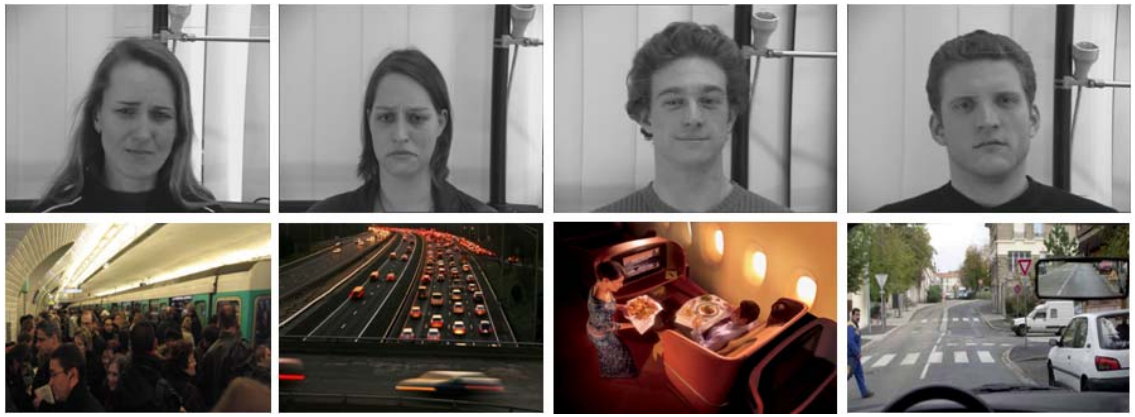
Travellers well-being measuring and dynamic facial expression recognition



Thomas Robin **Michel Bierlaire** **Javier Cruz**

The context

- Recent interest for emotion recognition in transportation:

  → Well-being measuring of users

  - Improve public transportation offers
  - Improve car comfort

  Abou-Zeid, M., Ben-Akiva, M. and Bierlaire, M. (2008). Happiness and travel behavior modification, *Proceedings of the European Transport Conference*, Leiden, The Netherlands.

  → Driving assistance

  - Safety
  - Mobility

The context

- Emotion: **mental** and **physiological** state associated with a wide variety of feelings, thoughts and behavior.

- Emotions signs easy to measure with non-intrusive techniques for transportation users:

  - Behavior
  - Facial expression
  - Voice intonation

The context

Well being measuring

→ Improve level of service

Driving assistance

→ Adapt car behavior to a danger

Objectives

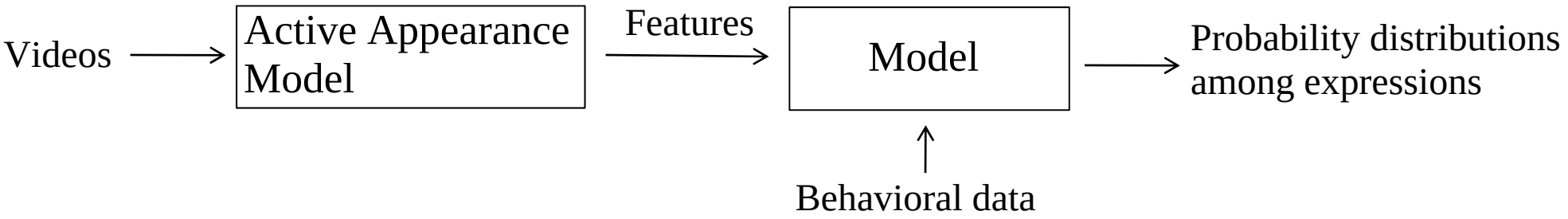
- Model the facial expression recognition made by a person looking at a facial video sequence
- Model explicitely the **causal effects**
- **No classification**
- Estimate the model on **behavioral** data (relax ground truth assumptions)

