QCompere @ REPERE 2013

BY quaero

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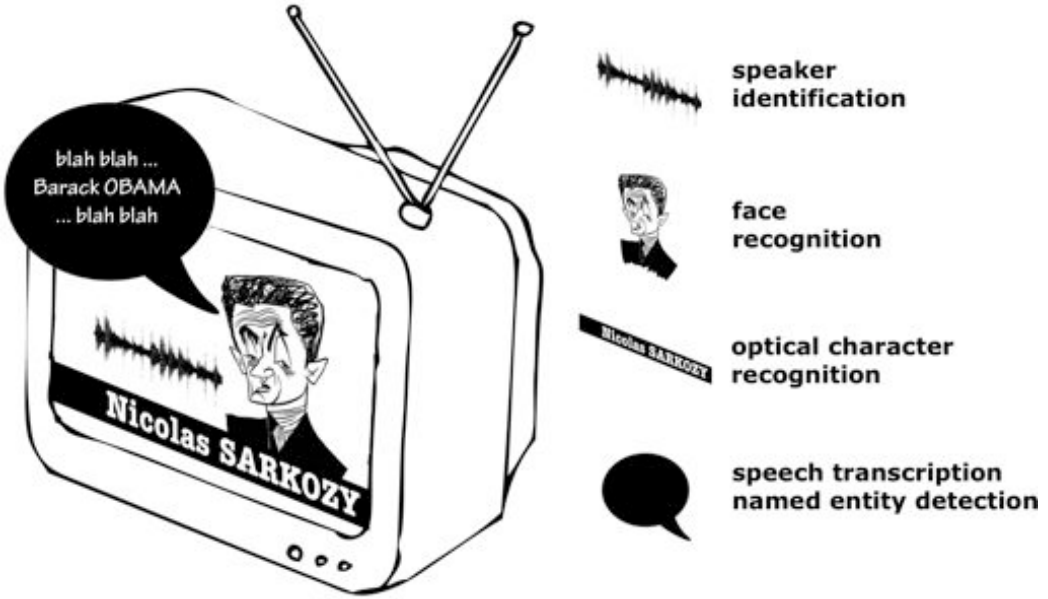
REPERE challenge

"Who speaks when?"

"Who appears when?"



QCompere consortium

BY quaero

CNRS LIMSI

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KIT Karlsruhe Institute of Technology

VOCAPIA research

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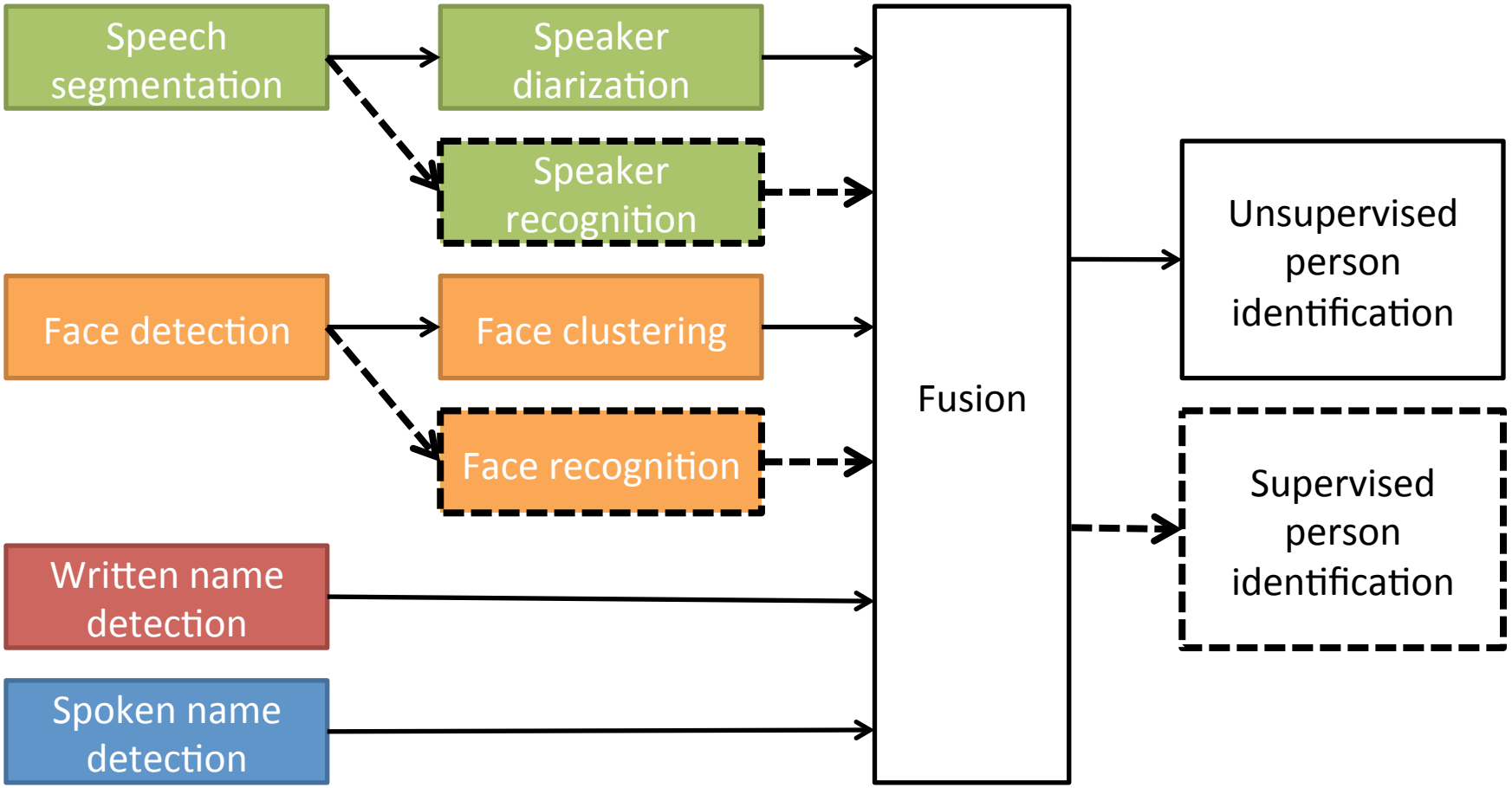
UNICAEN université de Caen Basse-Normandie

