

The SAD (Semantic Anomaly Detection) process

- **Knowledge Base Definition.** SAD learns common patterns in the object configurations for all the different object classes; like object *co-occurrence*, *relative positions* and *sizes*.
- **Anomaly Detection:** find in the segmented image object configurations which show a low likelihood according to the information stored in the knowledge base.

Motivation

- **Our goal**
 - inspect **anomalies** in the classification results produced by **semantic segmentation** neural networks
- **Definitions**
 - **anomaly:** entity which deviates from one or more *semantic rules* modeling *normal data*
 - **semantic image segmentation:** assigning a class label to each pixel
- **Points of strength** of our method
 - provides a human **understandable** description of the anomaly
 - highlights **potentially misclassified objects**
 - **semantic enrichment** of the image segmentation even when the classification is correct

Proposed methodology

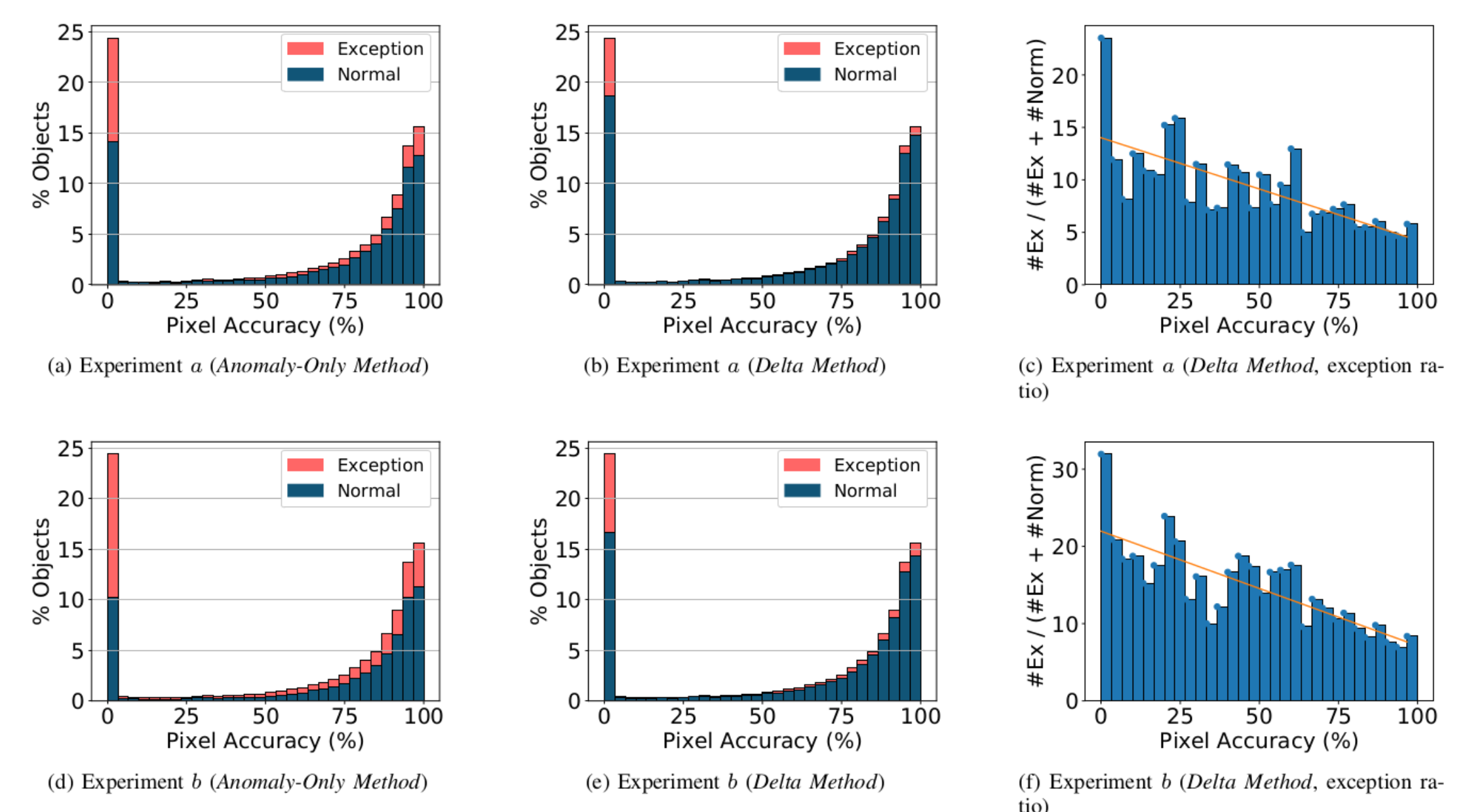
- **Contribution**
 - defining a **knowledge base** to describe how objects of different classes are related together in the training images
 - deriving a set of **relationships** between objects and in particular a new method to compute their relative position
 - detecting **contextual anomalies** in segmented images by means of the semantic rules stored in the knowledge base

Results

Position relationship examples

Class Pair	Sup	Histogram
runway, sky	151	<i>below</i> =0.87 <i>side-down</i> =0.1
ball, pool table	33	<i>inside</i> =0.91 <i>above</i> =0.03
light, sink	1321	<i>side-up</i> =0.83 <i>above</i> =0.17

