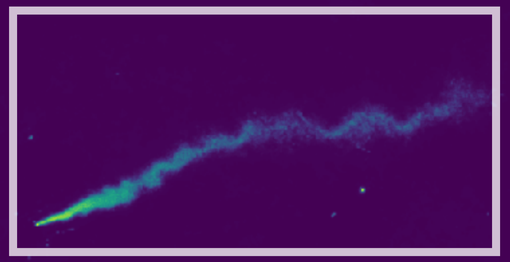
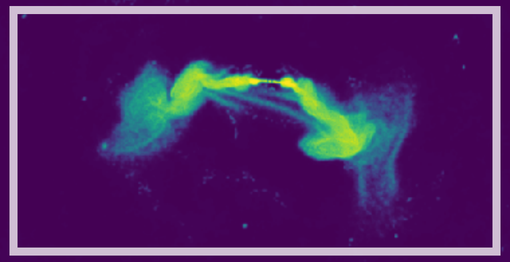
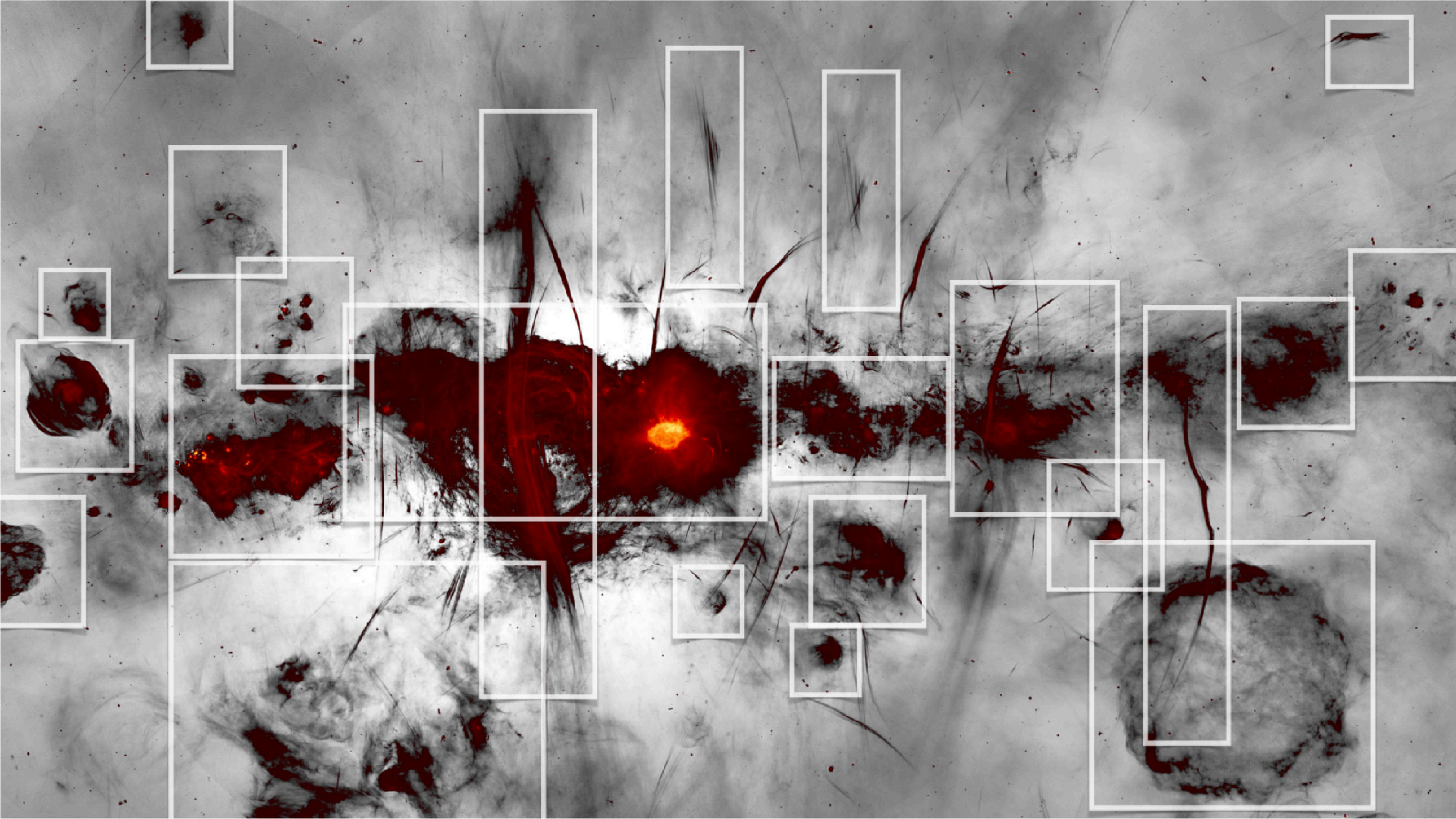
Automatic Modelling of superposed & complex Signals