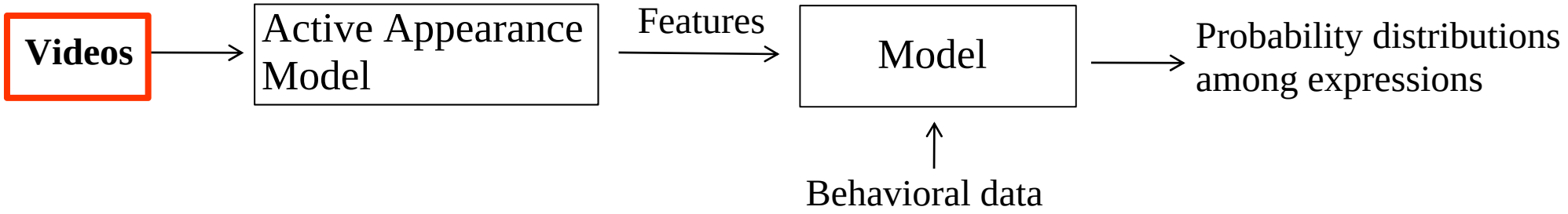
Outline

- Introduction
- Data: video
- Features extraction
- Data: behavioral data
- Models
- Model predictions
- Conclusion and Perspectives

Introduction

- Model overview:



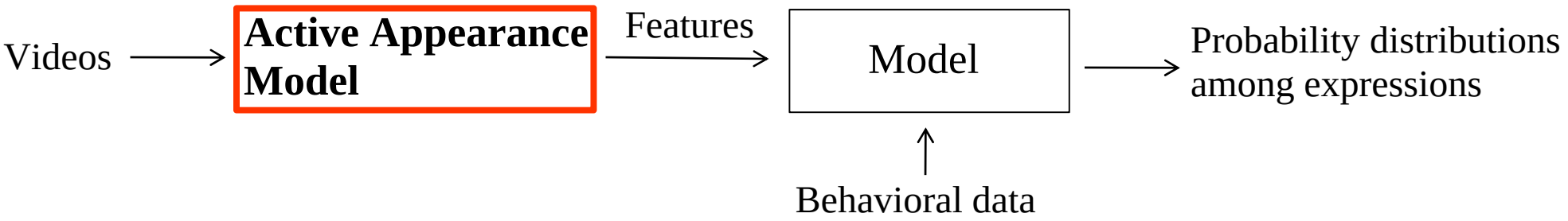

Videos
Active Appearance Model
Features
Model
Probability distributions among expressions
Behavioral data

Data: video database

- The Technical University of Munich database (TUM)
  Facial Expression and Emotion Database (FEED)

➡ Students faced to a video, natural expressions recorded

138 sequences, 18 subjects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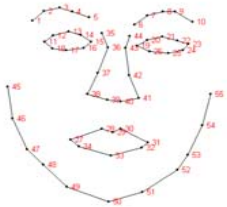
Features extraction: Active Appearance Model

AAM

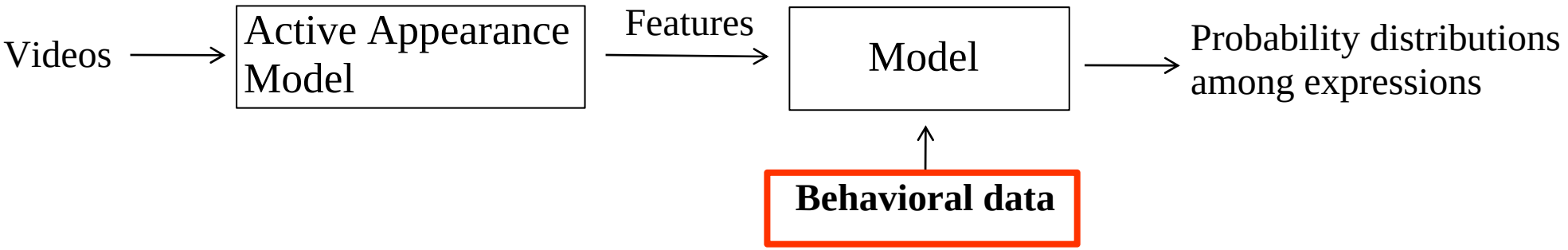


Shape, x = $(x_1, y_1, \ldots, x_n, y_n)^T$

Texture

(C vectors)

