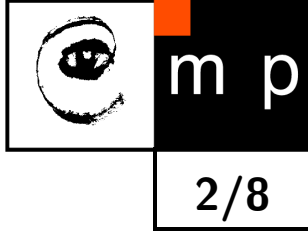


# PHILOSOPHICAL INTRODUCTION TO 3D VISION

Václav Hlaváč

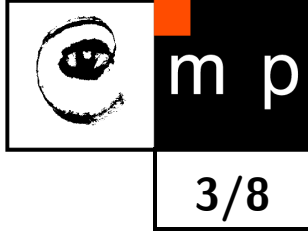
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# TRADITIONAL APPROACH TO 2D IMAGE PROCESSING/UNDERSTANDING



- ◆ Image capturing (and digitization).
- ◆ Image preprocessing.
- ◆ Objects detection (segmentation).
- ◆ Objects description.
- ◆ Objects recognition.

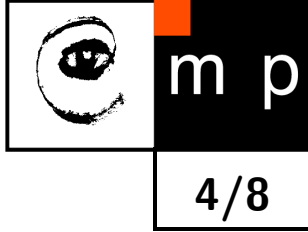
# 3D VISION, CONSIDERATIONS



What principles might enable us to:

- ◆ understand vision of living organisms,
- ◆ equip machines with visual capabilities.

# 3D VISION, QUESTIONS



Types of related questions:

- ◆ *Empirical questions* (what is?) determine how existing visual systems are designed.
- ◆ *Normative questions* (what should be?) deal with classes of animals or robots that would be desirable.
- ◆ *Theoretical questions* (what could be?) are interested in mechanisms that could exist in intelligent visual systems.

**System theory** provides a general framework that allows us to treat understanding of complex phenomena using the machinery of mathematics.

The inherent complexity of the vision task is solved here by distinguishing the **object** (everything of interest or system or phenomenon) from the **background**.

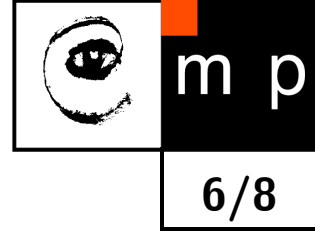
The objects and their properties need to be characterized. A formal mathematical **model with a relatively small number of parameters** is typically used for this abstraction.

**Model parameters** are typically **estimated from the (image) data**.

This methodology allows us to describe the same object using qualitatively different models (e.g. algebraic or differential equations) when **varying resolution** is used during observation. Studying changes of models with respect to several resolutions may give deeper insight into the problem.

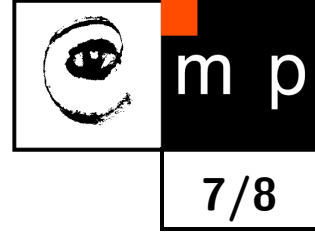
# COMPUTER VISION SYSTEM

## THREE INTERTWINED PROBLEMS



1. **Feature observability in images:** We need to determine whether task-relevant information will be present in the primary image data.
2. **Representation:** This problem is related to the choice of model for the observed world, at various levels of interpretation complexity.
3. **Interpretation:** This problem tackles the semantics of the data. In other words, how are data mapped to the (real) world. The task is to make certain information explicit from a mathematical model storing it in an implicit form.

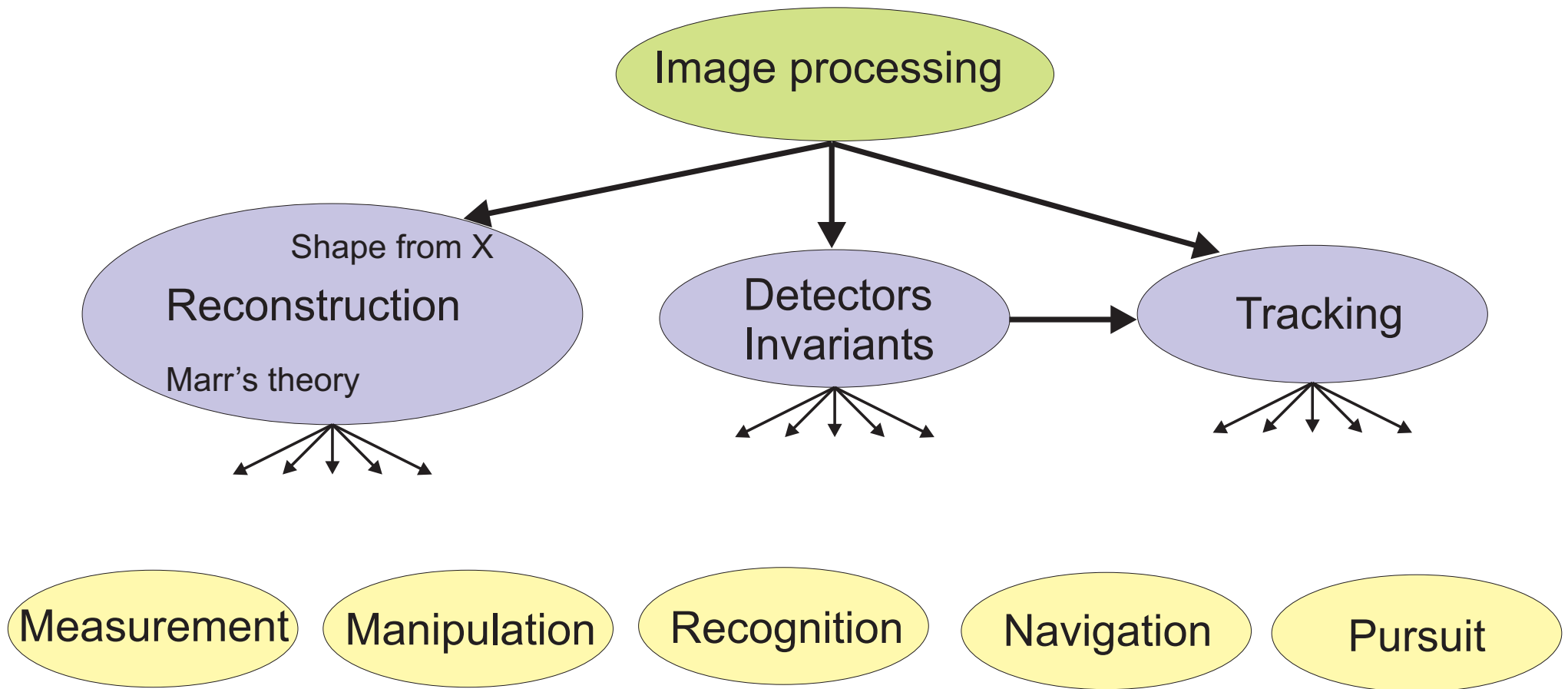
# TWO MAIN APPROACHES TO ARTIFICIAL VISION



according to the flow of information and the amount of a priori knowledge:

1. **Reconstruction, bottom-up:** The aim is to reconstruct the 3D shape of the object from an image or set of images, which might be either intensity or range images. One extreme is given by Marr's theory, which is strictly bottom-up with very little a priori knowledge about the objects needed. Some, more practical, approaches aim to create a 3D model from real objects.
2. **Recognition, top-down, model-based vision:** The a priori knowledge about the objects is expressed by means of the models of the objects, where 3D models are of particular interest.

# STRUCTURE OF 3D VISION



D. Marr thought in 1970s that all processing should involve **3D reconstruction**.

However, it can be seen that there are other tasks too.