Richard Fuchs







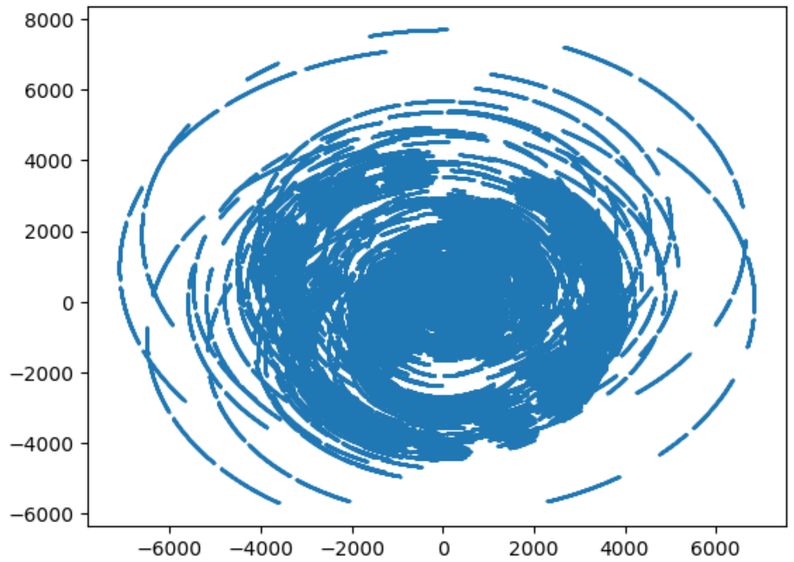
Radio interferometry

- **Radio interferometric measurement equation**

$$d_{uvw} = n_{uvw} + \iint \frac{dl\,dm}{n(l,m)}\; A(l,m)\; I(l,m)\; \mathrm{e}^{-2\pi \mathrm{i}\,[ul+vm+w(n(l,m)-1)]}$$

