

Interest



Sad



Calm



Happy



Disgust



Angry



Surprise

images © Peter Menzel



# Introduction to affect computing and its applications

# Overview

- **What** is emotion?
- What is **affective computing** + examples ?
- Why is affective computing **useful**?
- **How** do we do affect computing?

# Some interesting questions

- What is emotion?
- How do we expression emotion?
- Why do we have it?
- What does it do?
- What are the potential applications?

# Emotion (what is it)?



- Common emotions: fear, anger, happiness, sadness, surprise, disgust
- **Short episode of synchronized system activity triggered by event:**
  - subjective feelings (the emotion we normally refer to)
  - tendency to do something (action preparation)
  - facial expressions
  - evaluation of the situation (cognitive evaluation, thinking)
  - physiological arousal (heartbeat, alertness)
- **Affect** (*affectie*)= related to emotion and mood:
  - **emotion**: short term, high intensity, object directed,
  - **mood**: unfocused, long term, low intensity,
  - **affect**: sometimes seen as abstraction of emotion/ mood in terms of,

# Emotion (why do we have it)?

- **Situational evaluation** and **communication**.
- **Heuristic** relating **events** to personal **goals**, needs and beliefs:
  - evaluates **personal relevance** of event (*Scherer*) and helps decision-making (*Damasio*),
  - **fast reactions** and **action** preparation (*Frijda*),
  - influence **information processing** and **decision making** (*Damasio*):
- **Communication medium**:
  - **communicate** internal state (show feelings),
  - **alert** others (direct attention),
  - show **empathy** (show understanding of situation).
  - Give **feedback** (evaluate behavior).

# Emotion (what does it do)?

- Emotion and affect influence thought and behavior:
  - The **kind of thoughts** we have
  - The way we **process information**
  - How we **learn** and **adapt**
    - Emotion/affect as social reinforcement (emotion expression as signal)
    - Emotion/affect as intrinsic reinforcement (use my own emotion as feedback)

# Emotion (how can we study it)?

- Biological/Neurological (*Damasio, Panksepp, LeDoux, Rolls*):
  - aim: find the necessary / sufficient **brain areas** and **circuits** involved in emotions /feelings / self-regulation / adaptation.
- Biological/Evolutionary (*Darwin, Ekman*):
  - aim: **why** emotions exist in the first place, what' s the **utility** of **emotion**.
- Cognitive/Psychological (*Scherer, Frijda*):
  - aim: understand **relation cognition/emotion**, why does event e results in emotion x while:
    - the **same event** e may result in a **different emotion**, and
    - **other events** may result in the **same emotion** x.
- Social (*Ekman, and others*):
  - aim: understand the role of **emotion** in **communication**.



# What is affective computing?

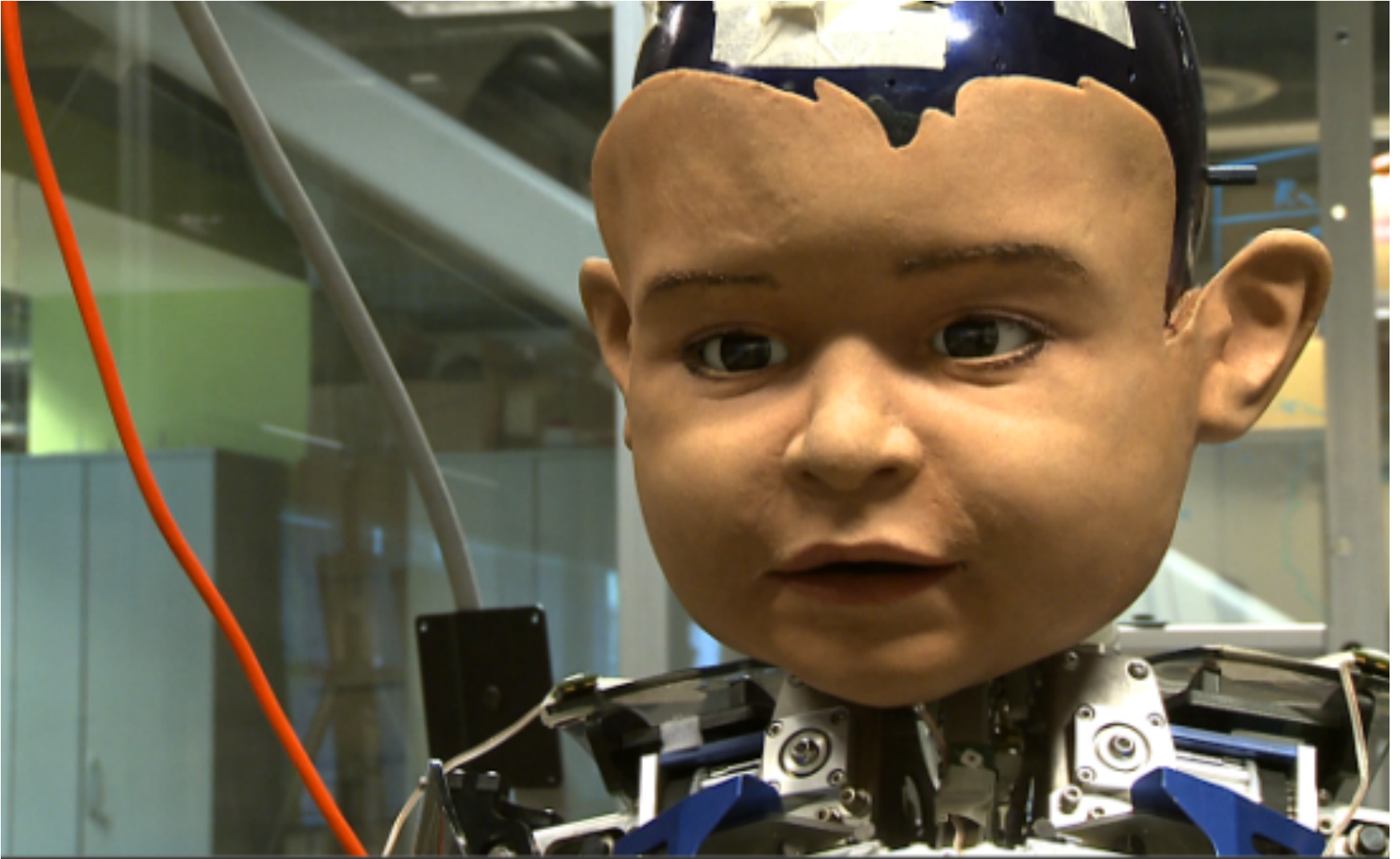
- *Computing that relates to, arises from, or deliberately influences emotions (Picard).*
- *Different types of computer models:*
  - **recognize,**
  - **interpret/elicit** emotions
  - **emotional influence** on behavior
  - **show** emotions
  - complex mixtures of these...
- **An affective computing system is**
  - *a system of computational processes that perceives, expresses, interprets, or uses emotions,*

# SIMS 2 (*Electronic Arts*)

- Entertainment: emotions are used to provide **entertainment value**.



# Robot Baby



# Mission Rehearsal Exercise (*Gratch & Marsella*)

- *Cognitive*: study the influence of artificial emotions on
  - **planning** mechanism of virtual characters,
  - **training effect** on **trainees** (emotion might enhance effect)

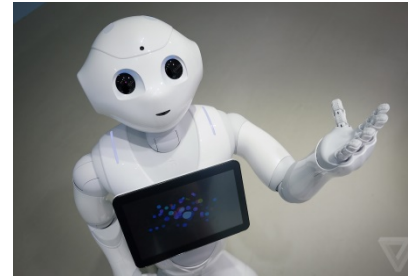


# Assistive robotics

- [Aibo](#) (Sony, Japan)  
Entertainment robot



- Emotional Robot "[Pepper](#)"  
goes on Sale to public in Japan



- Paro (Wada et al, Japan)  
Robot companion for elderly



- [Huggable](#) (MIT, USA)  
Robot companion for elderly



# Why is affective comp. useful (I)?

- From a theoretical point of view...
- Advance emotion theory
  - simulated agents that elicit emotions to **study** possible **psychological structure of emotions** (Scherer),
  - emotion as **artificial motivator** (e.g. *a bored robot that explores*) (Canamero).
- Understand intelligence and adaptation
  - **laws** and **rules** are **not sufficient** for understanding or predicting human behavior and intelligence (e.g. *how to sift thru many possible choices*) (Damasio, Picard)
  - simulated **learning** agents **influenced by emotions** (e.g., *emotion as reward*) (Breazeal, Broekens),

# Why is affective comp. useful (2)?

- From a practical point of view...
- **Facilitate Human-Computer (Robot) interaction**
  - use **emotions in simulated-agent plans** (*to simulate human reasoning*) (Gratch & Marsella),
  - **communication and joint attention** (Breazeal, MIT)
  - robot acceptance (Heerink, Telin)
  - Interactive robot learning
- Entertainment
  - Computer **games** such as the Sims (EA), Aibo Robot (Sony).