yacast

Multimodal fusion

Supervised *vs.* unsupervised identification



Outline

- Monomodal approaches
  - Speaker recognition
  - Face recognition
- Person name detection
  - Written name detection
  - Spoken name detection
- Multimodal fusion
  - Propagation-based fusion
  - Graph-based fusion
  - Classifier-based fusion
  - Hybrid fusion

Mono-modal person recognition

Speaker diarization

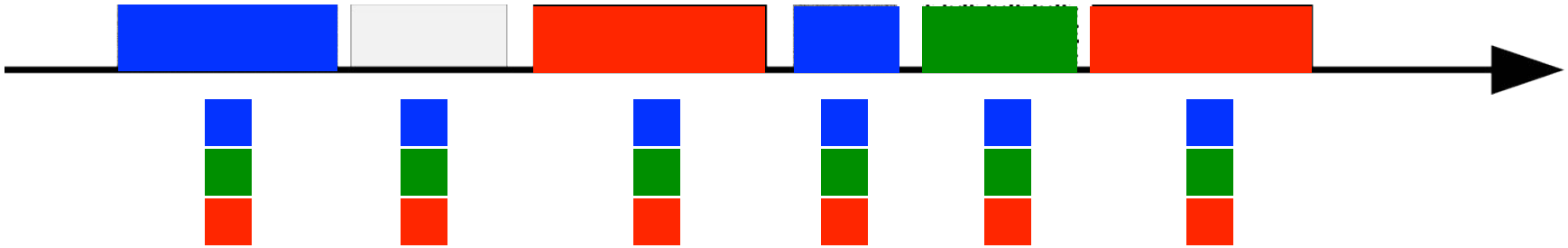
- Speech activity detection
- Divergence-based segmentation

- Two-steps speech turns clustering
  - BIC agglomerative clustering
  - CLR agglomerative clustering

- Cross-show speaker diarization

Mono-modal person recognition

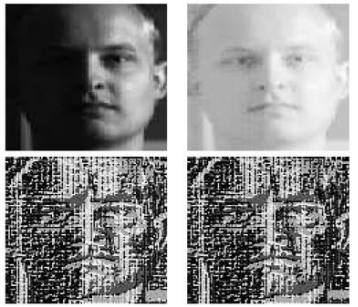
Open-set speaker identification



- GMM-UBM approach
  - Gaussian Mixture Models with 128 diagonal Gaussians
  - by MAP adaptation of gender-matching UBM
  - Log-likelihood ratio
- GSV-SVM approach
  - Mean supervectors of the adapted GMM with the UBM
  - Support Vector Machine with linear kernel
  - Negative samples come from other target speakers

