Different Contributions to Cost-Effective Transcription and Translation of Video Lectures

Thesis

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- Internet has brought new opportunities to academic institutions.
- Multimedia repositories as fundamental knowledge assets.
- Subtitles are really needed in these repositories.
- Most repositories are neither transcribed nor translated.
- **Cost-effective** transcription and translation of video repositories.

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Scientific and Technological Goals

- To propose an approach to explicit length modelling for SMT.
- To develop efficient audio segmentation systems.
- To design a system architecture for ASR and SMT integration.
- To improve adaptation techniques for ASR and SMT.
- To design recommender systems using speech transcriptions.
- To evaluate these contributions in real-life scenarios.

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- Length modelling is a well-known problem.
- Focus on **explicit** length modelling for SMT.
- Comparative study on phrase length modelling for SMT.
- Two novel length models for phrase-based SMT are presented.

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SMT and Log-linear Modelling

Search the most likely translation $\hat{y}$:

$$\begin{aligned}\hat{y} &= \arg\max_y \; p(y \mid x) \\ &\approx \arg\max_y \; \frac{1}{Z(x)} \exp\left(\sum_i \lambda_i f_i(x,y)\right) \\ &= \arg\max_y \; \sum_i \lambda_i f_i(x,y)\end{aligned}$$

where feature functions $f_i(x,y)$ are logs of:

- Phrase-based translation models: $p(\bar{y} \mid \bar{x})$, $p(\bar{x} \mid \bar{y})$.
- Lexical models: $l(\bar{y} \mid \bar{x})$, $l(\bar{x} \mid \bar{y})$.
- Language model: $p(\bar{y})$.
- Reordering models.
- **Phrase-length models**: std and spc (param/non-param).

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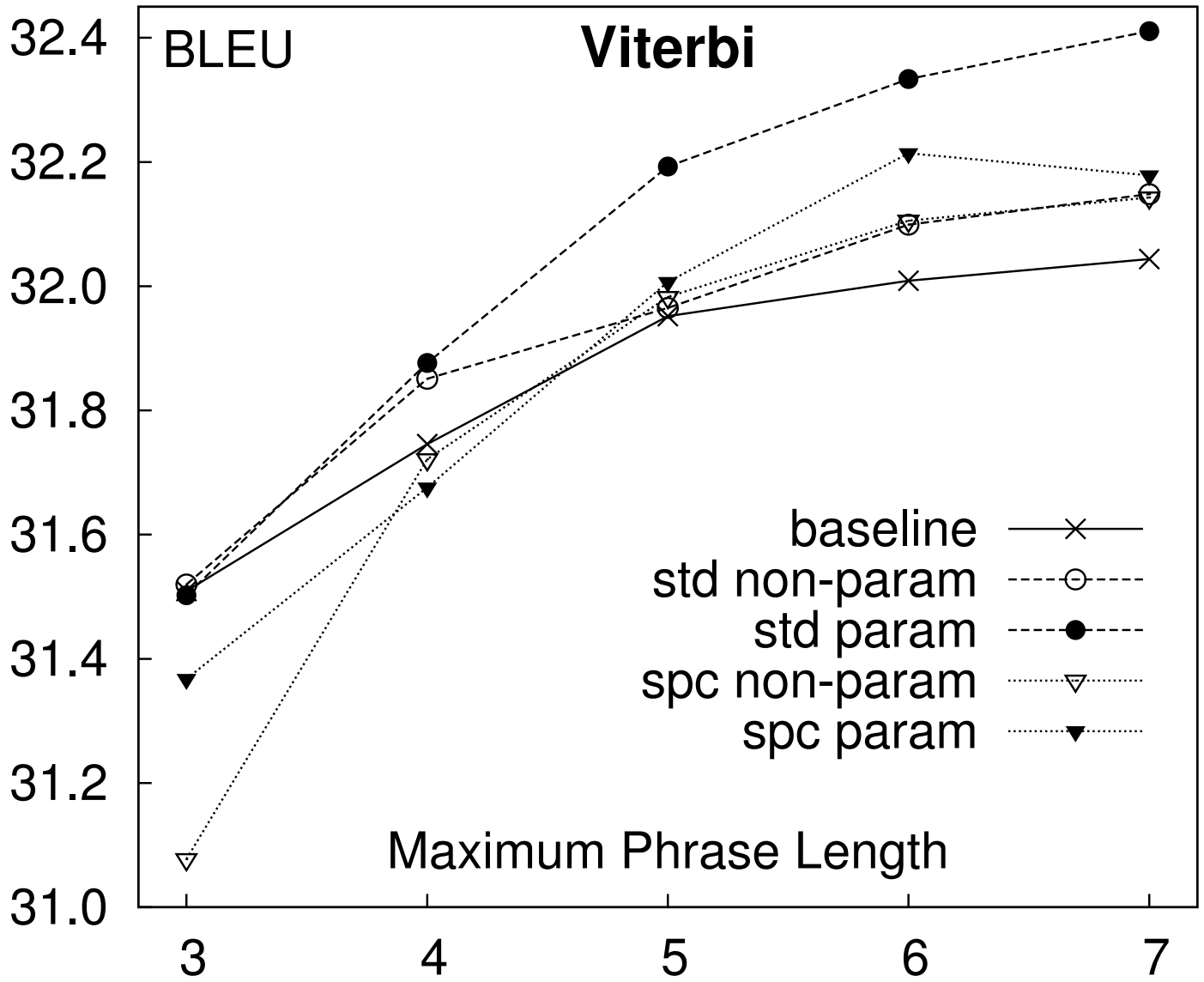
Europarl En→Es (train 1M, test 2K)