# Affective Computing in short...

- Affect has different meanings related to emotion.
  - **emotion**: short term, high intensity, object directed,
  - **mood**: unfocused, long term, low intensity,
  - **affect**: sometimes seen as abstraction of emotion/mood in terms of,
- Affective computing is about computing with emotions
  - “a system of **computational processes that perceives, expresses, interprets, or uses emotions**”
- Why?
  - advance emotion theory,
  - understand intelligence,
  - facilitate Human-Computer (Robot) interaction,
  - entertainment.



# So how do we go about it?

- Interpret emotion
- Express emotion

# Express Emotions

- Display Emotions
  - Computer voices with natural intonation
  - Computer Faces
  - “How” to show I'm happy.
  - Example:- Animation
- Model Emotions
  - React to events
  - Internal Representation of Emotion
  - Example:-Kismet

# Importance of Emotions in HRI

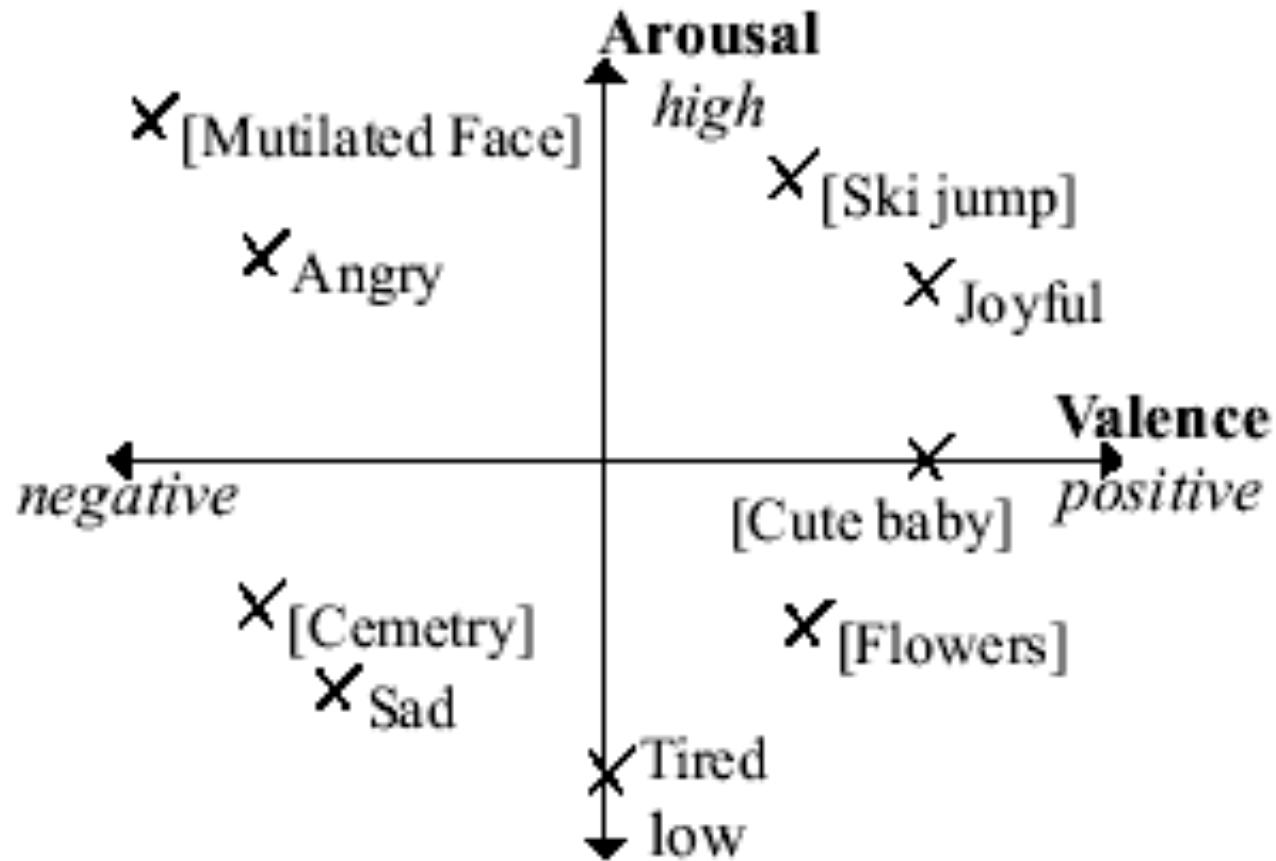
- Emotions help prevent people from repeating their mistakes (decisions that resulted in negative feelings)
- Recognizing emotions would allow robots to become more responsive to users' needs
- Exhibiting emotions would help robots interact with humans

# Classification of Emotions

- Continuous
  - Emotions defined in multi-dimensional space of attributes
  - Arousal-Valence Plane
- Discrete
  - Defines 5, 6, or more “basic” emotional states upon which more complex emotions are based

# Arousal-Valence Plane

- Valence – whether emotion is positive or negative
- Arousal – intensity of emotion

