

# Occlusion Patterns for Object Class Detection

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In this material we bring more intuition behind our explicit occlusion modelling approach by visualizing the trained models as well as by showing the strongest false positives for the best performing OC-DPM model. In section 1 we visualize the OC-DPM, Sym-DPM and Asym-DPM models. Then in section 2 we visualize the strongest false positives generated by OC-DPM model.

Please see the supplemental video for direct qualitative comparison on true positives with the DPM [1] (release 4 [2]).

## 1. Model Visualization

Figure 1 visualizes a subset of the model components in the OC-DPM model. The first row visualizes a component trained to detect visible objects, while the rest of them show components trained to detect occluded objects. The number of components in the model vary for the different folds. Table 1 provides number of components for visible and occluded components in the OC-DPM model for *Cars*.

	FOLD 1	FOLD 2	FOLD 3
Occluded	13	19	24
Visible	3	3	3

Table 1. Statistics on visible and occluded components in the OC-DPM model, class *Car*.

Fig 2 is visualizing the trained Sym-DPM model. In this case, we are visualizing the occluded components only. Occlusion components for different occlusion patterns are shown. For each component we visualize the joint root filter, the occlusion pattern centroid, the filters for the individual objects and the learned deformation terms for each of the objects.

Fig 3 is visualizing the trained Asym-DPM model. In this case, again we are visualizing the occluded components only. For each component we visualize the occlusion pattern centroid, the filters for the individual objects and the learned deformation terms for each of the objects. Note that the occluder in this case is the root of the model and in addition to the occluded objects it has its own parts as well.

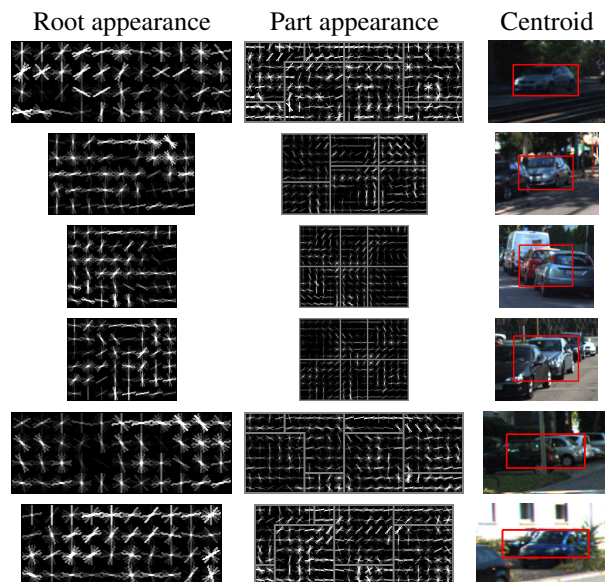


Figure 1. OC-DPM model components for the *Car* class. (First column) Root filter. (Second column) Part filters (Third column) Component centroids. The bounding box depicts the centroid.

## 2. False Positives

In the end we provide the strongest 100 false positives by the OC-DPM. After carefully examining these cases, we came to conclusion that most of them happen due to missing annotations. One can also observe that quite a few false positives fail to localize the objects accurately especially in terms of objects size, thus providing larger object hypotheses from what the objects actually are.

## References

- [1] P. F. Felzenszwalb, R. Girshick, D. McAllester, and D. Ramanan. Object detection with discriminatively trained part based models. *PAMI*, 2010.
- [2] P. F. Felzenszwalb, R. B. Girshick, and D. McAllester. Discriminatively trained deformable part models, release 4. <http://people.cs.uchicago.edu/~pff/latent-release4/>.

