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Object condensation: one-stage grid-free multi-object reconstruction in physics detectors, graph, and image data

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High-energy physics detectors, images, and point clouds share many similarities in terms of object detection. However, while detecting an unknown number of objects in an image is well established in computer vision, even machine learning assisted object reconstruction algorithms in particle physics almost exclusively predict properties on an object-by-object basis.
Traditional approaches from computer vision either impose implicit constraints on the object size or density and are not well suited for sparse detector data or rely on objects being dense and solid. The object condensation method proposed here is independent of assumptions on object size, sorting or object density, and further generalises to non-image-like data structures, such as graphs and point clouds, which are more suitable to represent detector signals. The pixels or vertices themselves serve as representations of the entire object, and a combination of learnable local clustering in a latent space and confidence assignment allows one to collect condensates of the predicted object properties with a simple algorithm.
The object condensation method is described and results on a simple object classification problem in images and as well as an application to particle flow are presented.

Primary author: KIESELER, Jan (CERN)

Presenter: KIESELER, Jan (CERN)

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