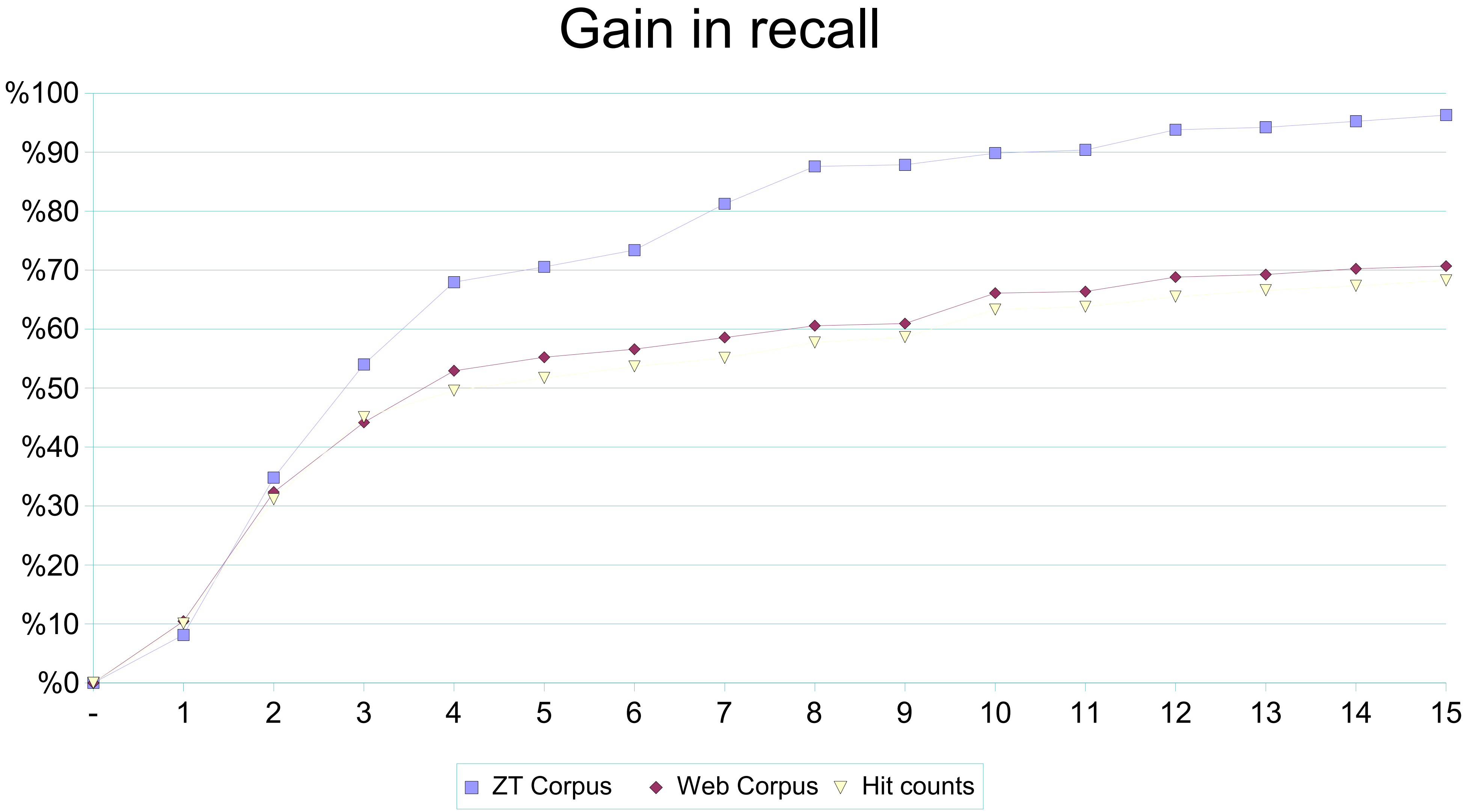
Most frequent cases

	Verb	Adjective	Noun	Proper noun	Place name
1	Participle / perfective aspect (*sortu*)	Nominative singular (*berria*)	Nominative indefinite (*hiztegi*)	Nominative (*Mikel*)	Nominative (*Egipto*)
2	Imperfective aspect (*sortzen*)	Nominative plural/Ergative singular (*berriak*)	Nominative singular (*hiztegia*)	Ergative (*Mikelek*)	Genitive locative (*Egiptoko*)
3	Verbal noun + *-ko* (*sortzeko*)	Nominative indefinite (*berri*)	Nominative plural/Ergative singular (*hiztegiak*)	Genitive (*Mikelen*)	Inessive (*Egipton*)
4	Unrealized aspect (*sortuko*)	Genitive plural (*berrien*)	Genitive locative singular (*hiztegiko*)	Dative (*Mikeli*)	Allative (*Egiptora*)
5	Short stem (*sor*)	Inessive singular (*berrian*)	Genitive singular (*hiztegiaren*)	Associative (*Mikelekin*)	Ablative (*Egiptotik*)
6	Verbal noun + Nominative singular (*sortzea*)	Genitive singular (*berriaren*)	Dative singular (*hiztegiari*)	Genitive + Nominative singular (*Mikelena*)	Genitive (*Egiptoren*)
7	Adjectival participle (*sortutako*)	Associative singular (*berriarekin*)	Inessive singular (*hiztegian*)	Partitive (*Mikelik*)	Dative (*Egiptori*)
8	Participle + Nominative singular (*sortua*)	Ergative indefinite (*berrik*)	Partitive (*hiztegirik*)	Genitive + Nominative Plural/Ergative singular (*Mikelenak*)	Genitive locative + Nominative singular (*Egiptokoa*)