=> discretize

$$d = R\,s + n$$



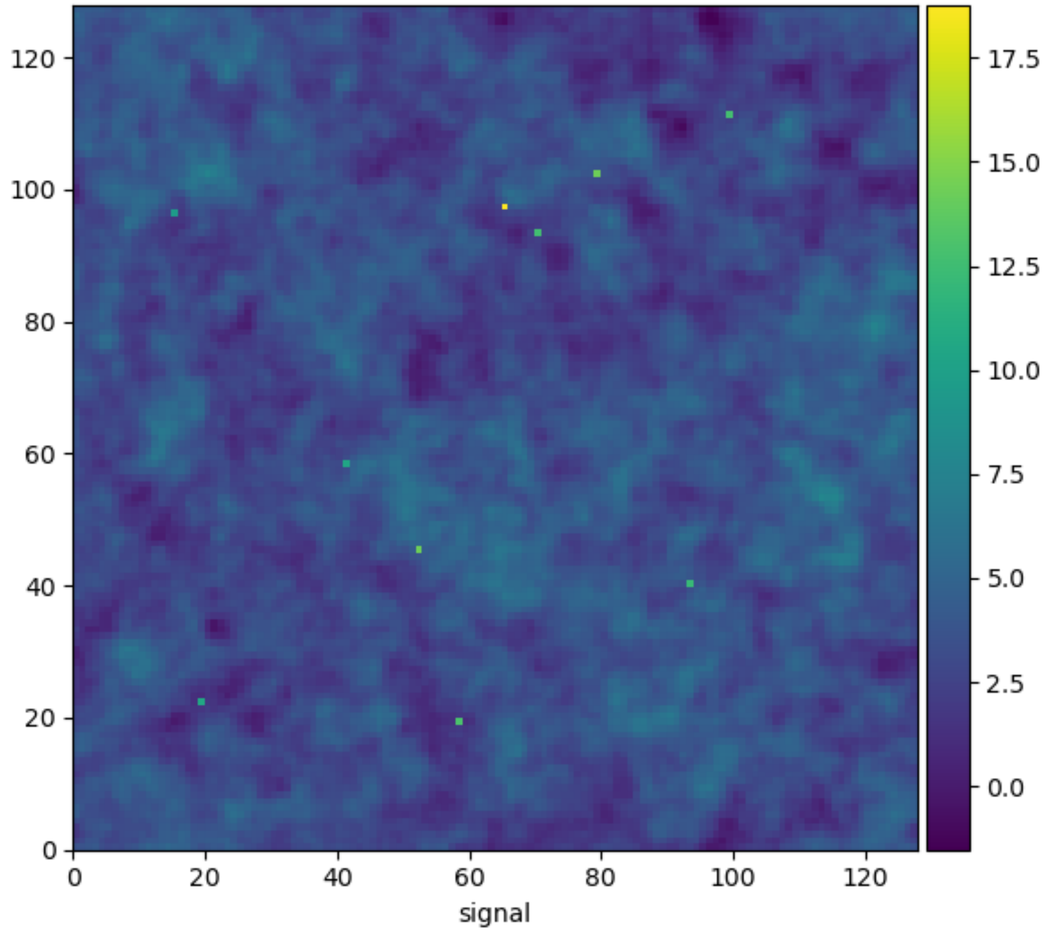
Information field theory

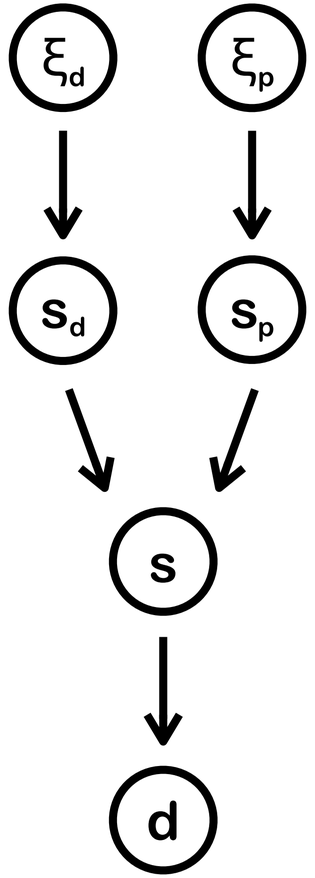
- **Bayes' principle**

$$P(s \mid d) = \frac{P(d \mid s)\ P(s)}{P(d)}$$

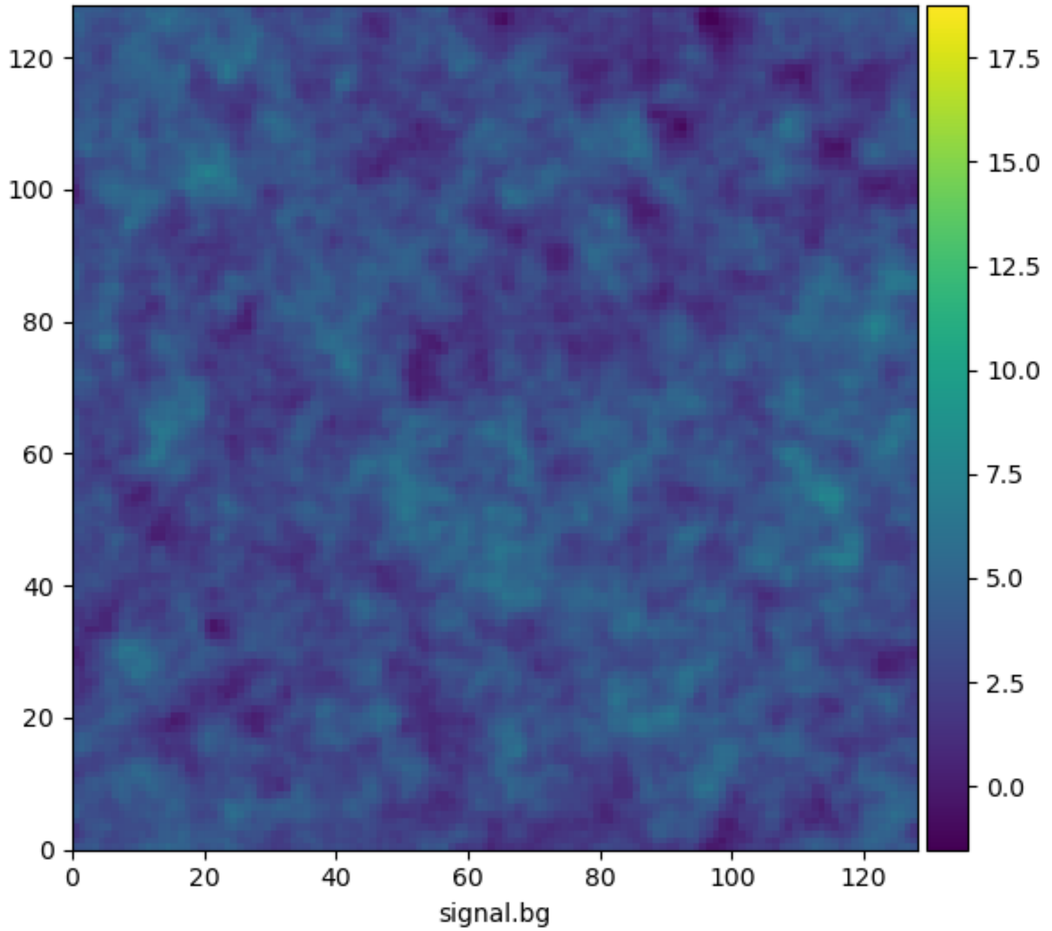
- **Essential components**
  - **prior model**
  - **likelihood**
  - **inference scheme**