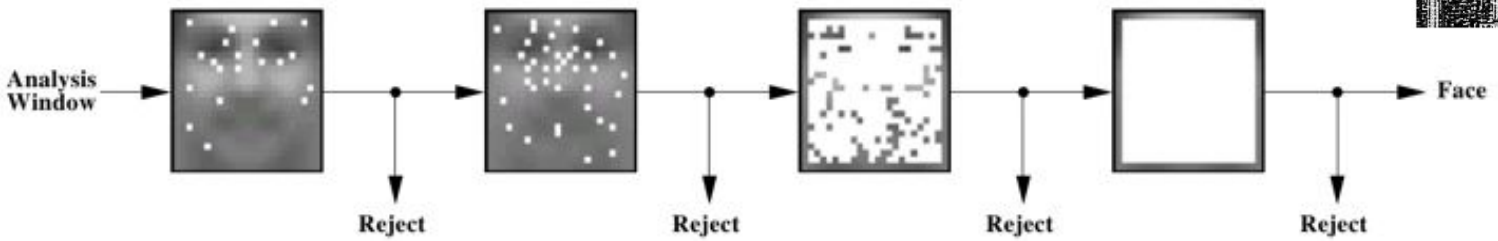
Mono-modal person recognition

Face detection & tracking



Feature: Modified Census Transform (Lighting conditions)

Classification: Boosting Cascade



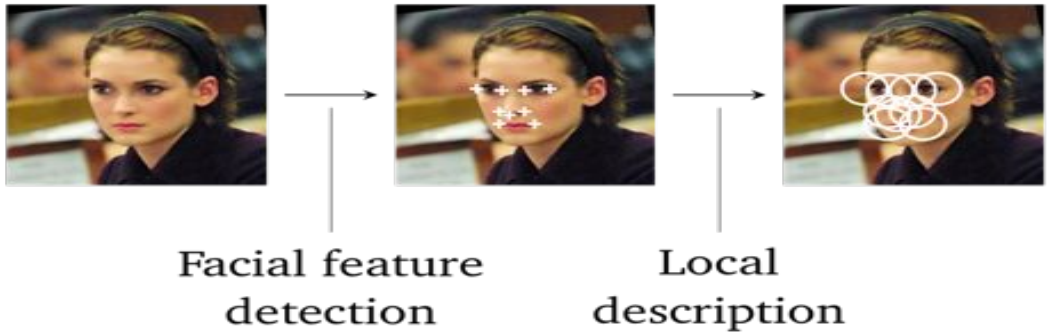
Tracking by Detection, using Particle Filter

State = {x, y, s, α}; Location (x, y); Face size (s) and Angle (α)