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- Two novel phrase-length models for phrase-based SMT.
- **Statistically significant improvements** on all language pairs.
- Length models behave differently depending on the task.
- Trade-off between model complexity and data sparseness.

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- The temporal cost of ASR depends on the input length.
- Only speech segments should be delivered to ASR systems.
- A prior segmentation can provide a better transcription quality.
- A **fast GMM-HMM Audio Segmentation** system is proposed.
- Albayzin Audio Segmentation Evaluation 2012.

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System description

- AS can be seen as a simplified case of ASR.
- Reduced set of acoustic classes $\mathscr{C}$ (i.e. speech, noise, music).
- Search for a sequence of class labels $\hat{c}$ so that

$$\begin{aligned}\hat{c} &= \arg\max_{c \in \mathscr{C}^*} p(c \mid x) \\ &= \arg\max_{c \in \mathscr{C}^*} p(x \mid c)\, p(c)\end{aligned}$$

where:

$p(x \mid c)$ GMM-HMM based acoustic model.
$p(c)$ n-gram language model.

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Albayzin Audio Segmentation Evaluation 2012

- Albayzin corpus: 111h train, 18h blind test.

	SER			
	Speech	Music	Noise	Overall
test	1.9	36.8	46.5	26.5

- Real Time Factor (RTF) values close to zero.
- Final standings for the Albayzin 2012 Competition:

Pos.	System	SER
1	AHOLAB-EHU	26.3
2	**MLLP-UPV**	**26.5**
3	GTM-UVIGO	28.1
4	...	> 33

- MLLP was the fastest among the two best (RTF 0.001 vs 1.6).

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Conclusions

- Simple AS approach based on current ASR technology.
- **Excellent performance** when detecting speech segments.
- Improvable results when dealing with noise and music.
- **Extremely fast** segmentation.
- Among the best two systems in the Albayzin 2012 Evaluations.

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- System architecture to **integrate ASR and MT** technologies.
- **Collaborative framework** to review automatic subtitles.
- Adopted in the EU project trans**Lectures**.
  1. Improvement of transcription & translation by massive adaptation.
  2. Improvement of transcription & translation by intelligent interaction.
  3. Integration into Opencast to enable real-life evaluation.
- Focus on the integration with the poliMedia video repository.