(facial action coding system) FACS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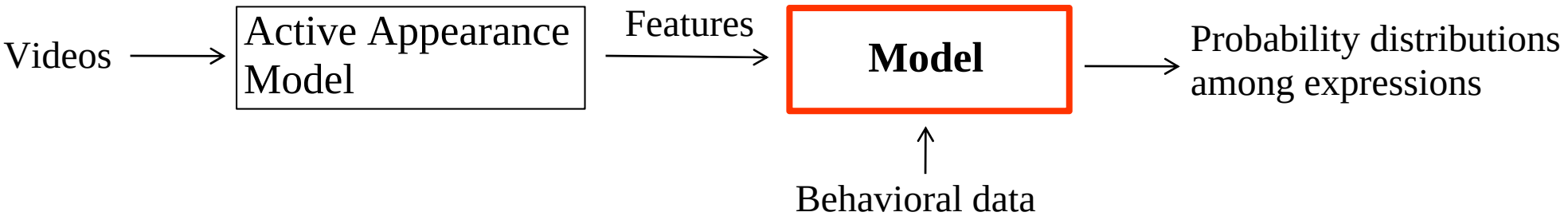
Data: internet survey

- Survey conducted at the address below (English, French, Italian, Spanish):

  http://transp-or2.epfl.ch/videosurvey/

- Respondents have to:
  - create an account
    → Socio-economics characteristics
  - label some video sequences with expressions
    → **observations**

- 1 database of video is used:
  - Facial Expression and Emotion Database (FEED)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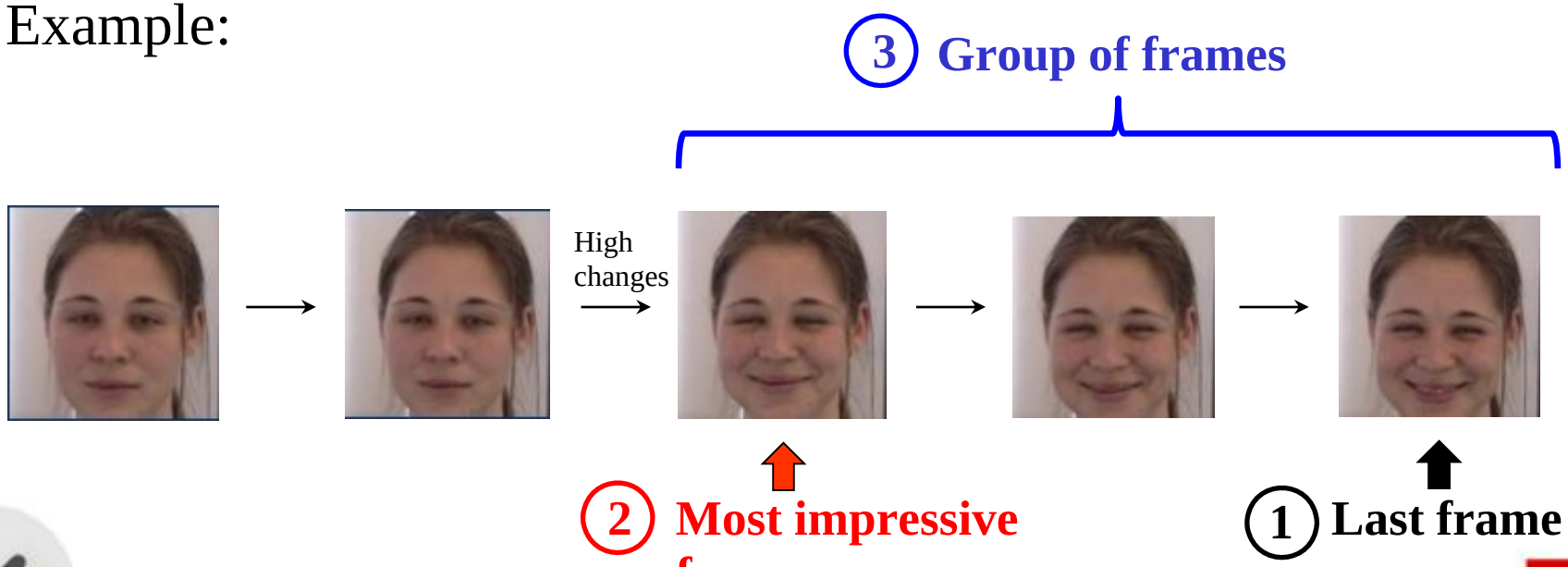
Models: introduction

- 3 models based on different assumptions:
  - (1) - **Reduced** model: only **last** frame is relevant
  - (2) - **Latent** model: only **one** frame is relevant
  - (3) - **Smoothed** model: a **group of frames** is relevant
- Example:



Models: Reduced model①

- Example:

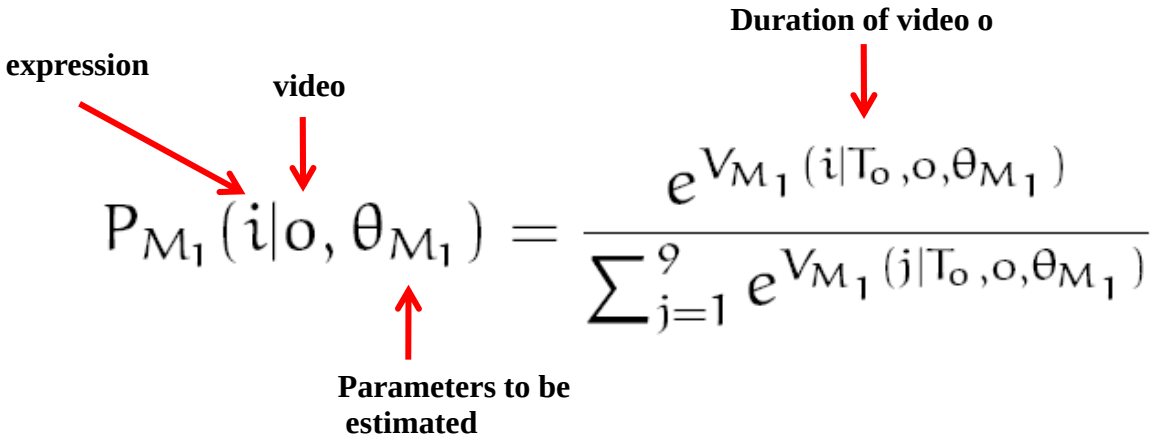
① **Last frame**

- Inspired from the static version of the work:

M.Sorci, M.Bierlaire, J-P.Thiran, J.Cruz, Th.Robin and G.Antonini (2008) Modeling human perception of static facial expressions, paper presented at *8th IEEE Int'l Conference on Automatic Face and Gesture Recognition*.

Models: Reduced model①

- Discrete choice model (DCM)
- Choice set: 9 expressions (Happiness, Surprise, Fear, Disgust, Sadness, Anger, Neutral, Other, Don't know)
- Logit model



- Utility specification: - Alternative specific constants (ASC)
  - Facial measures for AUs (FACS)
  - Elements of C vectors (outputs of AAM)

Models: Latent model ②

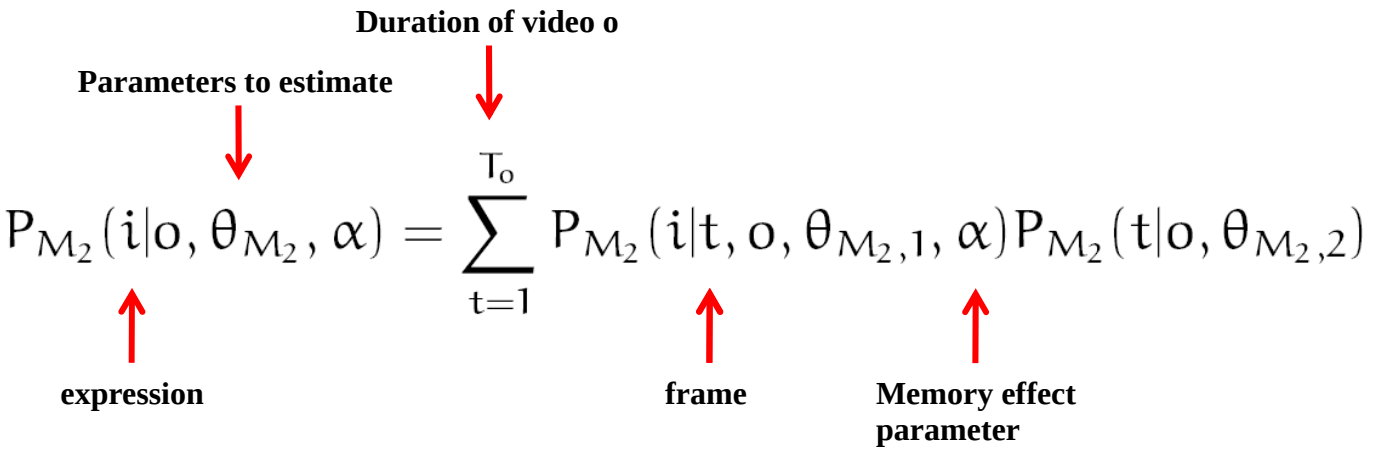
- Example:

② **Most impressive frame**

- Combination of 2 DCMs:

  - Instantaneous expression perception sub-model
  - Frames weighing sub-model

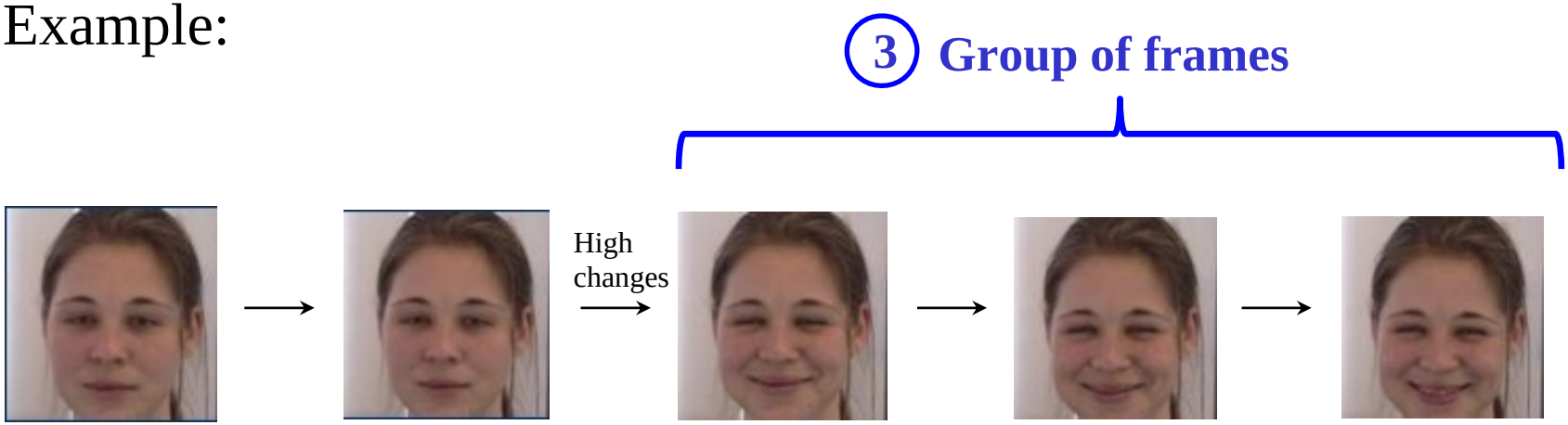
Models: Latent model②



- $P_{M_2}(i|t,o,\theta_{M_2,1},\alpha)$: Instantaneous expression perception sub-model (DCM).
- $P_{M_2}(t|o,\theta_{M_2,2})$: Video frames weighing sub-model (DCM).
- $P_{M_2}(i|o,\theta_{M_2},\alpha)$: Model.