9	Dynamic adverbial participle (*sortuz*)	Dative singular (*berriari*)	Instrumental indefinite (*hiztegiz*)	Instrumental (*Mikelez*)	Allative + Genitive locative (*Egiptorako*)
10	*-ta*/*-da* stative adverbial participle (*sortuta*)	Instrumental indefinite (*berriz*)	Instrumental singular (*hiztegiaz*)	Inessive (*Mikelengan*)	Associative (*Egiptorekin*)
11	Participle + Nominative plural/Ergative singular (*sortuak*)	Inessive indefinite (*berritan*)	Genitive singular + Nominative singular (*hiztegiarena*)		Genitive locative + Nominative plural/Ergative singular (*Egiptokoak*)
12	Verbal noun + Inessive singular (*sortzean*)	Sociative plural (*berriekin*)	Genitive plural (*hiztegien*)		Destinative (*Egiptorentzat*)
13	*-(r)ik* stative adverbial participle (*sorturik*)	Inessive plural (*berrietan*)	Sociative singular (*hiztegiarekin*)		Instrumental (*Egiptoz*)
14	Verbal noun + Allative singular (*sortzera*)	Genitive locative singular (*berriko*)	Ablative singular (*hiztegitik*)		Terminal allative (*Egiptoraino*)
15	Adjectival participle + Nominative plural/Ergative singular (*sortutakoak*)	Partitive (*berririk*)	Allative singular (*hiztegira*)		Genitive locative + Inessive singular (*Egiptokoan*)