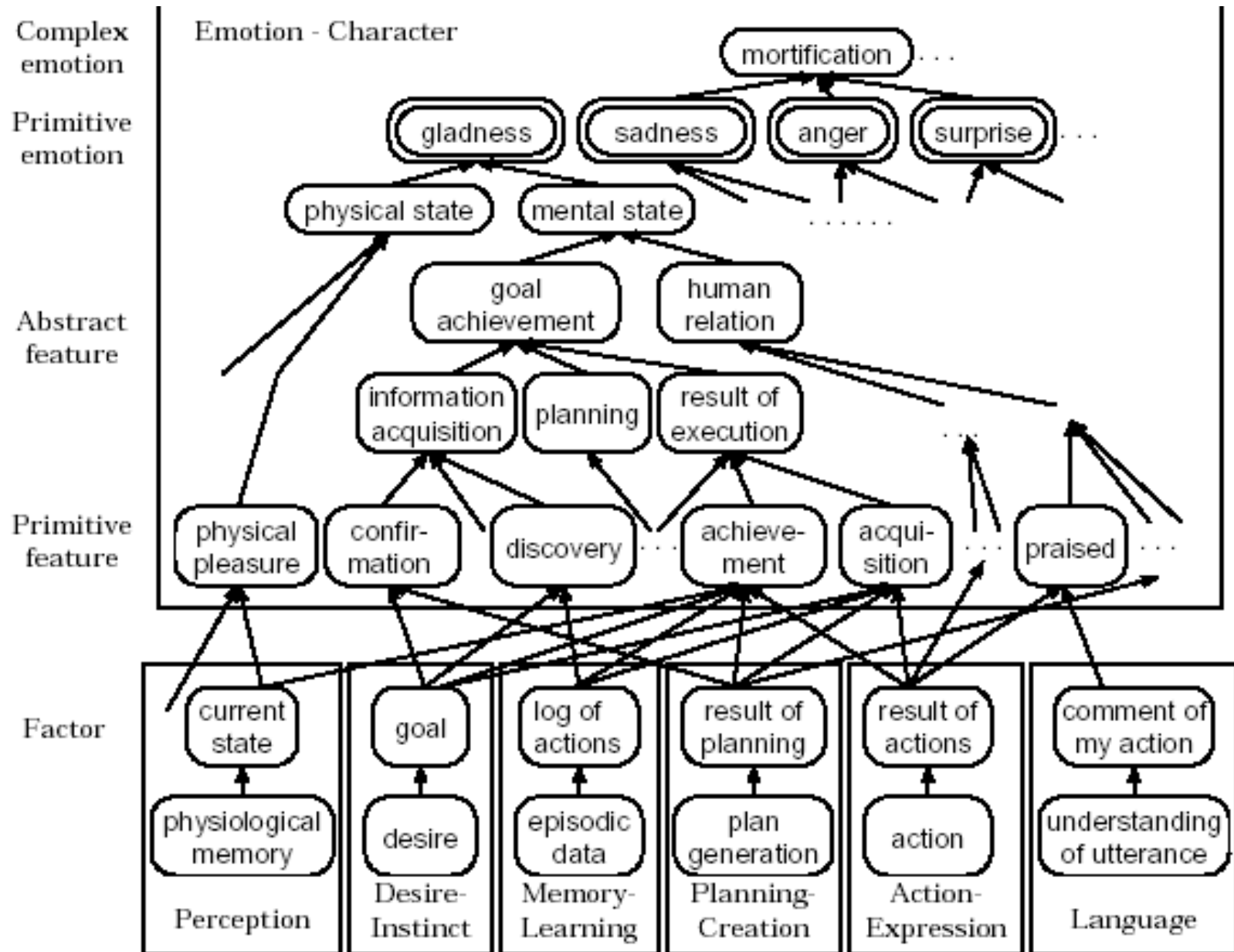


# Classification of Emotions

## Plutchik's Theory:

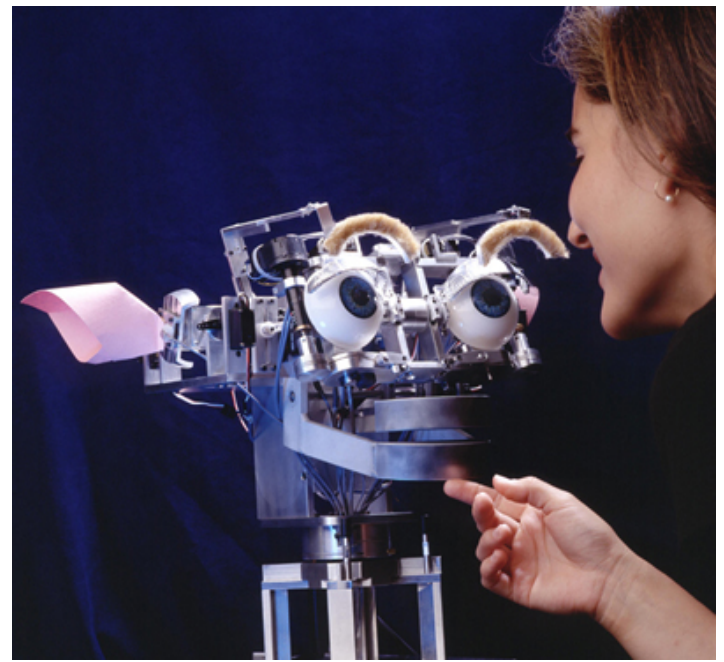
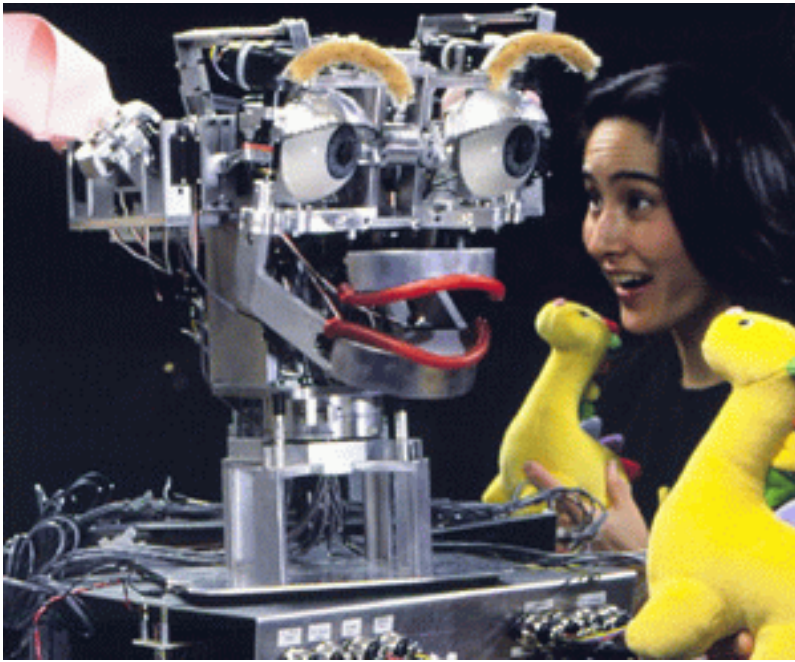
- Eight primitive emotions that more complex emotions are based upon
  - Gladness (joy)
  - Sadness
  - Anger
  - Surprise
  - Acceptance
  - Disgust
  - Expectancy
  - Fear

# Complexity of Emotional Classification



# Kismet (*Breazeal*)

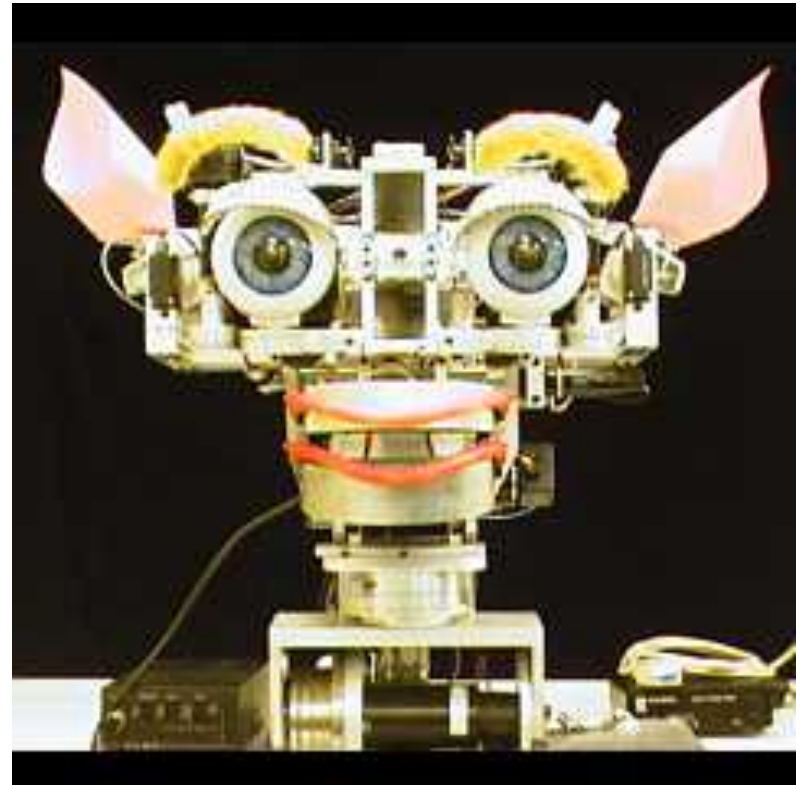
- *Social*: Kismet, A framework, using a humanoid head expressing emotions, to study:
  - effect of emotions on **human-machine interaction**.
  - learning of **social robot behaviors** during human-robot play.