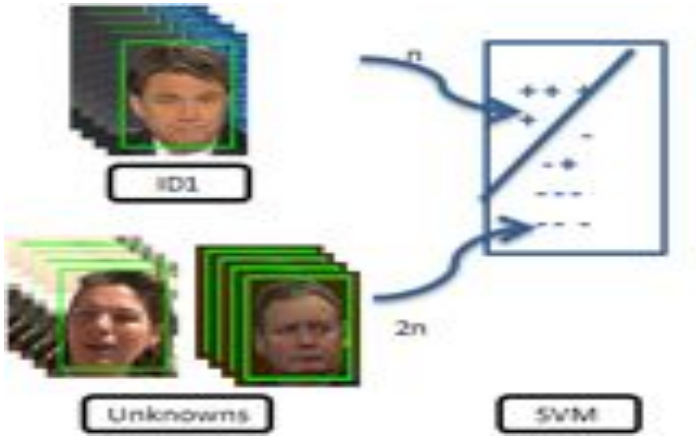
Mono-modal person recognition

Face recognition

- Frontal face descriptor using Histogram of Gradient



- Support Vector Machine in One-vs-All for classification



TRAINING phase

TESTING phase

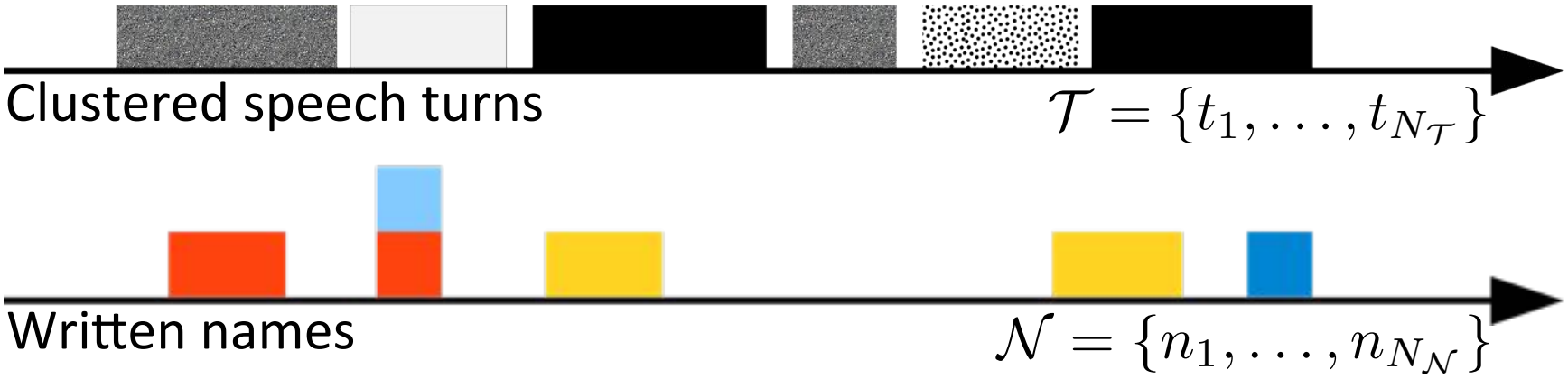
Cross-modal person recognition
Written name detection

- Video Optical Character Recognition
  - LOOV: LIG Overlaid OCR in Video
- Detection of title blocks
  Layout depends on the show
  - Use Wikipedia list of 175k names to learn spatial position of title blocks
- Detection of person names
  Blocks may contain other text
  - Filter false positives based on linguistic rules

Cross-modal person recognition
Spoken name detection

- Automatic speech recognition
  - state-of-the-art off-the-shelf STT system
  - 17% Word Error Rate
- Named entity recognition
  - applied on ASR output
  - based on Conditional Random Field
  - 60% Slot Error Rate (SER)
- Post-processing
  - Look for first or last name to get full names: 53% SER
  - Look for similar names in training set: 52% SER

Propagation-based (late) fusion
for unsupervised speaker identification



Find the best mapping function

$$m : \mathcal{T} \to \mathcal{N} \cup \varnothing$$

$$t \mapsto \begin{cases} n & \text{if name of speech turn } t \text{ is } n \in \mathcal{N} \\ \varnothing & \text{if it is unknown or not in } \mathcal{N} \end{cases}$$

Propagation-based (late) fusion
for unsupervised speaker identification

$$m^*(s) = \underset{n \in \mathcal{N}}{\operatorname{argmax}} \, \mathrm{TF}(s,n) \cdot \mathrm{IDF}(n)$$

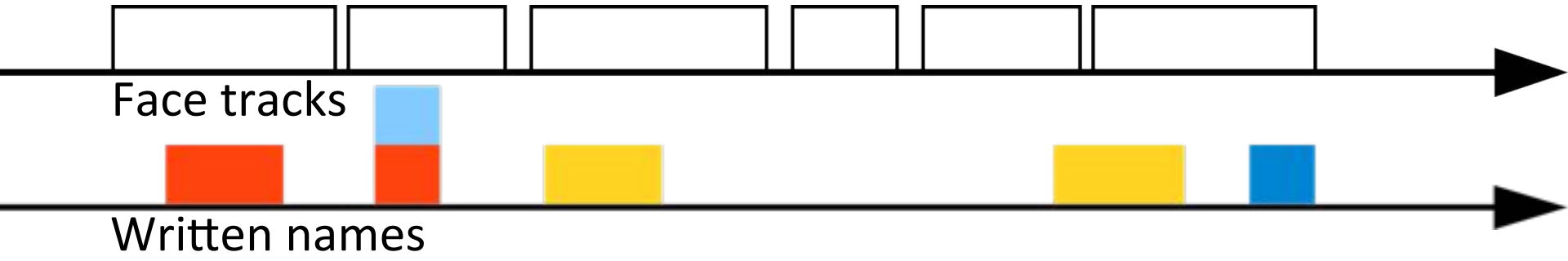
$$\mathrm{TF}(s,n) = \frac{\text{duration of name } n \text{ in cluster } s}{\text{total duration of all names in cluster } s}$$

$$\mathrm{IDF}(n) = \frac{\#\text{ speaker clusters}}{\#\text{ speaker clusters co-occurring with } n}$$