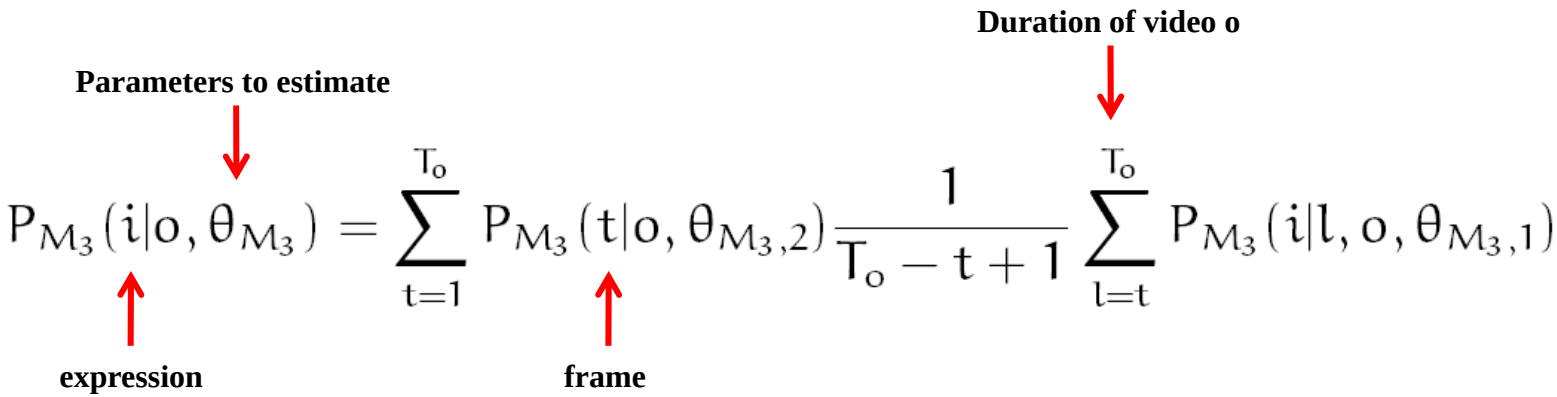
Models: Smoothed model ③

- Example:



- Combination of 2 DCMs:
  - Instantaneous expression perception sub-model
  - Sub-model handling with the detection of the first frame of the relevant group of frames

Models: Smoothed model ③



- $P_{M_3}(i|l,o,\theta_{M_3,1})$: Instantaneous expression perception sub-model (DCM).
- $P_{M_3}(t|o,\theta_{M_3,2})$: Detection of the first frame of the relevant group (DCM).
- $P_{M_3}(i|o,\theta_{M_3})$: Model.

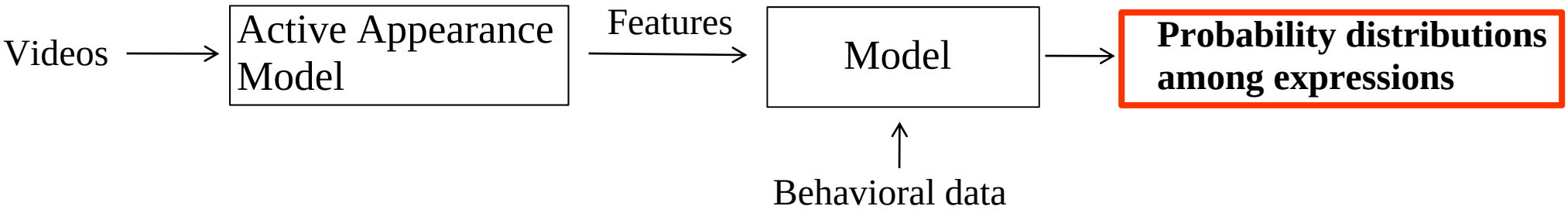
Models: Estimation results

- Simultaneous estimation of sub-models by **likelihood maximization**
- Estimation of the models using codes based on BIOGEME

	Reduced model	Latent model	Smoothed model
Nb of observations	369	369	369
Nb of parameters	32	45	44
Null log-likelihood	−810.78	−810.78	−810.78
Final log-likelihood	−475.79	−441.28	−447.67
$\bar{\rho}^2$	0.374	0.400	0.394

- Parameters are interpretable and have the good signs:

M.Sorci, M.Bierlaire, J-P.Thiran, J.Cruz, Th.Robin and G.Antonini (2008) Modeling human perception of static facial expressions, paper presented at *8th IEEE Int'l Conference on Automatic Face and Gesture Recognition*.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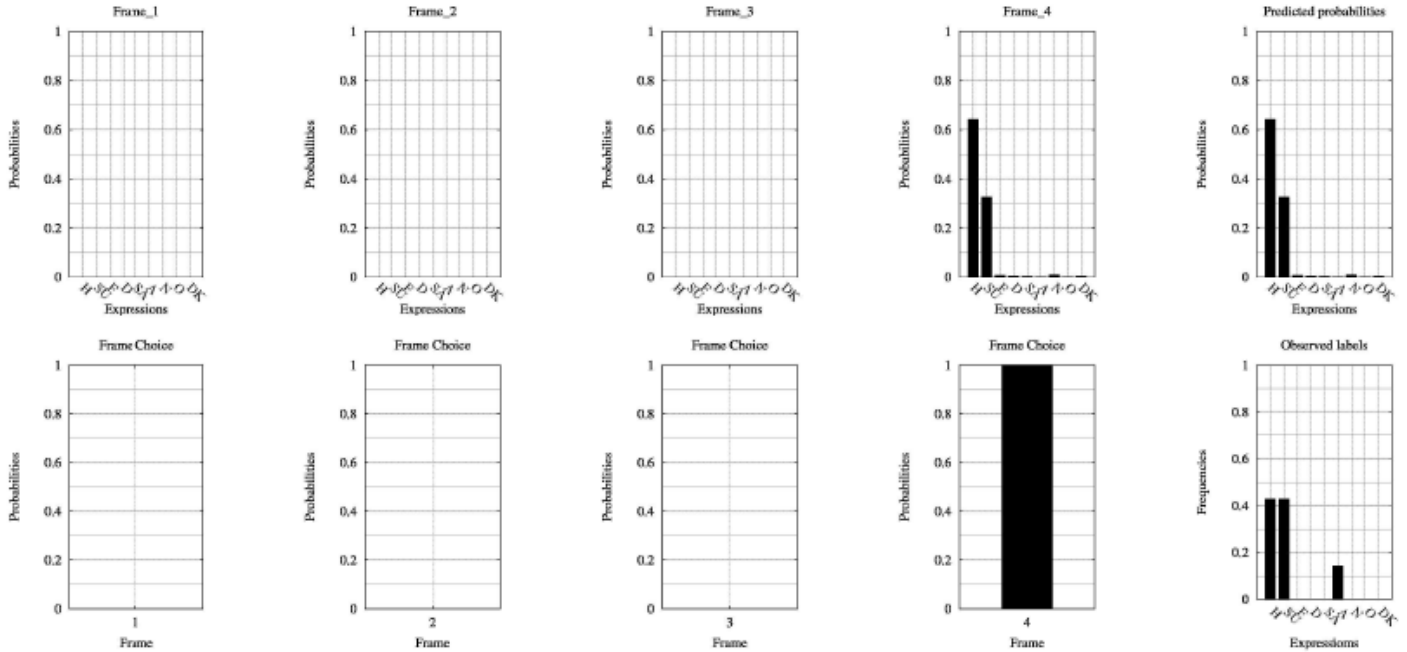
Model predictions: Reduced model①

- Expressions order: **H, SU, F, D, SA, A, N, O, DK**



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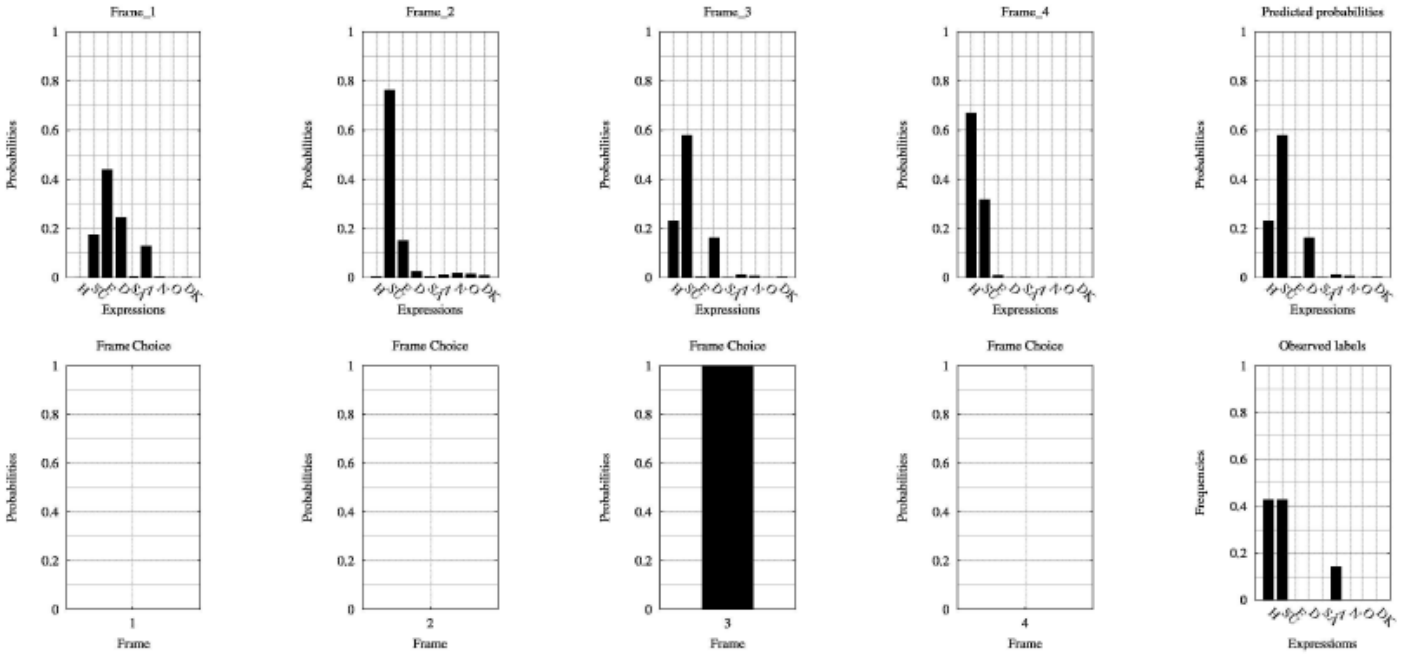
Model predictions: Latent model②

