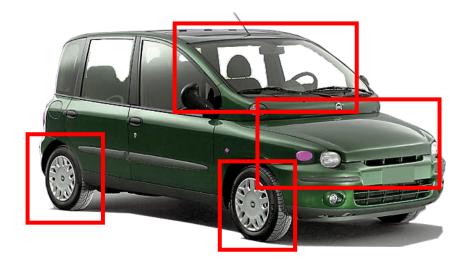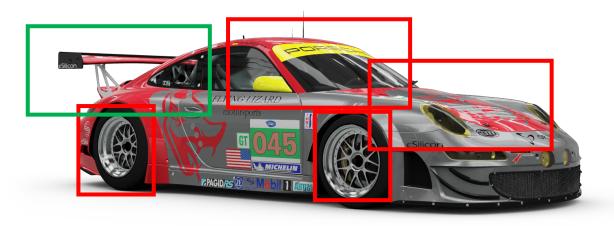# Exploring Latent Class Structures in Classification-By-Components Networks

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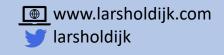
Example: Two classes in the ImageNet dataset

Describe relation between object classes

Observation:

- Both objects share a number of components; wheels, doors, windshield, etc.
- Some components are unique to the objects; raised roof and spoiler
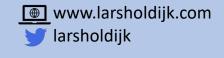
Discriminative features

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Latent Class Structure

"The information about the relationship between classes encoded in the way they share components."

Observation:
- Investigating if, and how, classifiers use the latent class structure in their classification process can provide useful information.

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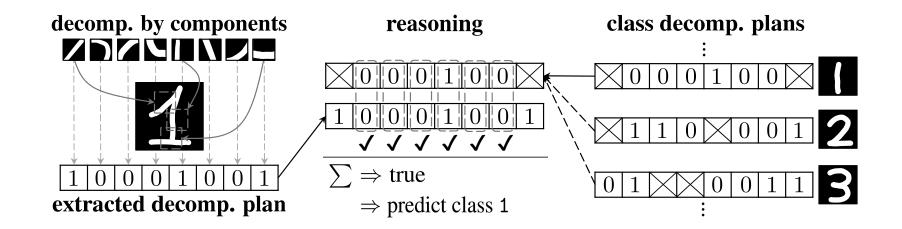
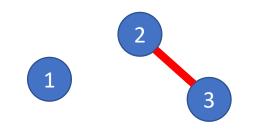🐦 larsholdijk

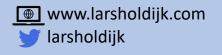✉ larsholdijk@gmail.com

Classification-By-Components Network

Saralajew et al, *Classification-by-Components: Probabilistic Modeling of Reasoning over a Set of Components,* NeurIPS2019

decomp. by components

reasoning

class decomp. plans

| ⊠ | 0 | 0 | 0 | 1 | 0 | 0 | ⊠ |

| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |

✓ ✓ ✓ ✓ ✓ ✓

$\sum \Rightarrow$ true

$\Rightarrow$ predict class 1

| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |

extracted decomp. plan

| ⊠ | 0 | 0 | 0 | 1 | 0 | 0 | ⊠ | **1**

| ⊠ | 1 | 1 | 0 | ⊠ | 0 | 0 | 1 | **2**

| 0 | 1 | ⊠ | ⊠ | 0 | 0 | 1 | 1 | **3**

Shared Component Graph:
- Nodes represent classes
- Classes sharing a component are connected with an edge

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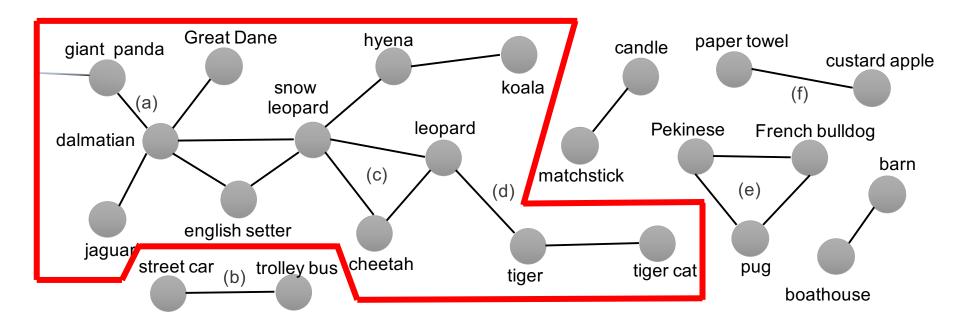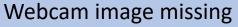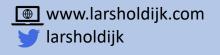
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Evaluation: <u>ImageNet</u> and CUB bird species

Observation:
- CBCs use the latent class structure in its classification process.
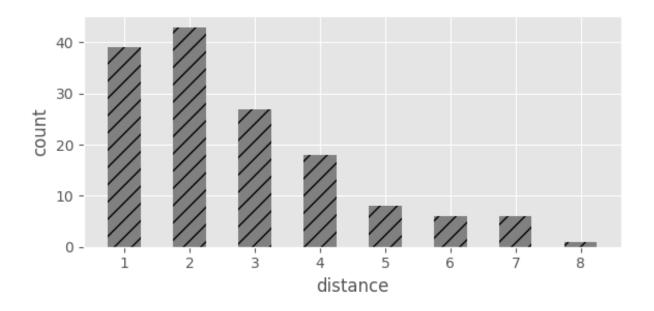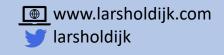 - eg: large clusters of animals

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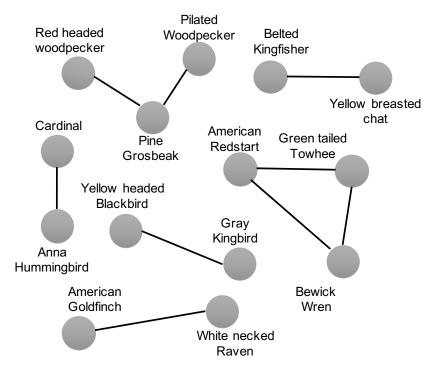# Evaluation: <u>ImageNet</u> and CUB bird species

Observation:
- Consider WordNet hierachy as ground-truth for class relation.
- Classes close to eachother in the WordNet hierachy more often share a component than classes in completely different subtrees.
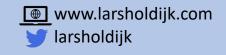
Webcam image missing

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Evaluation: ImageNet and <u>CUB bird species</u>

Observation:
- CBCs can fail to uncover the latent class structure when overparameterized.
- With an ample number of components, specialized class specific components can be formed.

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