J. Poignant, H. Bredin, V.B. Le, L. Besacier, C. Barras, G. Quénot
Unsupervised Speaker Identification using Overlaid Texts in TV Broadcast
Interspeech 2012

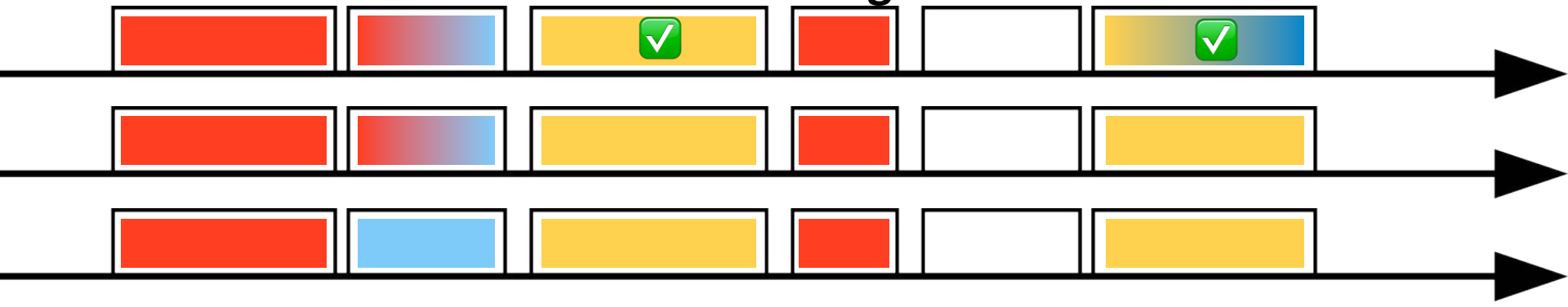
Propagation-based (early) fusion

for unsupervised face identification



1. Direct name propagation

2. Name-constrained face clustering



Graph-based fusion

Person Instance Graph

- Two types of vertices
  - Person instances
    e.g. speech turns, face tracks or written names
  - Person identities
- Three types of edges
  weighted by the probability that vertices are the same person
  - Intra-modal edges
    e.g. speech turn / speech turn
  - Cross-modal edges
    e.g. speech turn / written name
  - Instance/identity edges
    e.g. speech turn / identity

Graph-based fusion

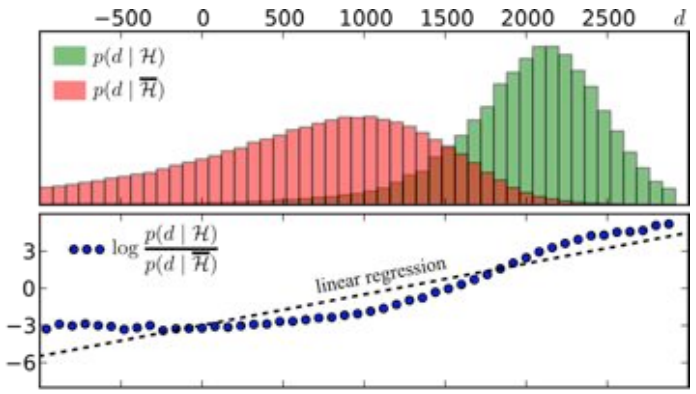
Edges

Intra-modal edges

e.g. between speech turns

- Bayesian Information Criterion as distance between speech turns
- Distance to probability with Bayes' theorem

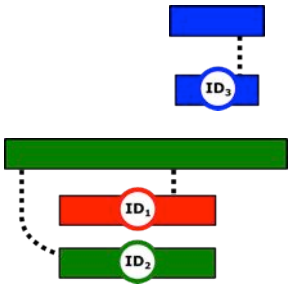
$$p\left(\mathcal{H} \mid d\right) = \frac{1}{1 + \frac{p(d \mid \overline{\mathcal{H}})}{p(d \mid \mathcal{H})} \frac{p(\overline{\mathcal{H}})}{p(\mathcal{H})}}$$



Cross-modal edges

e.g. between speech turn and written name

- Only between cooccurring person instances
- Probability is learned automatically from the training set
- Probability depends on the number of simultaneous "tracks" in both modalities