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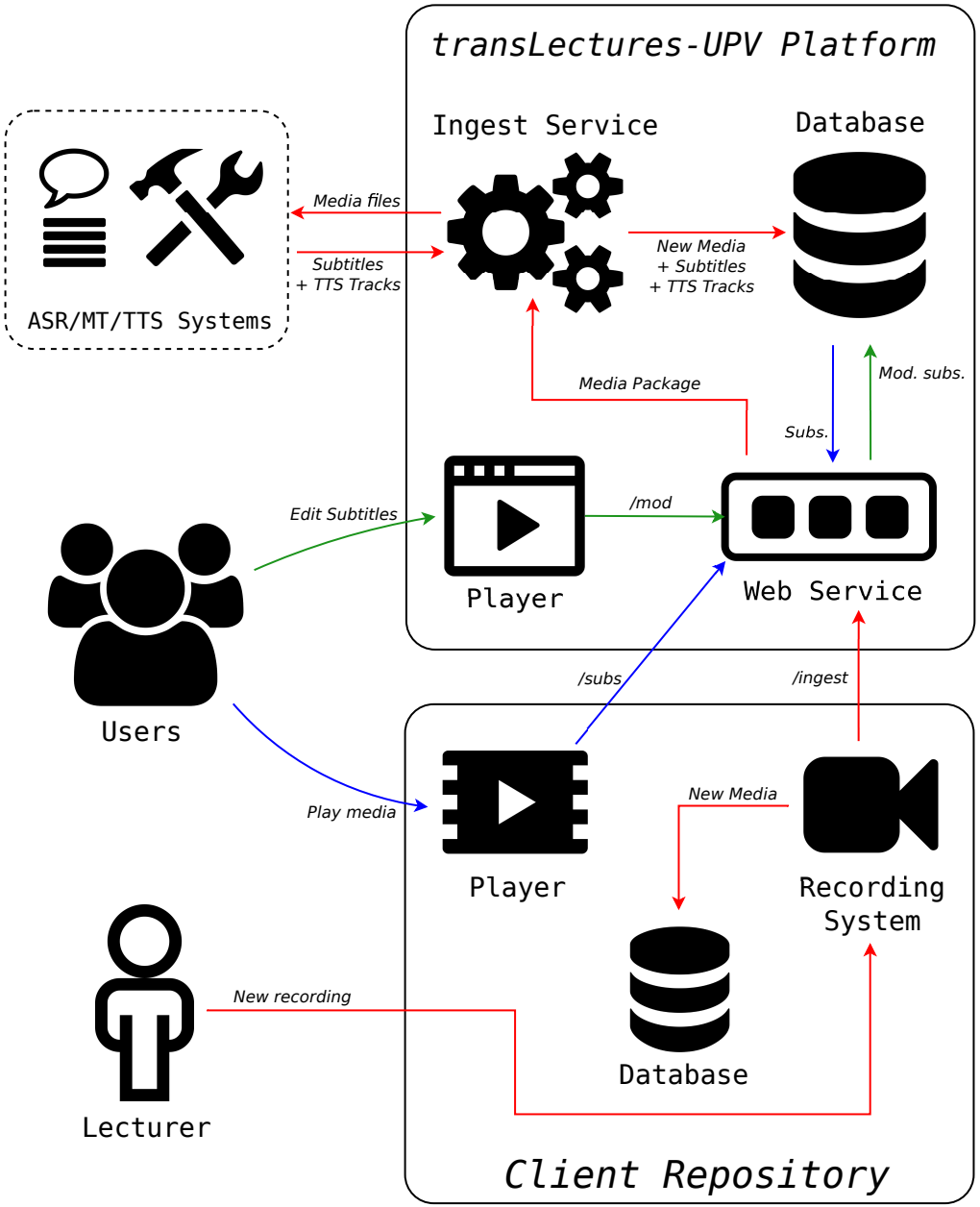
System Architecture and Use Cases



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The transLectures-UPV Platform (TLP) and poliMedia

- TLP is the **open source toolkit** implementing the architecture.
- In production at the UPV's **poliMedia** video lecture repository.
- Service for the distribution of multimedia educational content.
- Courses in videos accompanied by time-aligned slides.
- Statistics of the poliMedia repository (September 2015):

Lectures	15436
Duration (hours)	3079
Avg. Lecture Length (minutes)	12
Speakers	1759
Avg. Lectures per Speaker	8

  - Spanish (88%), English (7%), Catalan (3%), others (2%).