# Affective Research: Kismet

- Decides proper emotional response to stimuli and exhibits corresponding facial expression, body posture, and vocal quality
- Behavioral response serves either social or self-maintenance functions



*Kismet smiling*

# Organization of Kismet's Emotions

- Some of Kismet's emotions, what causes those emotions, and what purpose they serve Kismet

<b>Prototype</b>	<b>Function of the Associated Behavior</b>	<b>Emotion Associated</b>	<b>Activation Conditions for Kismet</b>
Incorporation	Accept environmental stimulus	acceptance, calm	Acceptance of a desired stimulus
Rejection	Get rid of something harmful already accepted	disgust	Attend to a salient but <i>undesired</i> stimulus
Protection	Avoid being destroyed	fear, distress	Appearance of a threatening, overwhelming stimulus
Deprivation	React against important loss	sorrow	Loss of a desired stimulus

# Perceive Emotions

- Observe a human and infer his/her emotion
- Approaches:-
  - Speech Tone Recognition
  - Facial Expression Recognition
- We'll talk about the Facial Expression

# Facial Expression Recognition: Learning by Feedback

- Classical Example of Learning By Feedback.
- Young children look at their parents, and “learn” from their facial expressions what is right and what is not



Image courtesy  
Google Images

# Question

- Given a set of images of human faces and the emotion label for each image



happy



sad

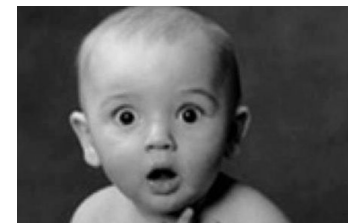


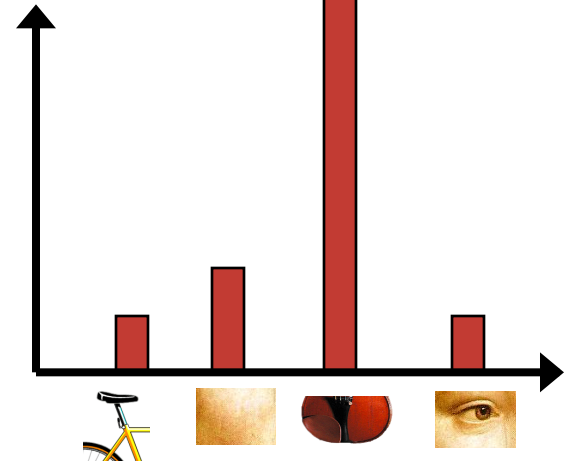
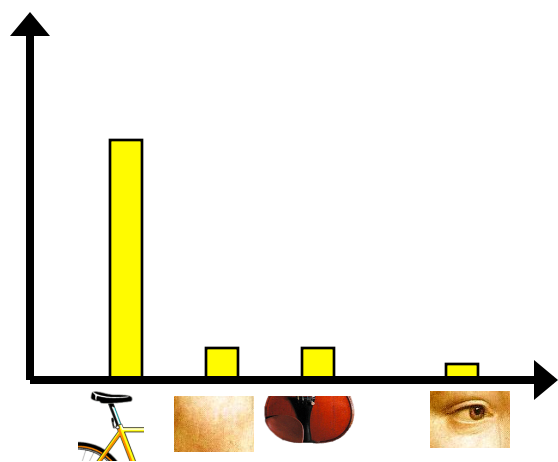
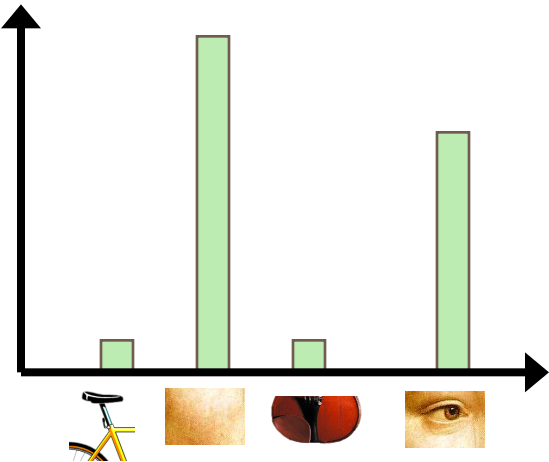
disgust



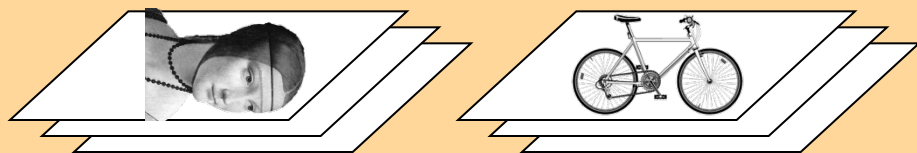
surprise

- How to learn a model that can classify an unknown expression into one of these classes





# learning



feature detection  
& representation



**codewords dictionary**

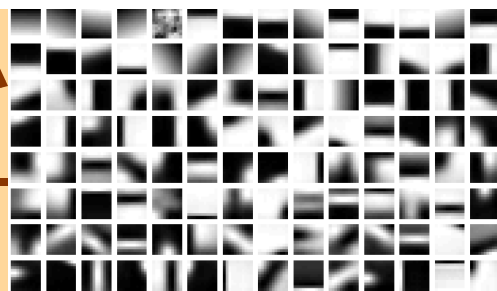
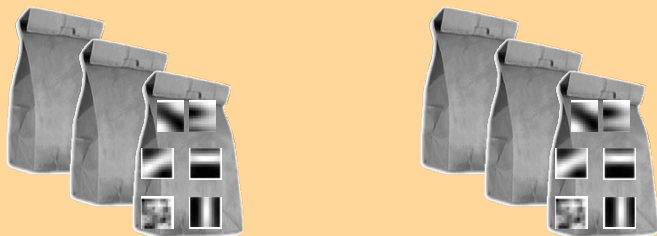
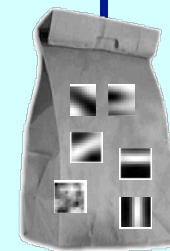
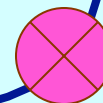


image representation



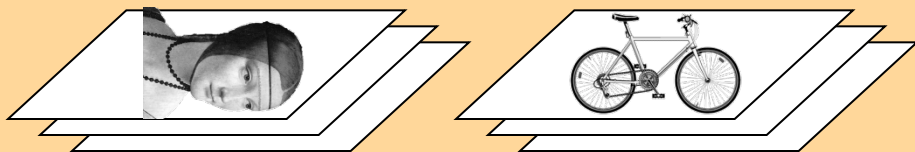
**category models  
(and/or) classifiers**

# recognition

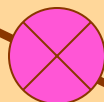


**category  
decision**

# Representation



1. feature detection & representation



2. codewords dictionary

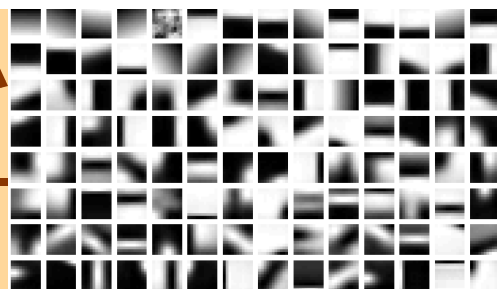
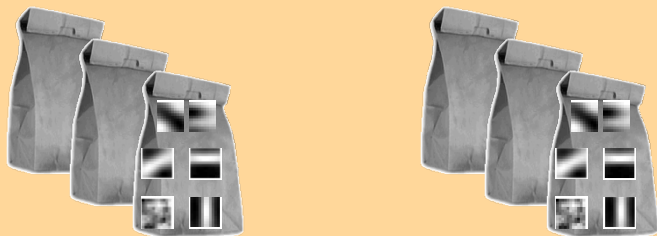


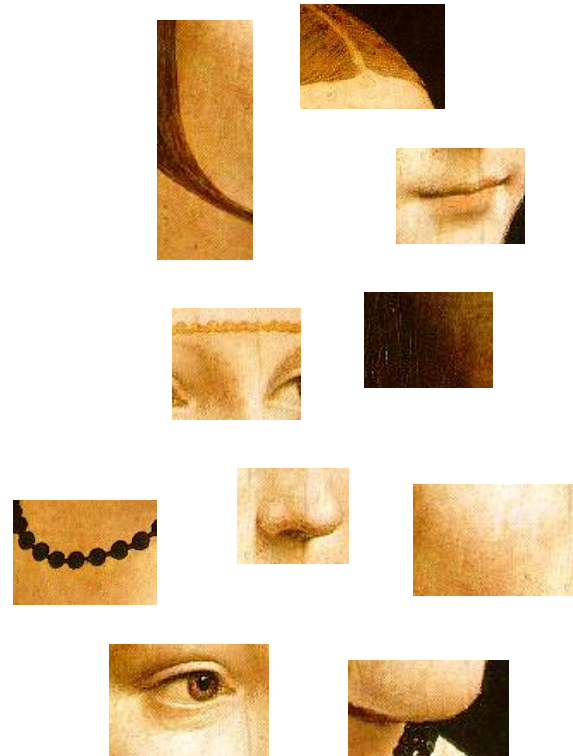
image representation

3.