1 speech turn
1 written name

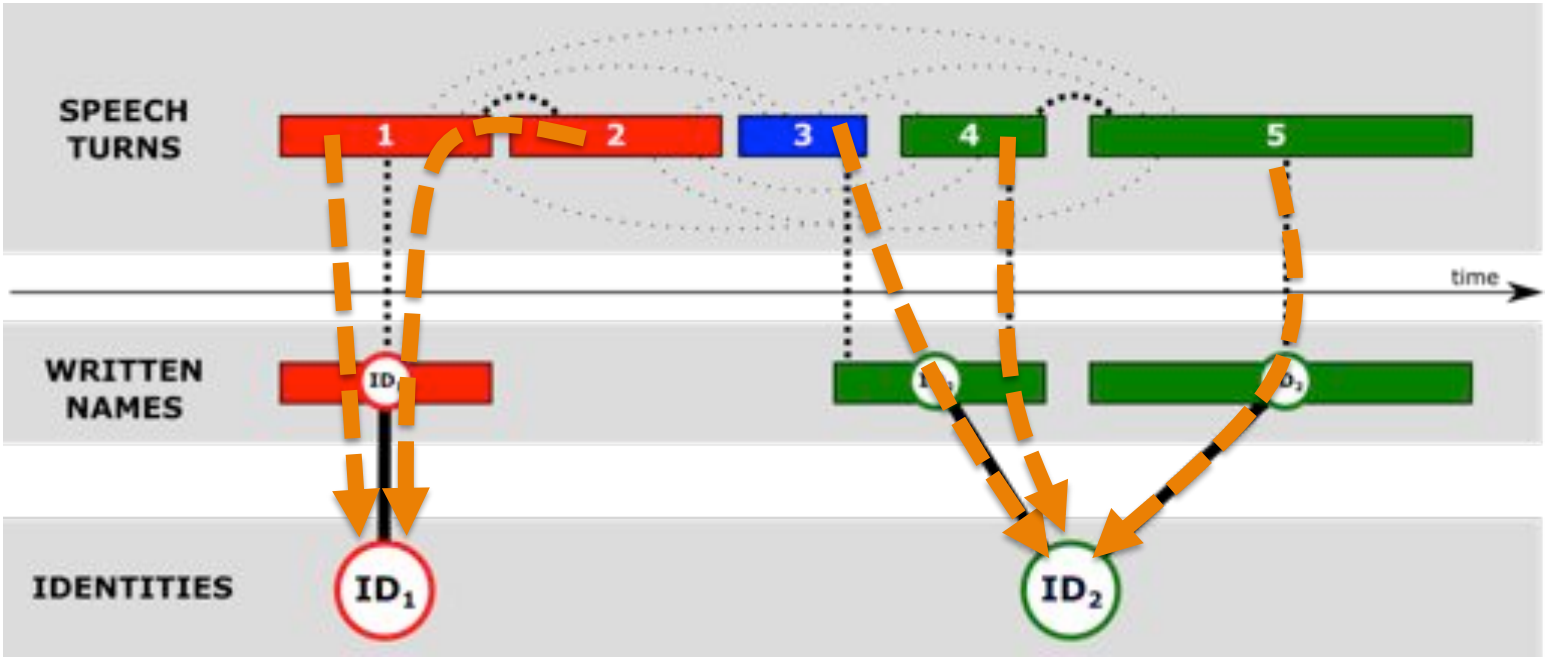
$P_{11} = 0.956$

1 speech turn
2 written names

$P_{12} = 0.996$

Graph-based fusion

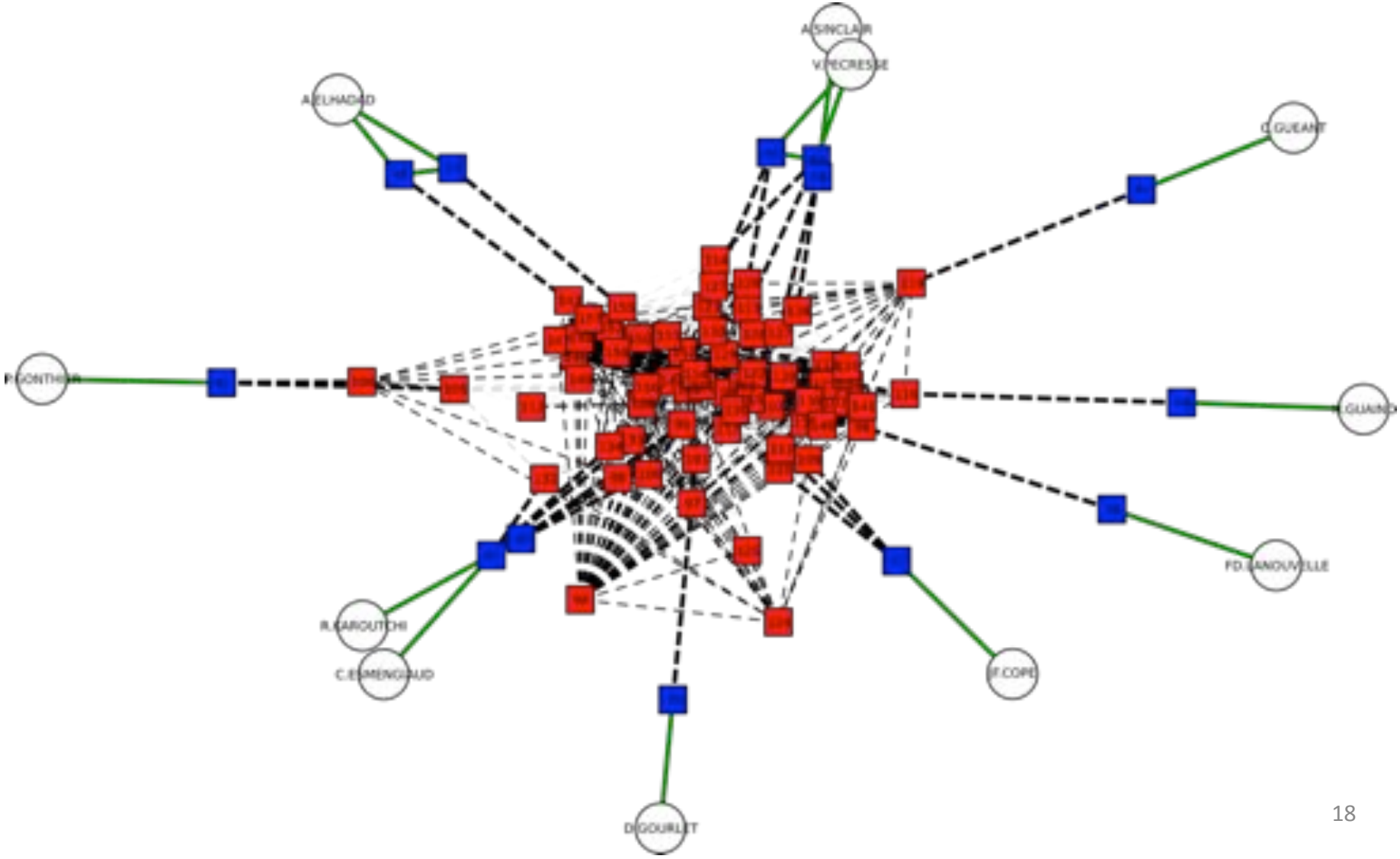
Maximum Probability Path



- For each (speech turn, identity) pair,
  - find the maximum probability path
- For each speech turn,
  - find the identity with highest maximum probability path

Graph-based fusion

"Real-life" Person Instance Graph



Results

Unsupervised person recognition

TASK	APPROACH	EGER
Who speaks when?	Propagation-based (late) fusion	26.2 %
	Graph-based fusion	38.1 %
Who appears when?	Propagation-based (early) fusion	46.2 %
	Graph-based fusion	50.3 %