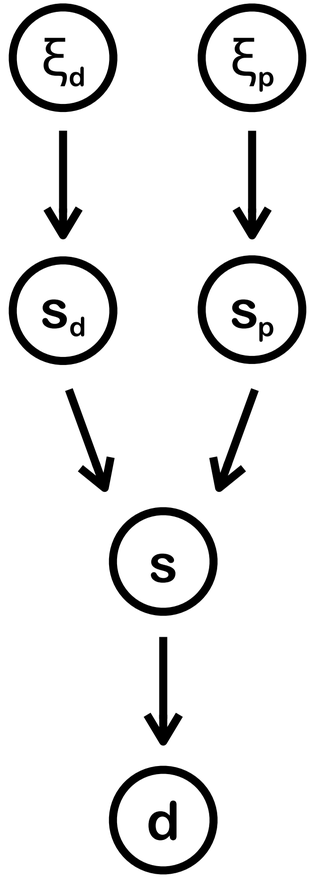
Component separation



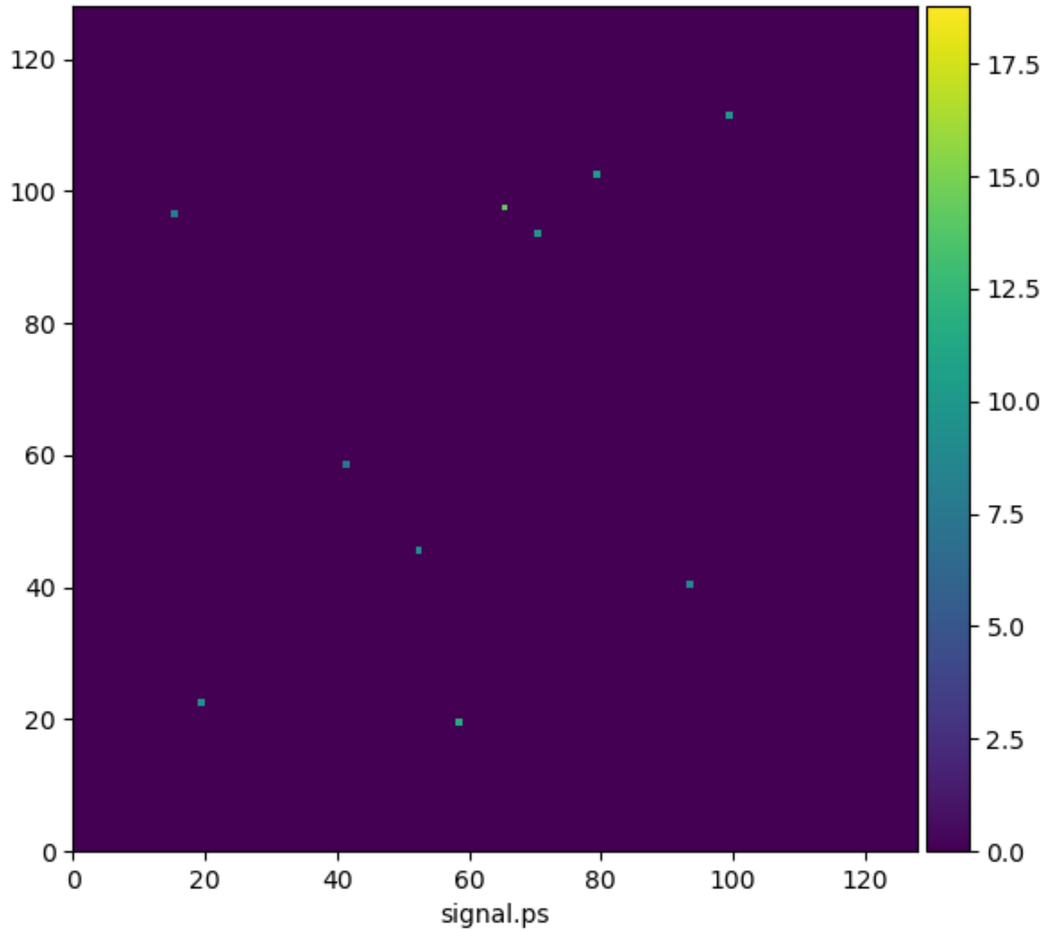


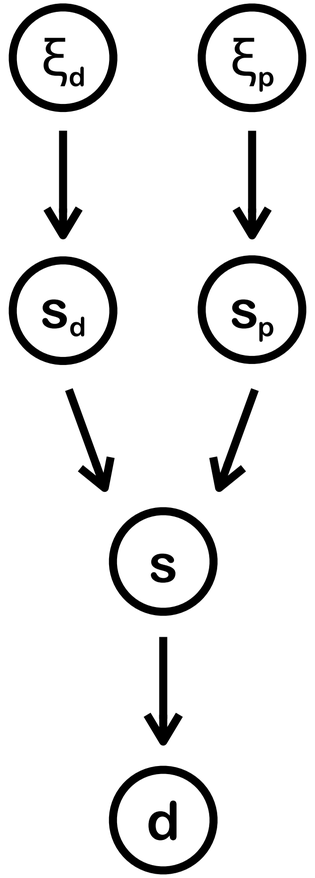