Gain in recall

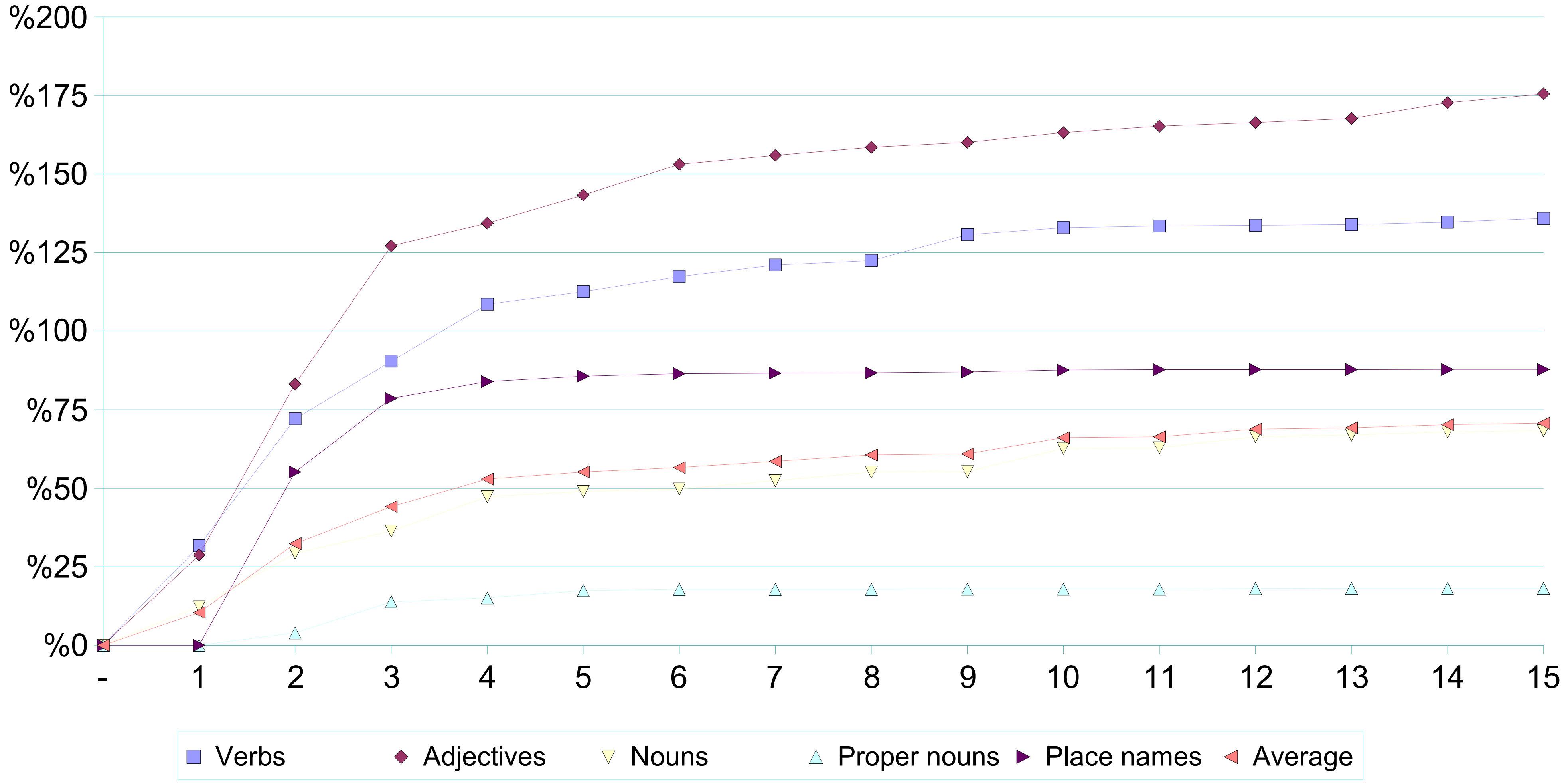
- Measured the gain in recall that would be obtained by including 1, 2, 3... of the most frequent cases in the queries within OR operators
- Using both corpora and also hit counts of Microsoft's Live Search API
- The remarkable similarity between the web corpus and hit counts series prove our supposition that it was better to base our study in a web corpus

Gain in recall



Gain in recall

Gain in recall for each POS in the web corpus



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Choosing the words

- Language-filtering words need to be:
  - Very frequent, so that as many Basque pages as possible contain them
  - Specifically Basque, so that as few pages in other languages as possible contain them
- Observed which are the most frequent Basque words
  - Using both corpora