# I. Feature detection and representation



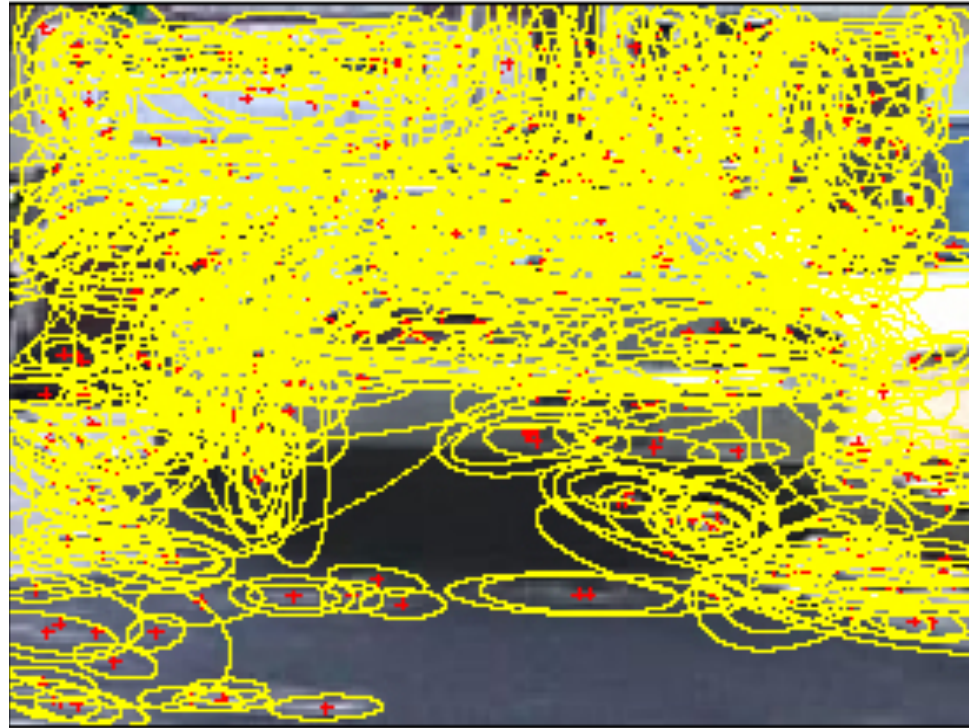
# I. Feature detection and representation

- Regular grid
  - Vogel et al. 2003
  - Fei-Fei et al. 2005

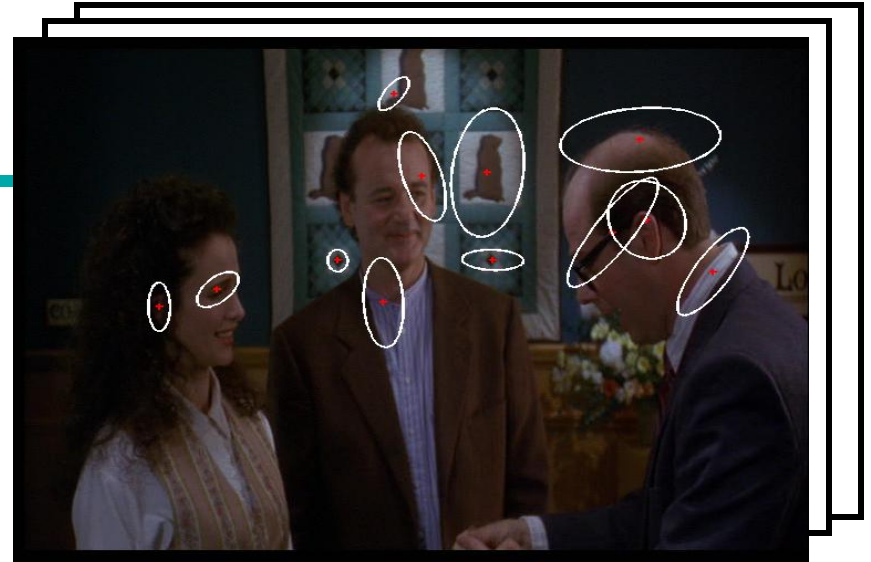
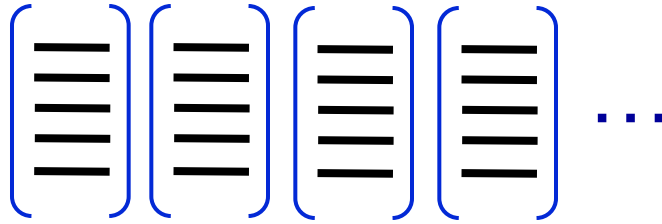


# I. Feature detection and representation

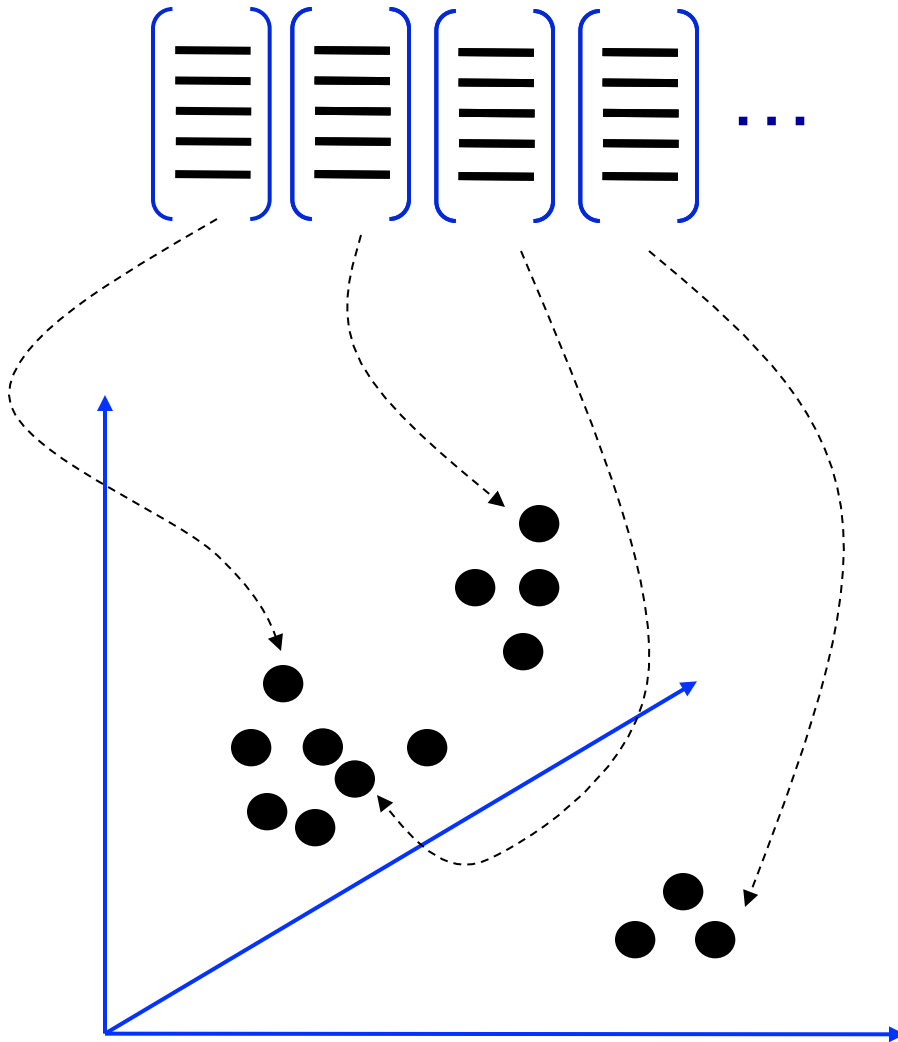
- Regular grid
- Interest point detector
  - Csurka et al. 2004
  - Fei-Fei et al. 2005
  - Sivic et al. 2005