Anomaly detection



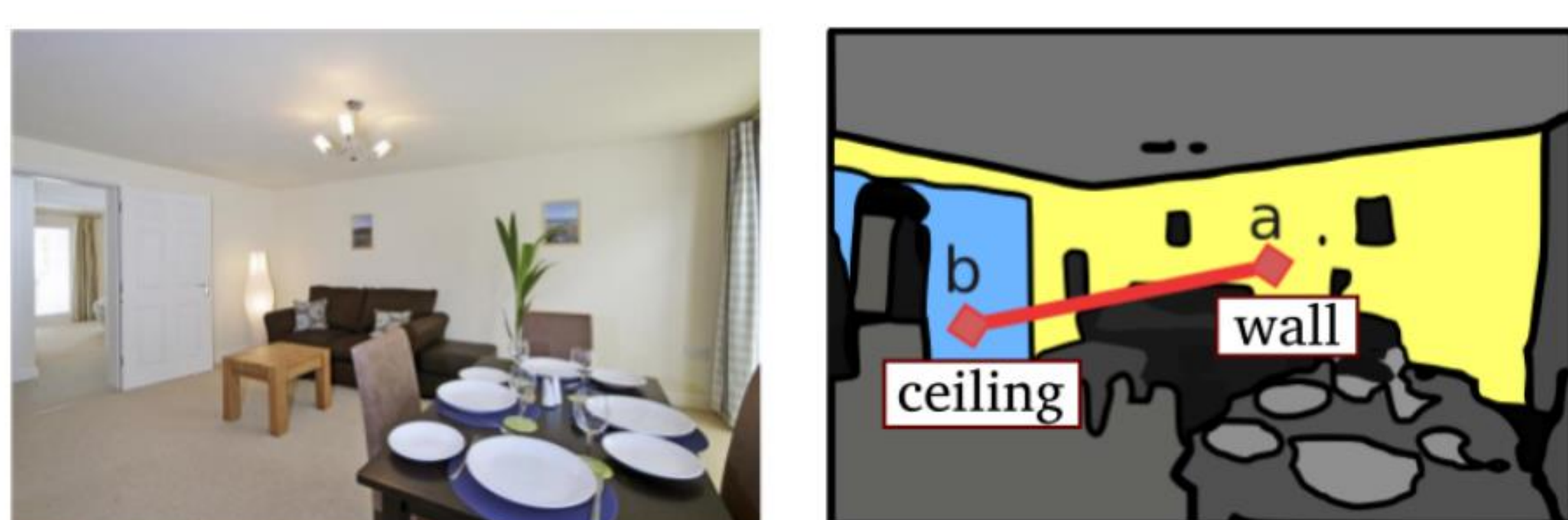
Precision Recall for the *exception* and *normal* classes

Experiment	Precision (Ex)	Recall (Ex)	Precision (Norm)	Recall (Norm)
experiment a, <i>Anomaly-Only Method</i> (Fig 10a)	0.6536	0.3601	0.5996	0.8339
experiment a, <i>Delta Method</i> (Fig 10b)	0.7440	0.1835	0.5708	0.9451
experiment b, <i>Anomaly-Only Method</i> (Fig 10d)	0.6152	0.5230	0.6328	0.7153
experiment b, <i>Delta Method</i> (Fig 10e)	0.7283	0.2596	0.5870	0.9157

Future work

- use prior knowledge extracted from **ontologies** to model more complex semantic relationships between objects
- build **semantic image descriptions** which consider the contextual information obtained from the object relationships

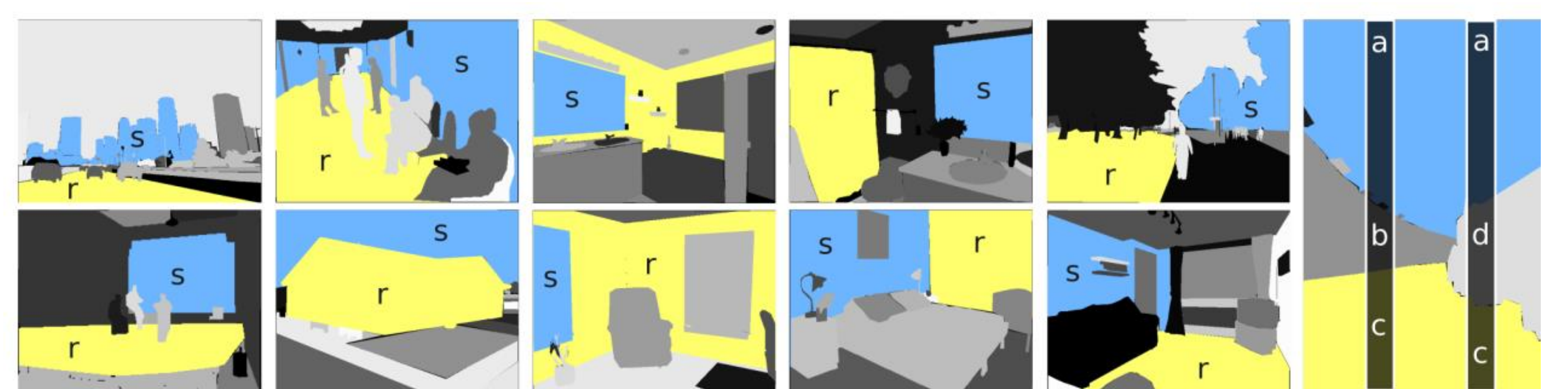
Examples of SAD output



a) query image b) segmented image

Anomaly: wall (a) **on** ceiling (b) has likelihood <0.01

c) model output



Object positions. The image shows the relationships between a subject (s) and a reference (r). The rightmost example shows the *string representation*, used to compute the object positions.