Choosing the words

Web corpus		**ZT Corpus**	
eta ("and")	91.94%	*eta* ("and")	98.44%
da ("is")	74.37%	*da* ("is")	92.67%
ez ("no")	64.51%	*ez* ("no")	79.05%
du ("has")	64.11%	*dira* ("are")	78.65%
bat ("a")	62.81%	*ere* ("too")	78.27%
ere ("too")	55.65%	*du* ("has")	75.49%
dira ("are")	55.45%	*izan* ("be")	73.45%
izan ("be")	54.24%	*dute* ("have")	72.14%
egin ("do")	52.77%	*bat* ("a")	67.66%
beste ("other")	47.74%	*baina* ("but")	64.41%
edo ("or")	42.94%	*den* ("that is")	64.04%
dute ("have")	41.72%	*egin* ("do")	62.56%
den ("that is")	39.19%	*beste* ("other")	57.21%
egiten ("doing")	38.98%	*baino* ("than")	56.77%
baina ("but")	36.94%	*egiten* ("doing")	55.78%
baino ("than")	27.29%	*edo* ("or")	55.59%

Choosing the words

- We have opted for the web corpus words
- *eta* and *da* are the clear first candidates because of the significant difference in frequency with the next ones
- Tried precision-recall on different combinations of the first six words: *eta*, *da*, *ez*, *du*, *bat* and *ere*