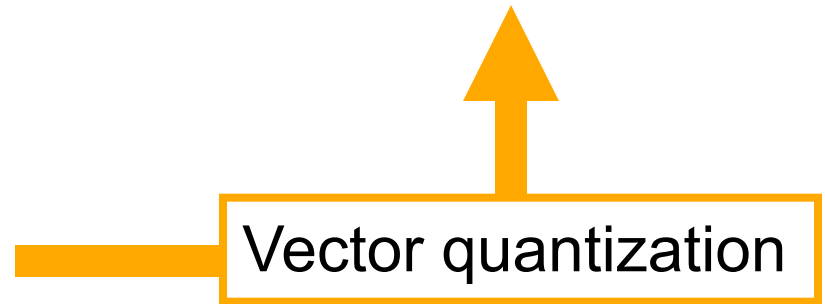
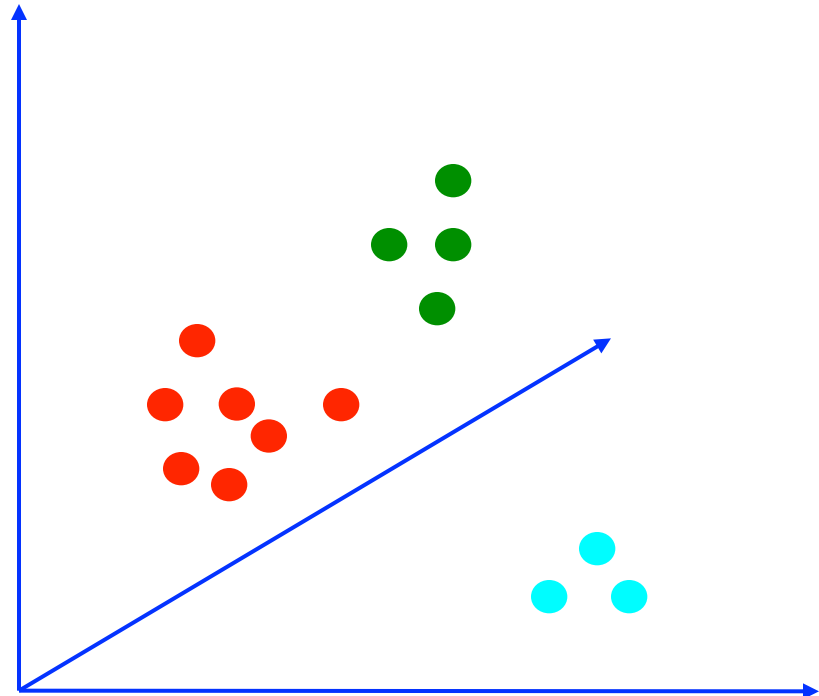
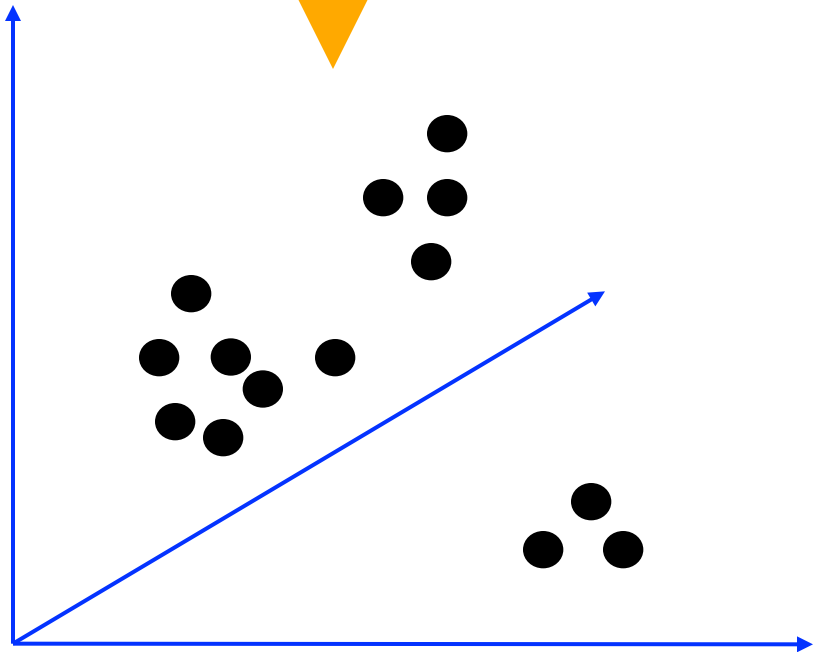
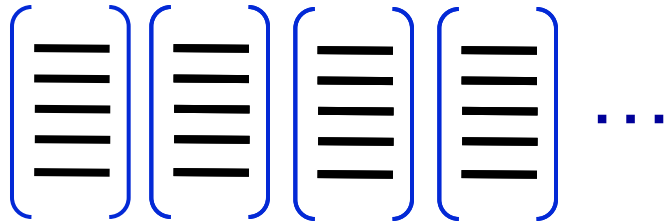
# 1. Feature detection and representation