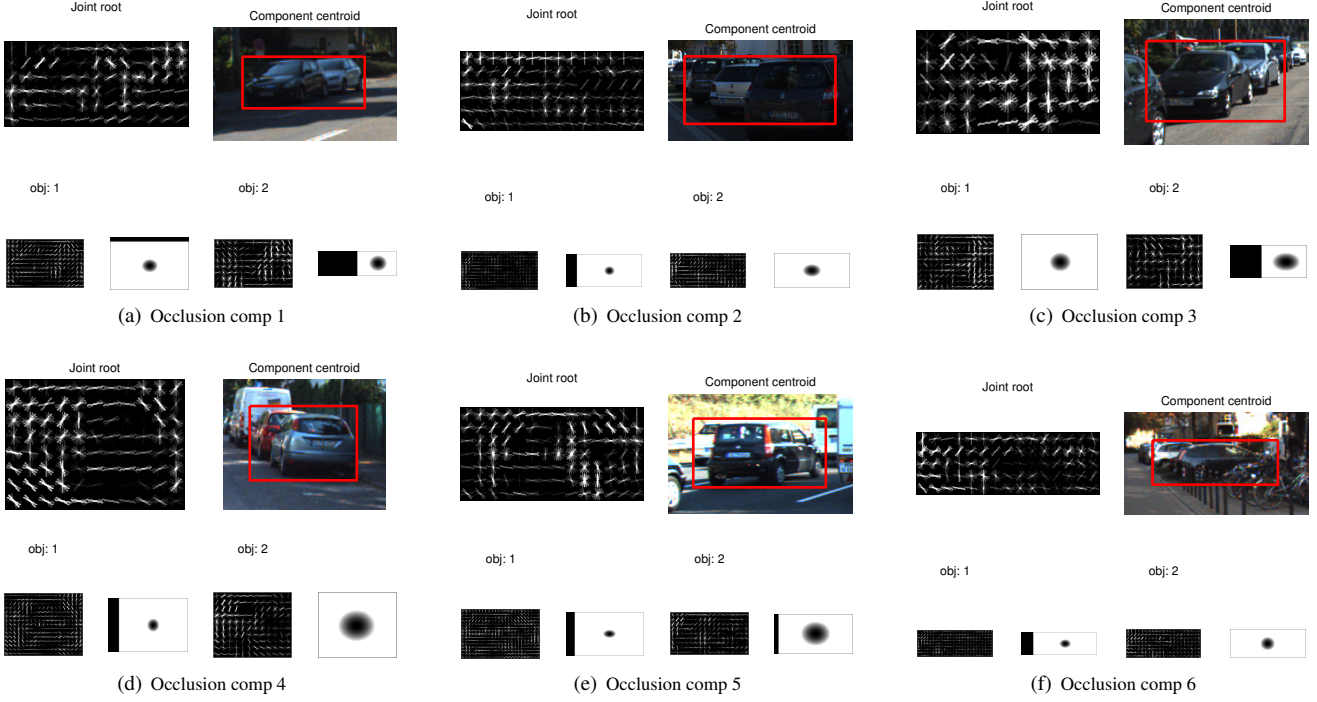


Figure 2. Sym-DPM model components for the *Car* class. (a)-(f) visualize different occlusion patterns. Each component visualization shows the double-object root filter (joint root) the component centroid and the filter for the occluder (obj:1) and the occluded (obj:2) object. Note that the objects themselves do not contain parts. In addition to the filters, the individual deformation terms are shown as well.

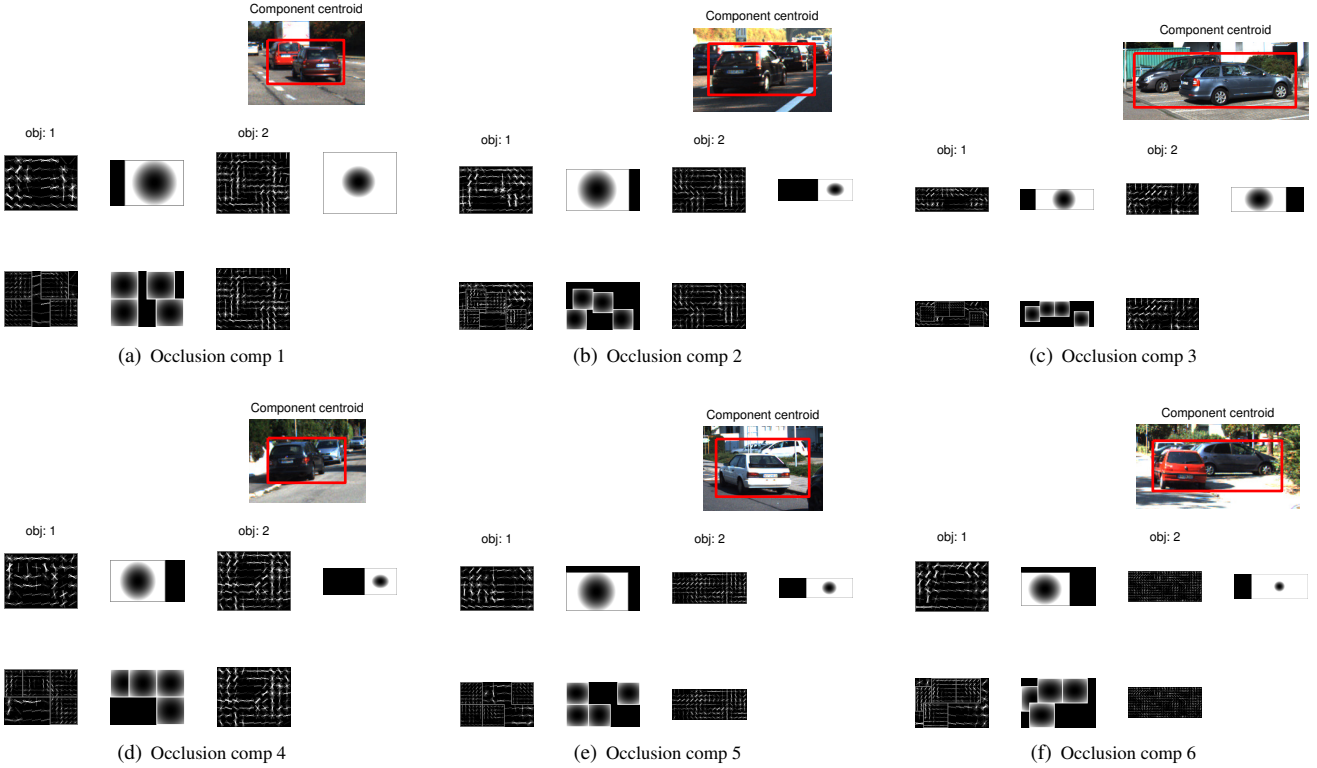


Figure 3. Asym-DPM model components for the *Car* class. (a)-(f) visualize different occlusion patterns. Each component visualization shows the component centroid and the filter for the occluder (obj:1) and the occluded (obj:2) object. Note that the occluded object does not contain parts. In addition to the filters, the individual deformation terms are shown as well.



Figure 4. The strongest 100 false positives by the OC-DPM model. Note that most of them occur due to missing ground truth annotations. In some cases the hypotheses fail to accurately localize the objects providing larger object hypotheses compared to the ground truth.