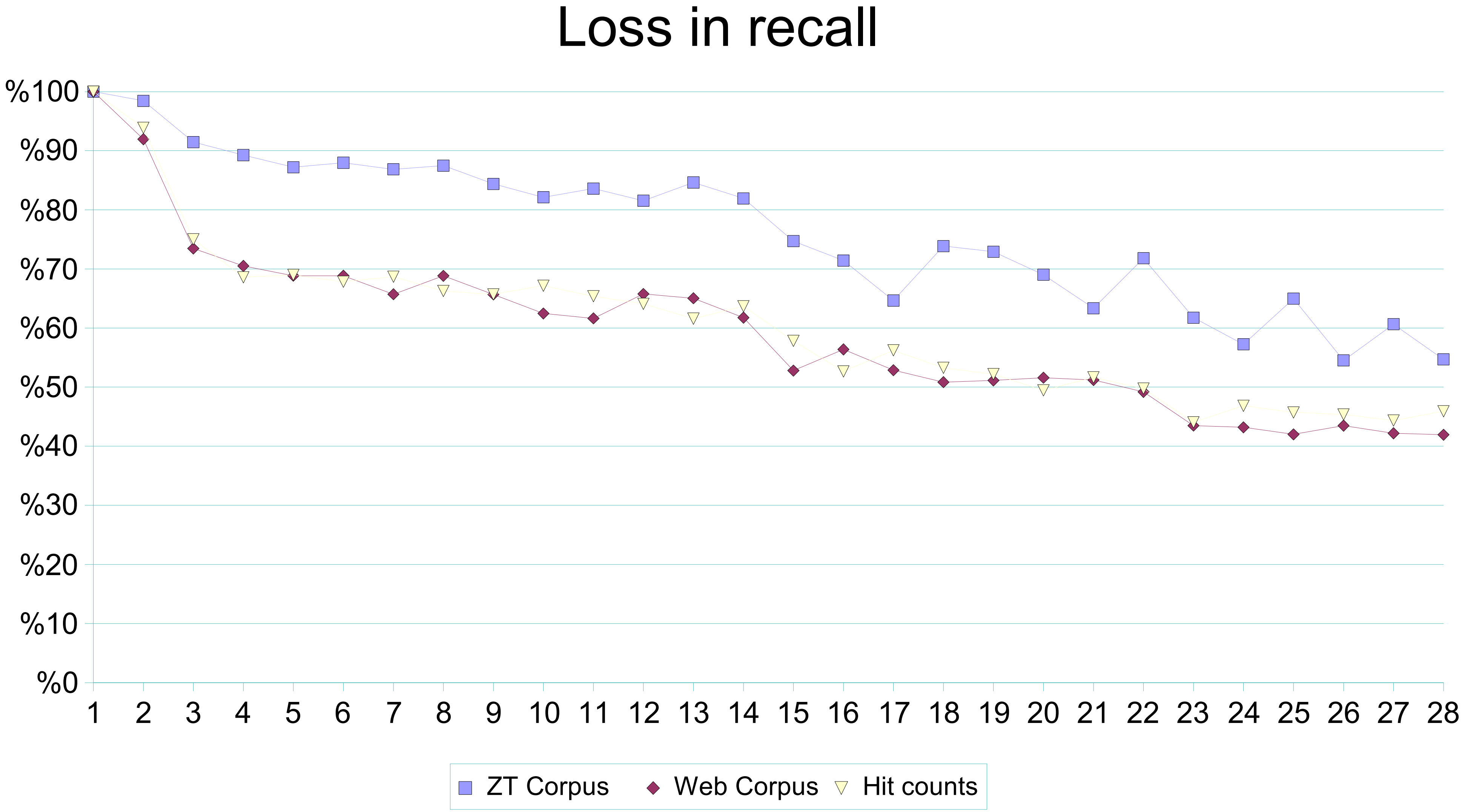
Choosing the words

Combinations	
0 words	-
1 word	*eta*
2 words	*eta* AND *da*
3 words	*eta* AND *da* AND (*ez* OR *du* OR *bat* OR *ere*)
	eta AND *da* AND (*ez* OR *du* OR *bat*)
	eta AND *da* AND (*ez* OR *du* OR *ere*)
	eta AND *da* AND (*ez* OR *bat* OR *ere*)
	eta AND *da* AND (*du* OR *bat* OR *ere*)
	eta AND *da* AND (*ez* OR *du*)
	eta AND *da* AND (*ez* OR *bat*)
	eta AND *da* AND (*ez* OR *ere*)
	eta AND *da* AND (*du* OR *bat*)
	eta AND *da* AND (*du* OR *ere*)
	eta AND *da* AND (*bat* OR *ere*)
	eta AND *da* AND *ez*
	eta AND *da* AND *du*
	eta AND *da* AND *bat*
	eta AND *da* AND *ere*
4 words	*eta* AND *da* AND *ez* AND (*du* OR *bat* OR *ere*)
	eta AND *da* AND *du* AND (*ez* OR *bat* OR *ere*)
	eta AND *da* AND *bat* AND (*ez* OR *du* OR *ere*)
	eta AND *da* AND *ere* AND (*ez* OR *du* OR *bat*)
	eta AND *da* AND *ez* AND *du*
	eta AND *da* AND *ez* AND *bat*
	eta AND *da* AND *ez* AND *ere*
	eta AND *da* AND *du* AND *bat*
	eta AND *da* AND *du* AND *ere*
	eta AND *da* AND *bat* AND *ere*

Loss in recall

- Measured the loss in recall
- Using both corpora and also hit counts of Microsoft's Live Search API
- Again the remarkable similarity between the web corpus and hit counts series confirm our supposition that it was better to base our study in a web corpus