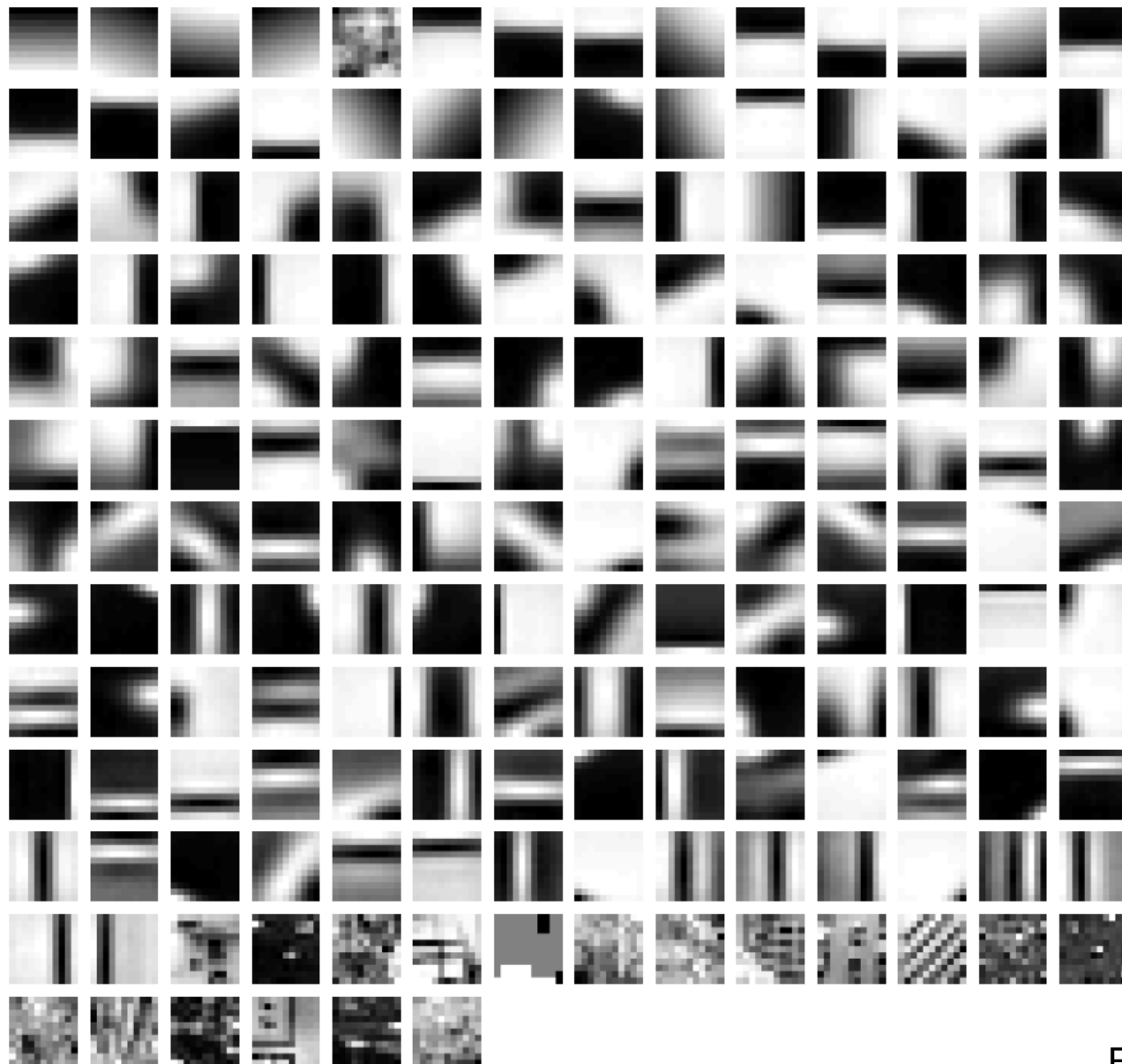
## 2. Codewords dictionary formation



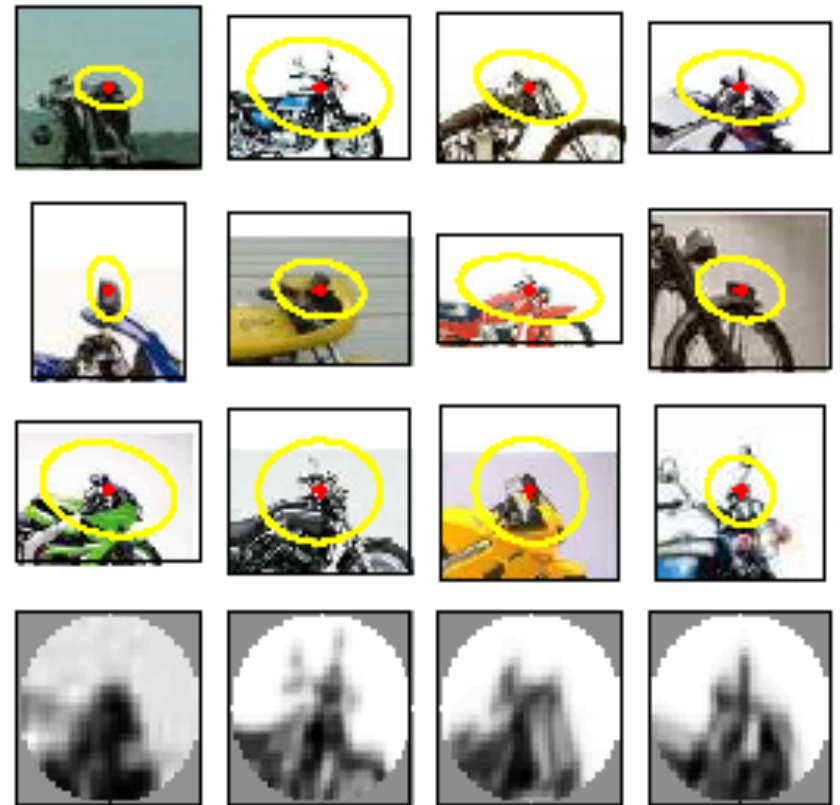
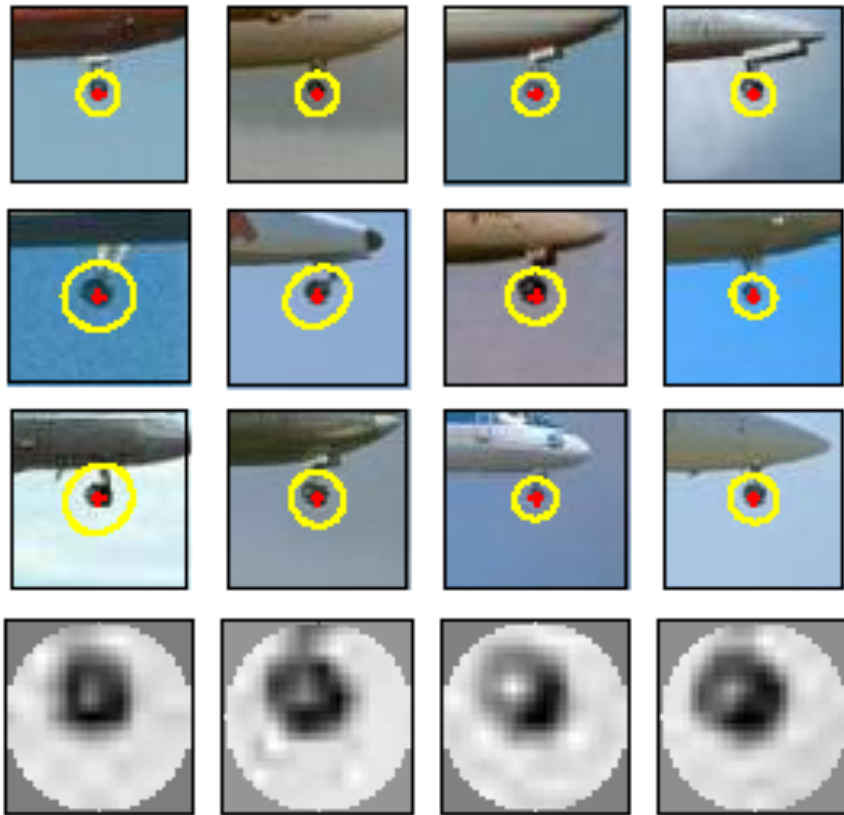
## 2. Codewords dictionary formation



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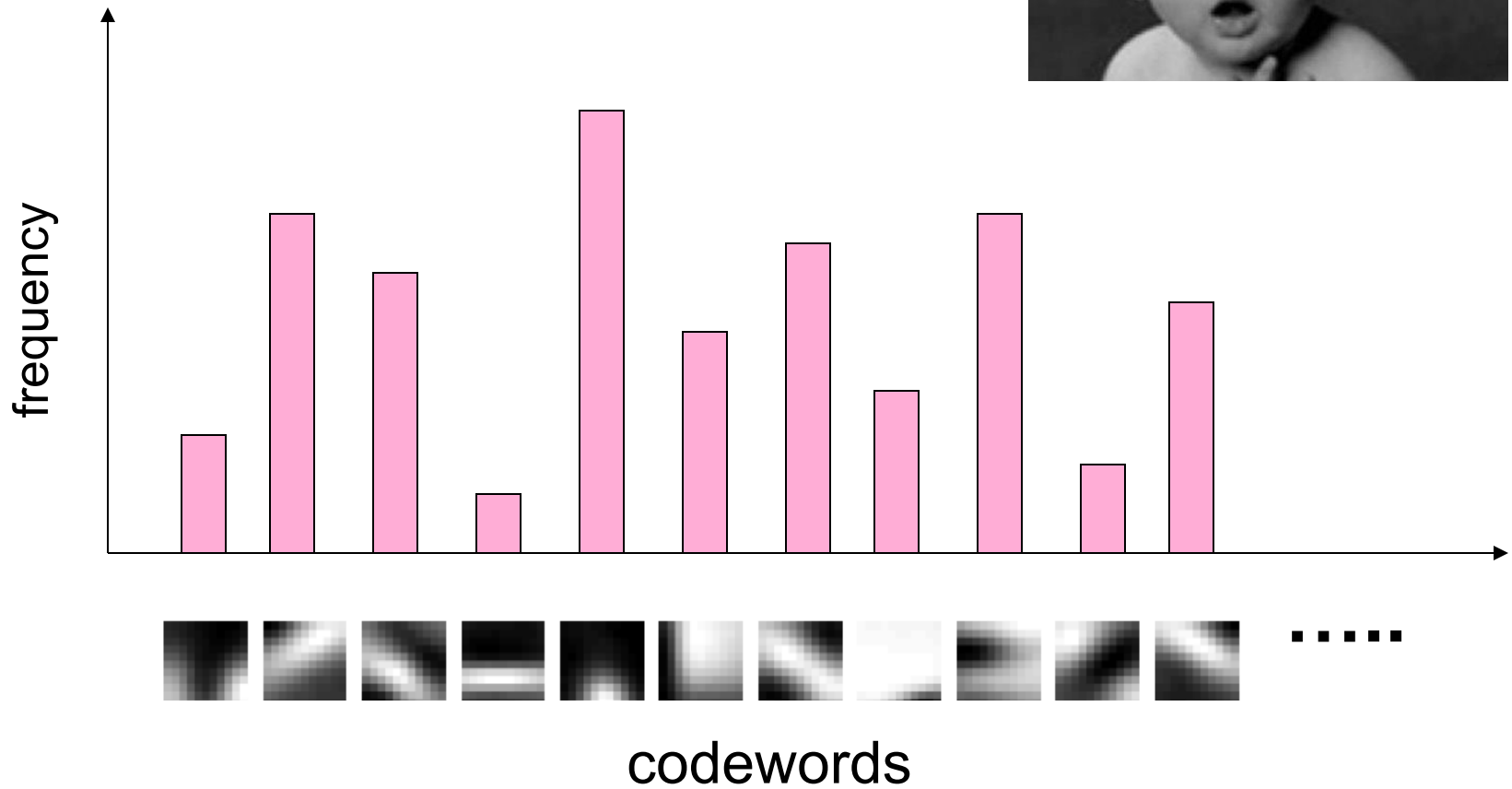