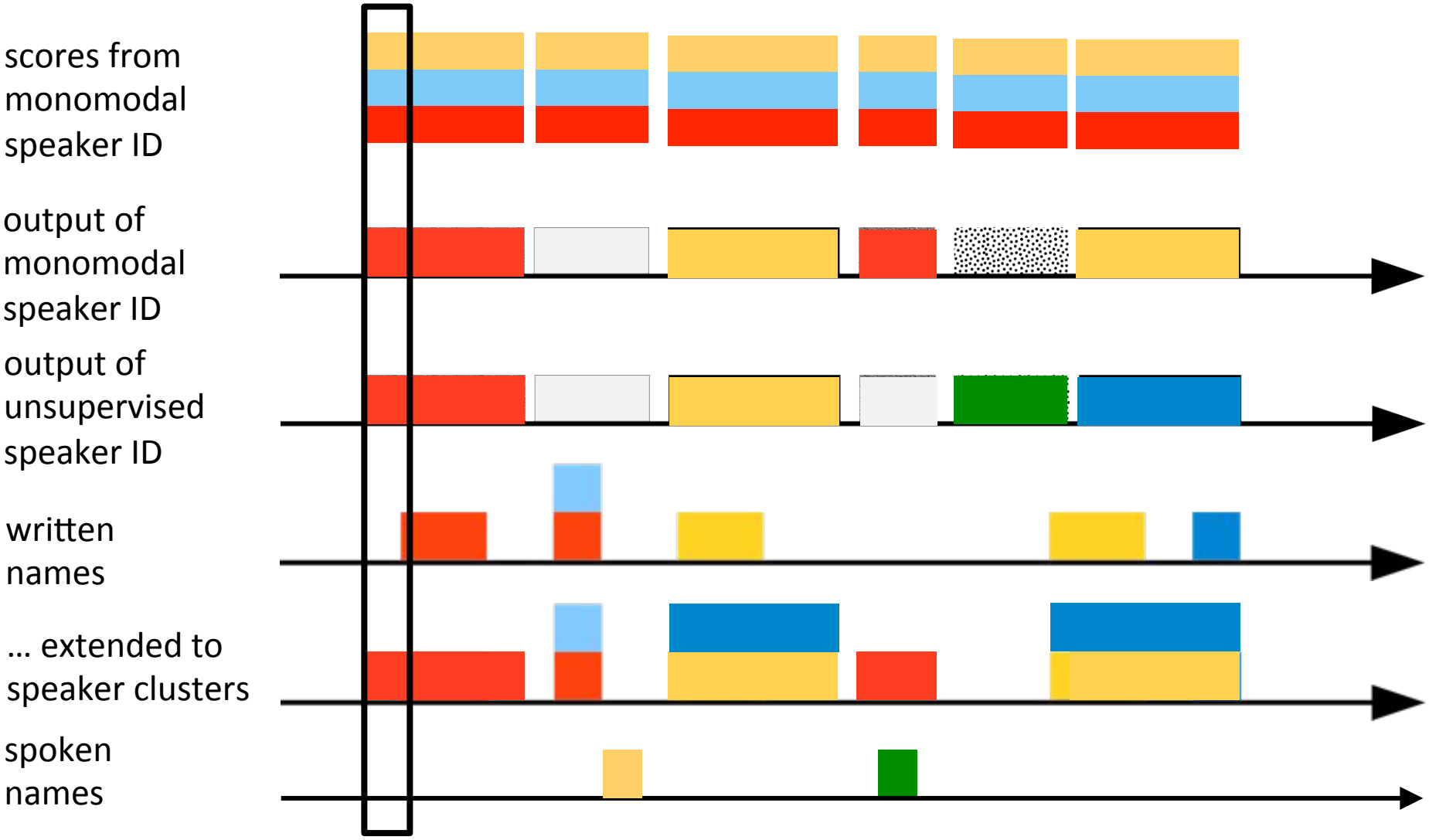
Classifier-based fusion
Multilayer perceptron

- Binary classification problem
  - Train a multilayer perceptron to answer the following: « *is speaker S speaking at time T?* »
  - Select the identity S with the highest score

- Short list of potential speaker S
  - from targets of monomodal speaker identification system
  - from detected written names at time T
  - from detected spoken names in previous/next speech turns

Classifier-based fusion

Feature vector



Hybrid fusion
for supervised face identification

- Heuristic cascading approach
  - Supervised monomodal face recognition for anchors only
  - Unsupervised propagation-based face recognition to remaining face tracks
  - Supervised monomodal face recognition for remaining face tracks
  - Propagation of multimodal speaker recognition to remaining face tracks

Results

Supervised person recognition

TASK	APPROACH	EGER
Who speaks when?	Best mono-modal approach	44.2 %
	Classifier-based fusion	17.8 %
	Graph-based fusion	35.3 %
Who appears when?	Best mono-modal approach	61.1 %
	Hybrid fusion	37.3 %
	Graph-based fusion	48.1 %

Conclusion

- OCR- and ASR-based name detection
  significantly improves person identification in TV broadcast

- Unsupervised multimodal *beats* supervised monomodal

- Face recognition is not as good as speaker recognition
  - Focus on face recognition for REPERE 2014
  - Use audio to achieve face recognition

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