- Expressions order: **H, SU, F, D, SA, A, N, O, DK**



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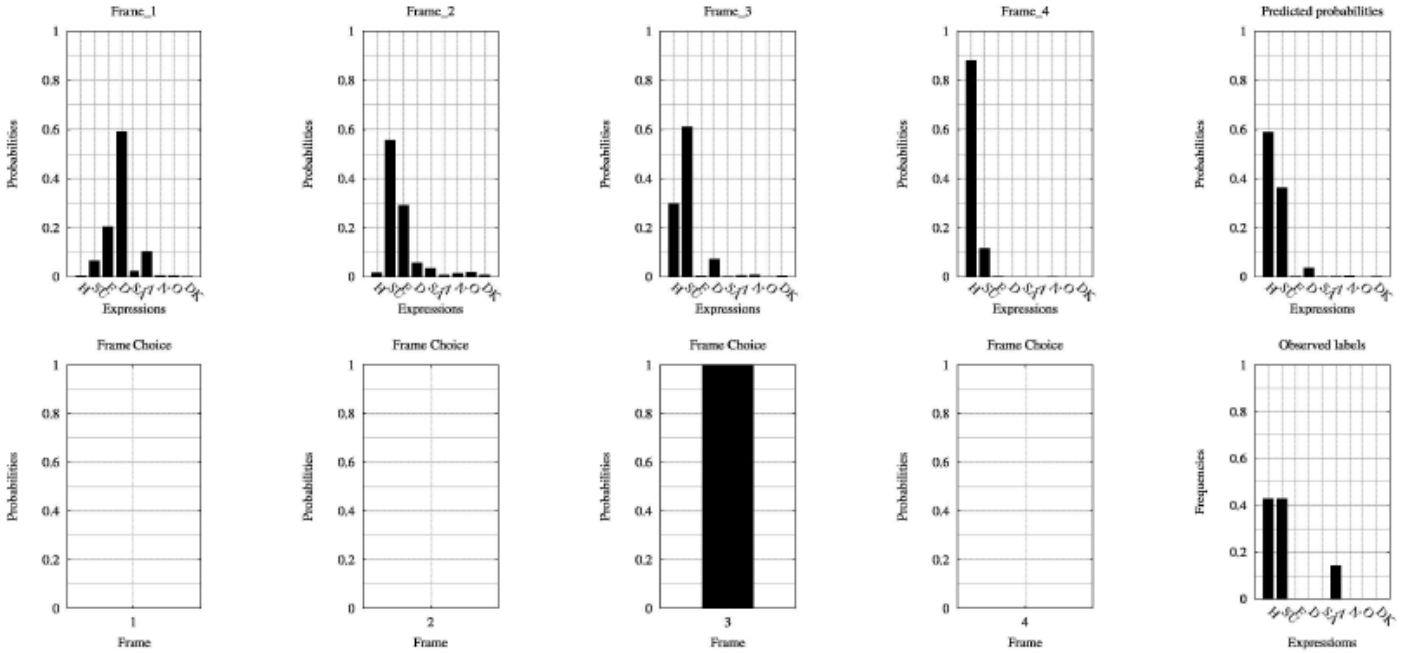
Model predictions: Smoothed model ③

- Expressions order: **H, SU, F, D, SA, A, N, O, DK**



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Conclusion and perspectives

- **Conclusions:**

  - Behavioral approach of the facial expression recognition
  - Pre-validated models
  - Models ready to use for applications

- **Perspectives:**

  - Validation of the models on another dataset
  - Couple the model with a tracker of facial characteristics
  - Applications of the models on a case study

Thanks for your attention

http://transp-or2.epfl.ch/videosurvey/