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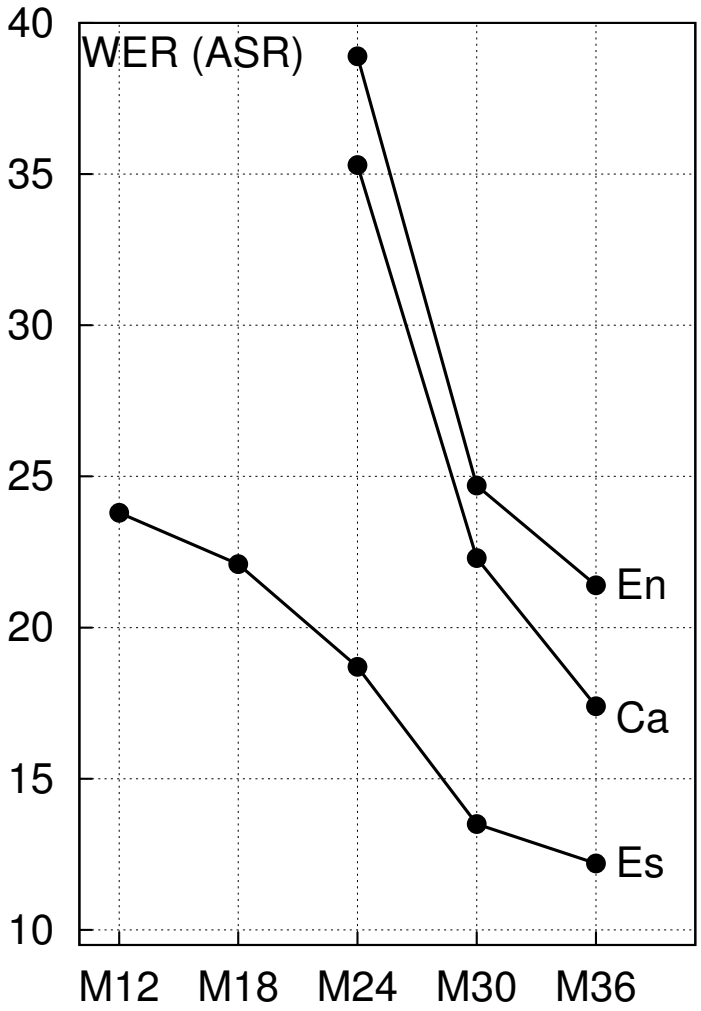
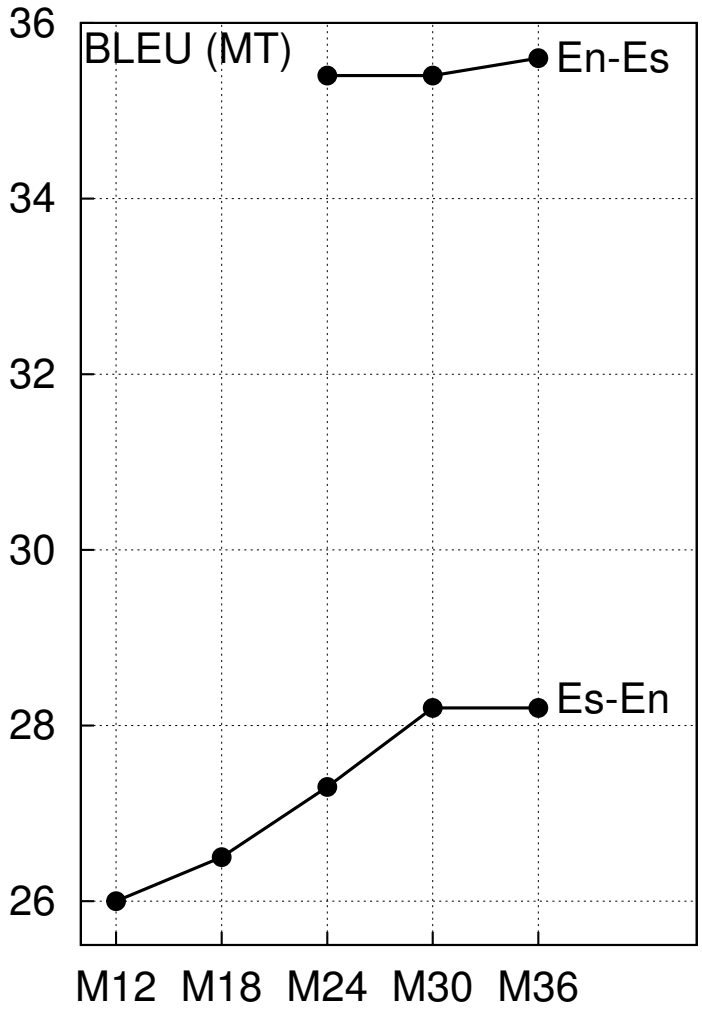
TLP integration into poliMedia and VideoLectures.NET

- In M12 (October 2012):
  - First Spanish (Es) ASR system.
  - First Es→En MT system.
  - All Spanish lectures were transcribed and translated into English.
- In M24 (October 2013):
  - First Catalan (Ca) and English (En) ASR systems.
  - First Ca↔Es, Ca↔En and En→Es MT systems.
  - All poliMedia lectures subtitled in Spanish, English and Catalan.
  - Any newly recorded lecture was automatically processed in TLP.
- poliMedia was **re-transcribed** and **re-translated** every 6 months.
- Platform assesment: automatic and human evaluations.
- Integration into VideoLectures.NET was similar.