Loss in recall

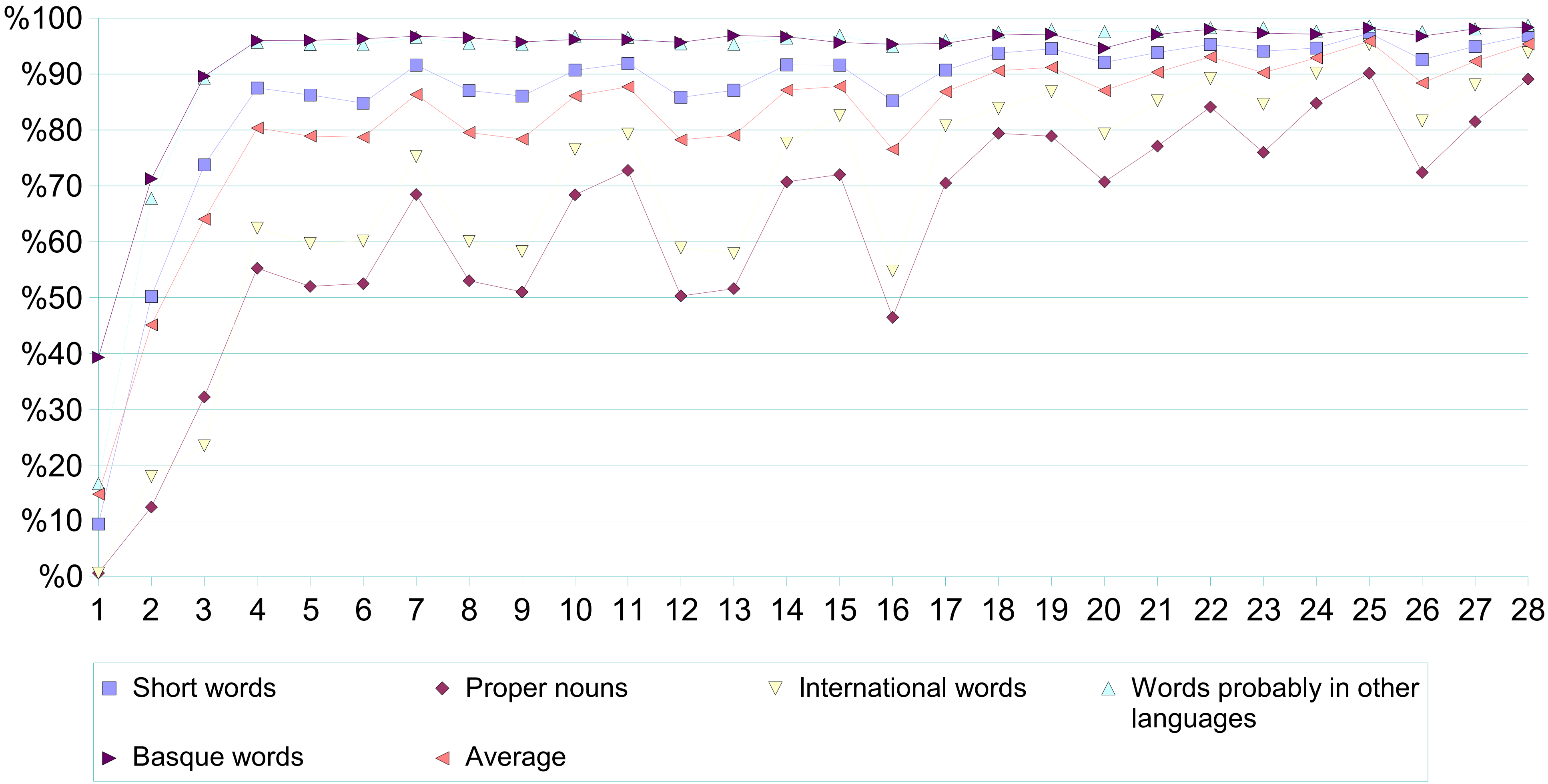


Gain in language-precision

- Impossible to measure the gain in precision over corpora: we would need a multilingual corpus with the same proportions of each language as in the web
- Instead used Microsoft Live Search's API
- Combined with LangId, an automatic language classifier specialized on Basque
- Applied LangId to the snippets returned by the API

