

Structured Prediction and Learning in Computer Vision

Sebastian Nowozin and Christoph H. Lampert

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Slides: <http://www.nowozin.net/sebastian/cvpr2012tutorial/>

Microsoft®
Research



Schedule

8:30-8:40 Introduction (Christoph)

8:40-9:15 Graphical Models (Sebastian)

9:15-10:00 Probabilistic Inference in Graphical Models (Sebastian)

10:00-10:30 **Coffee break**

10:30-11:15 Conditional Random Fields (Christoph)

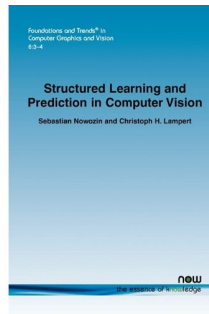
11:15-12:00 Structured Support Vector Machines (Christoph)

12:00-13:30 **Lunch break**

13:30-14:45 Structured Prediction and Energy Minimization (Sebastian)

Tutorial in Bookform

- ▶ Tutorial in written form
- ▶ now publisher's FnT Computer Graphics and Vision series
- ▶ <http://www.nowpublishers.com/>
- ▶ PDF available on authors' homepages



”Normal” Machine Learning:

$$f : \mathcal{X} \rightarrow \mathbb{R}.$$

Structured Output Learning:

$$f : \mathcal{X} \rightarrow \mathcal{Y}.$$

"Normal" Machine Learning:

$$f : \mathcal{X} \rightarrow \mathbb{R}.$$

- ▶ inputs \mathcal{X} can be any kind of objects
 - ▶ images, text, audio, sequence of amino acids, ...
- ▶ output y is a real number
 - ▶ classification, regression, density estimation, ...

Structured Output Learning:

$$f : \mathcal{X} \rightarrow \mathcal{Y}.$$

- ▶ inputs \mathcal{X} can be any kind of objects
- ▶ outputs $y \in \mathcal{Y}$ are complex (structured) objects
 - ▶ images, parse trees, folds of a protein, ...

What is structured data?

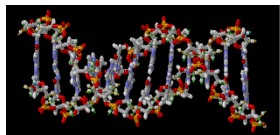
Ad hoc definition: data that consists of several parts, and not only the parts themselves contain information, but also the way in which the parts belong together.

Jemand musste Josef K. verleumdet haben, denn ohne dass er etwas Böses getan hätte, wurde er eines Morgens verhaftet. »Wie ein Hund!« sagte er, es war, als sollte die Scham ihn überleben. Als Gregor Samsa eines Morgens aus unruhigen Träumen erwachte, fand er sich in seinem Bett zu einem ungeheueren Ungeziefer verwandelt. Und es war ihnen wie eine Bestätigung ihrer neuen Träume und guten Absichten, als am Ziele ihrer Fahrt die Tochter als erste sich erhob und ihren jungen Körper dehnte. »Es ist ein eigentümlicher Apparat«, sagte der Offizier zu dem Forschungsreisenden und überlickte mit einem gewissemaßen

Text

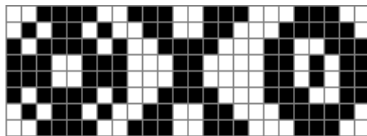


Documents/HyperText



Source: wikipedia.org

Molecules / Chemical Structures



Images

What is structured output prediction?

Ad hoc definition: predicting *structured* outputs from input data
(in contrast to predicting just a single number, like in classification or regression)

- ▶ Natural Language Processing:
 - ▶ Automatic Translation (output: sentences)
 - ▶ Sentence Parsing (output: parse trees)
- ▶ Bioinformatics:
 - ▶ Secondary Structure Prediction (output: bipartite graphs)
 - ▶ Enzyme Function Prediction (output: path in a tree)
- ▶ Speech Processing:
 - ▶ Automatic Transcription (output: sentences)
 - ▶ Text-to-Speech (output: audio signal)
- ▶ Robotics:
 - ▶ Planning (output: sequence of actions)

This tutorial: Applications and Examples from Computer Vision