TLP integration: automatic evaluations





TLP integration: user evaluations at the UPV

- **Docència en Xarxa (DeX)** programme of the UPV.
- DeX 2013: Post-editing was the preferred reviewing method.
- DeX 2014:

	Es	Es→En
Lecturers	39	10
Error (%)	12	42
RTF	3	12
RTF from scratch	10	30
Effort red. (%)	**70**	**60**

Conclusions

- System architecture for cost-effective automatic subtitling.
- Implemented as the open source **transLectures-UPV Platform**.
- Integration into pM showed **savings up to 2/3 of user effort**.
- Basis of MLLP's Transcription and Translation Platform (TTP):
  - More than 200 users (orgs) and 1000 videos (250h) uploaded.
  - 10 transcription languages and 14 translation pairs.
  - Support for the EMMA EU project.
  - Support for the Translation Centre for the Bodies of the EU (CdT).
  - Support for the SUBurbia EU project.
  - Under study by many interested organisations.

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- Recommender Systems (RS) are often needed by users.
- The use of speech transcripts for recommendation was studied.
- **La Vie PASCAL2 project:**
  - Main goal was to improve recommendations in VideoLectures.NET.
  - Baseline RS based on lecture keywords.
  - New RS based on SVMs and exploiting speech transcripts.

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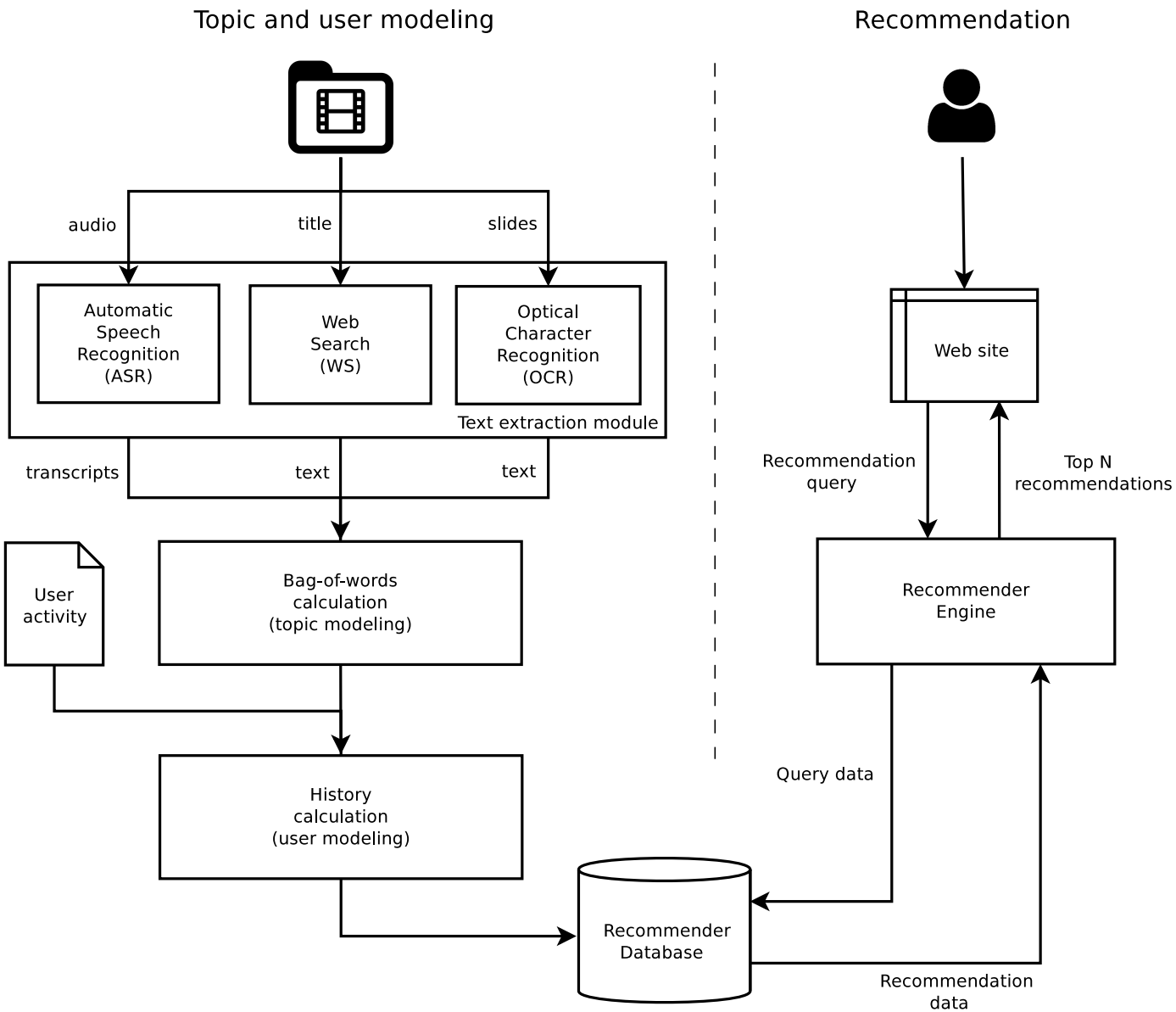
Recommender System Overview