Gain in language-precision

Gain in precision for each category of word



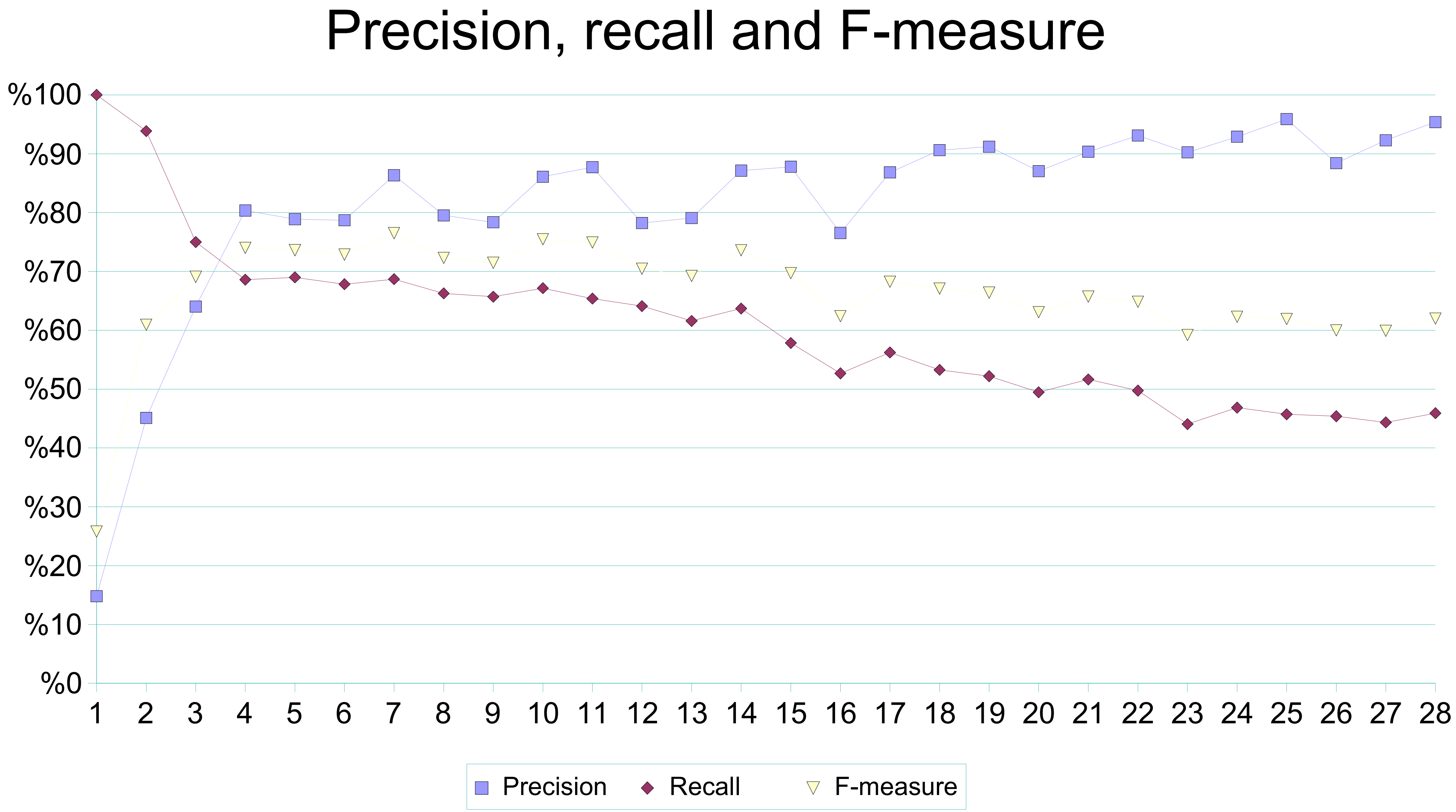
Gain in language-precision

- Observing the peaks and valleys gives indications as to which can be the best and worst words for being LFWs
  - Valleys contain *du* (a very common French word)
  - Peaks contain *ere*, but *bat* and *ez* also perform well

Best LFW combination

- For choosing the best LFW combination, we put together the precision and recall, and also the F-measure

Best LFW combination



Best LFW combination

- 4-word combinations can obtain a language-precision high above 90%, but with a recall near or below 50%
- 3-word combinations without *du* are the ones with the highest F-measure, as they achieve a precision of 86-87% and a recall of 68-65%; but for proper nouns or international words precision falls to 70%

Best LFW combination

- Two implementation options
  - Keep a database of the most searched-for proper nouns an international words, and use a 4-word combination for them and a 3-word combination otherwise
  - Use a 4-word combination by default to prioritise precision and, if the user does not find what he/she was looking for, offer the possibility of retry increasing recall (with a 3-word combination)

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Conclusions

- This study has produced very valuable data for Basque IR projects (most frequent cases for MQE, best word combinations for LFWs, etc.)
- Specifically, they will soon be applied in the Basque web services Elebila and CorpEus

Conclusions

- The study has also produced quantitative precision-recall measurements, proving that MQE and LFWs clearly improve the performance of search engines for Basque
  - LFWs raise precision from 15% to even 90%, although with a non-negligible loss in recall
  - MQE can improve recall up to 70%

Conclusions

- MQE and LFWs can be valid for building web IR services for other agglutinative or under-resourced languages in a cost-effective way, and also the corpora-based methodology described here can be used to define the implementation details and measure the improvement obtained

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