# Image patch examples of codewords

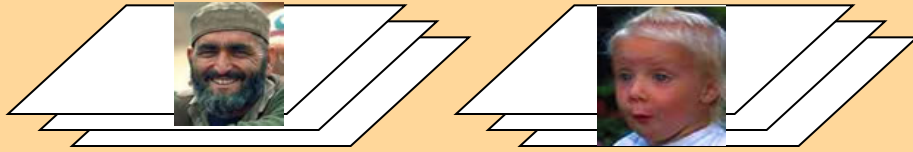




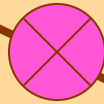
# 3. Image representation



# Representation



1. feature detection & representation



2. codewords dictionary

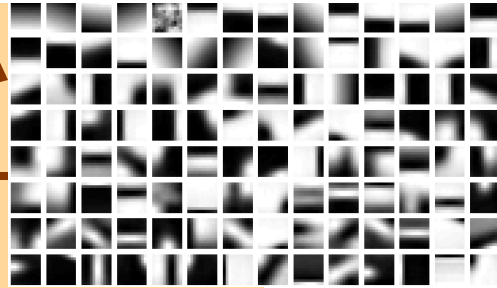
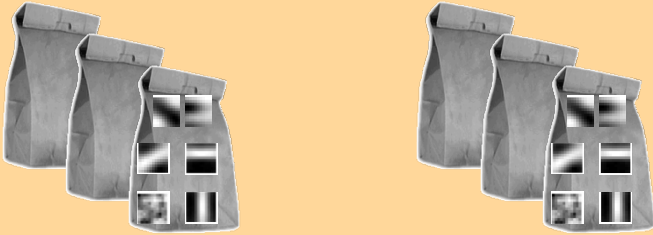


image representation

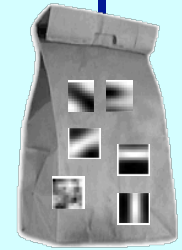
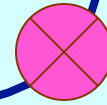
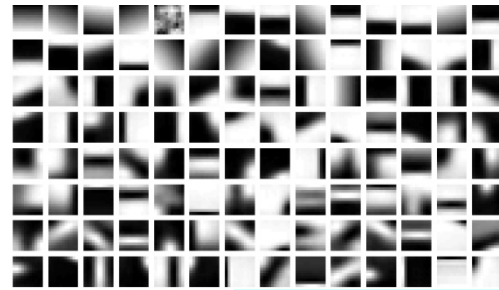
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# Learning and Recognition

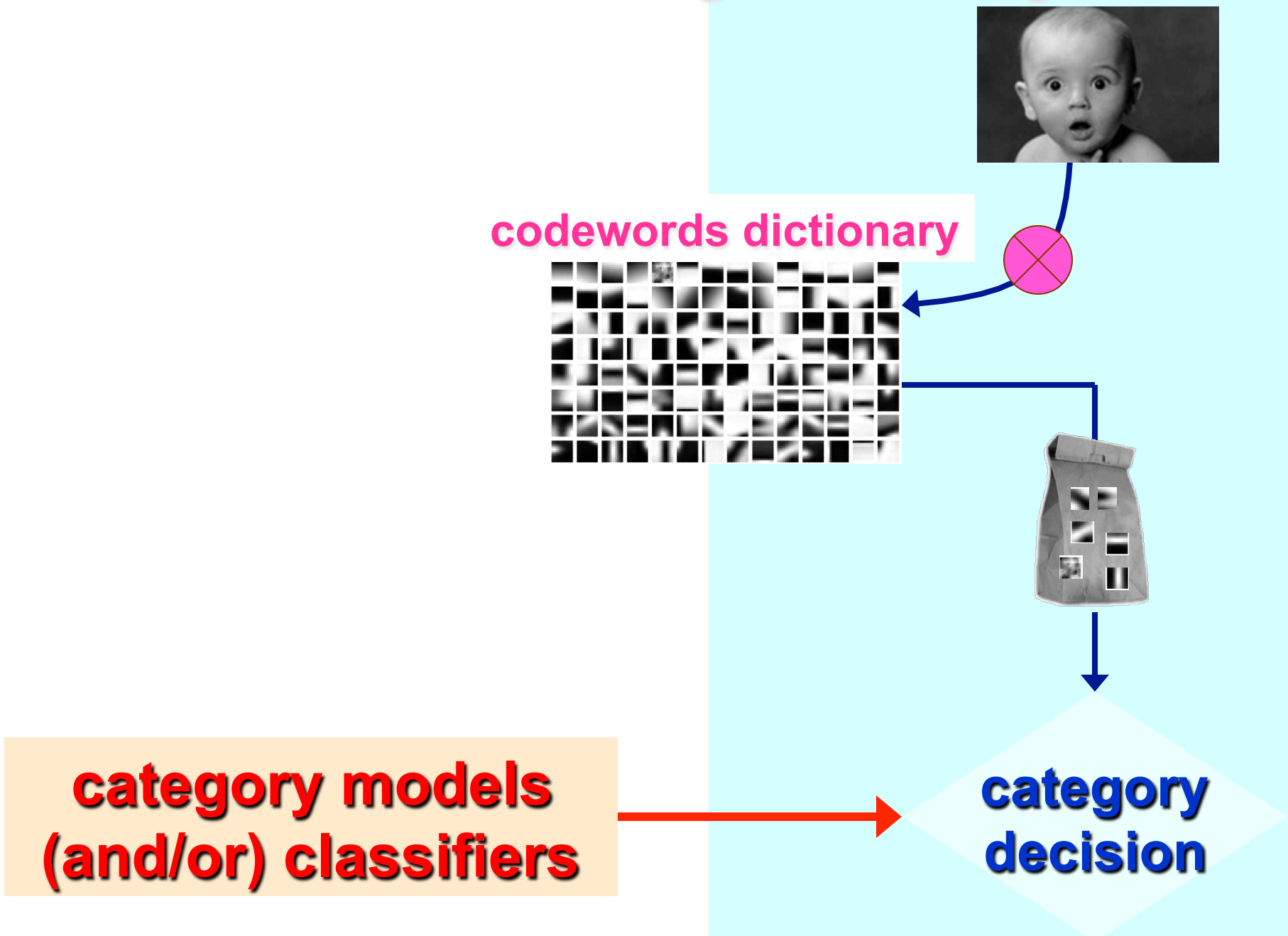


**codewords dictionary**



**category models  
(and/or) classifiers**

**category  
decision**



# Extra slides

- pepper

# Conclusion

- Affective Computing is a young field of research
- For interactive systems, something far better than the current crop of “intelligent” systems is needed.
- This field can really benefit from research into the human brain/mind.

# References

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