Evaluation

- Comparison with the baseline RS.
- User clicks on recommended videos were logged.
- Results after a 6-month evaluation were not conclusive.
- An in-depth analysis of the logs is still pending.

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- ASR performance can be greatly improved using in-domain data:
  - Lecture slides and related documents, if available.
  - Metadata such as title, keywords or abstract.
- LM adaptation by **document retrieval**:
  - PDF files retrieved from search queries based on lecture titles.
  - Per-lecture retrieval methods: exact and extended search.
  - Individual LMs are estimated on each data source separately.

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Evaluation and conclusions

- Spanish polimedia corpus: 107h train, 3h test.
- Comparison of search methods against the baseline system:

	WER	Δ%
Baseline (BL)	15.7	-
BL + Exact (5 docs)	14.6	7
BL + Extended (5 docs)	14.4	8
BL + Extended (10 docs)	14.4	8
BL + Extended (20 docs)	14.2	10
BL + OCR Slides	13.8	12
BL + OCR Slides + Extended (20 docs)	13.5	14

- Simple yet effective method to retrieve related documents.

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- TLP integration with poliMedia:
  - Live: `http://media.upv.es`
- MLLP's Transcription and Translation Platform:
  - Live: `http://ttp.mllp.upv.es`

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Main contributions

- An explicit phrase-length modelling approach for SMT.
- A simple segmentation approach for fast speech detection.
- The transLectures-UPV Platform (TLP) for ASR & MT integration.
- Integration of TLP into poliMedia (UPV), UC3M, etc.
- Support for the MLLP's TTP: EMMA, CdT, SUBurbia, etc.
- A new approach to video lecture recommendation.
- A new document retrieval technique for LM adaptation.

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Future work

- Explicit length modelling for SMT:
  - Perform a full Viterbi-like iterative training method.
  - Smooth Viterbi counts with extract counts.
  - Study alternative weight optimisation methods to MERT.
- Audio segmentation for speech detection:
  - Measure impact on transcription quality in terms of WER.
  - Adopt a hybrid DNN-HMM approach.
- The transLectures-UPV Platform (TLP):
  - To extend TLP to give full support to MOOCs.
  - To explore other applications (i.e. film industry).
- Recommender systems for online learning platforms:
  - Retrain RS using better speech transcriptions.
  - Extend the system to provide cross-lingual recommendations.
- LM adaptation using external resources:
  - Consider also retrieving web pages (HTML).
  - Adaptation speaker's vocabulary.

Publications

This work has derived **9 scientific publications**:

- Explicit Length Modelling for SMT (2):
  - 1 International Journal (Pattern Recognition)
  - 1 International Conference (IbPRIA)
- Efficient Audio Segmentation for Speech Detection (1):
  - 1 Competition (Albayzin evaluations)
- Transcription and Translation Platform (4):
  - 1 International Journal (Speech Communication)
  - 2 International Conferences (IEEESMC, EC-TEL)
  - 1 National Conference (IberSpeech)
- Recommender Systems for Online Learning Platforms (1):
  - 1 National Conference (IberSpeech)
- LM Adaptation Using External Resources for ASR (1):
  - 1 National Conference (IberSpeech)

Thank you for your attention!

Gràcies per la vostra atenció!

Gracias por vuestra atención!

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MLLP | Machine Learning and Language Processing