Component separation



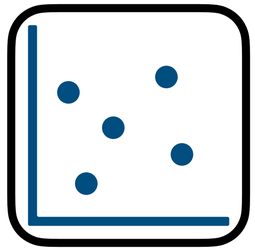


Component separation





Automatic pipeline

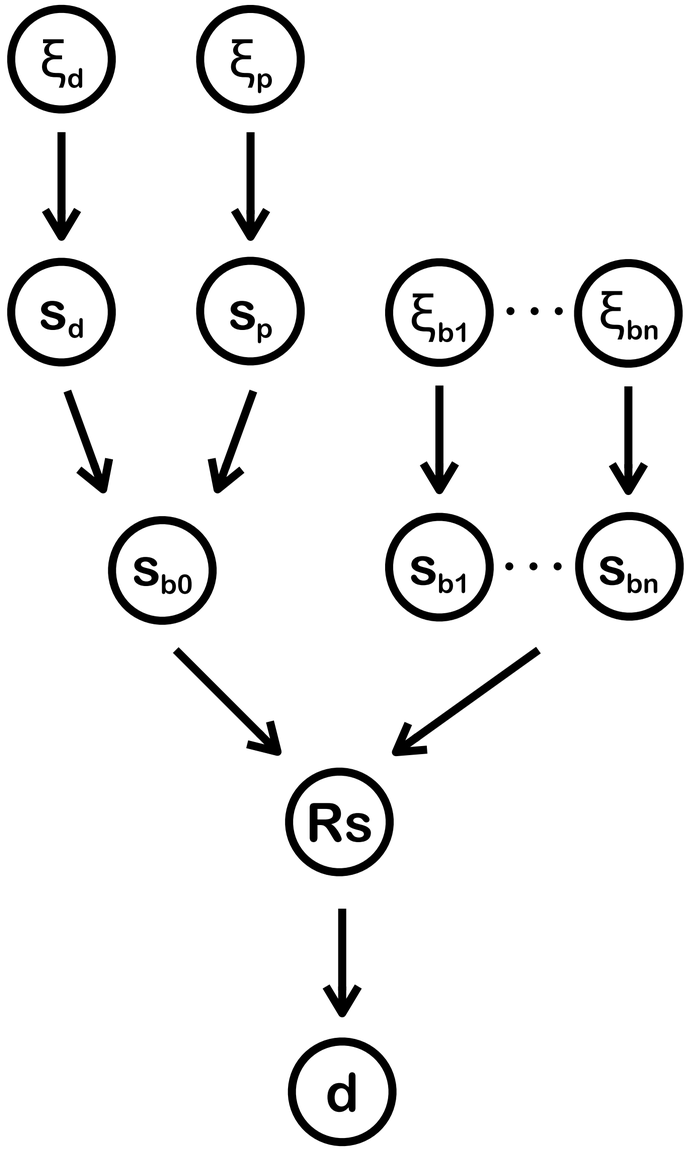


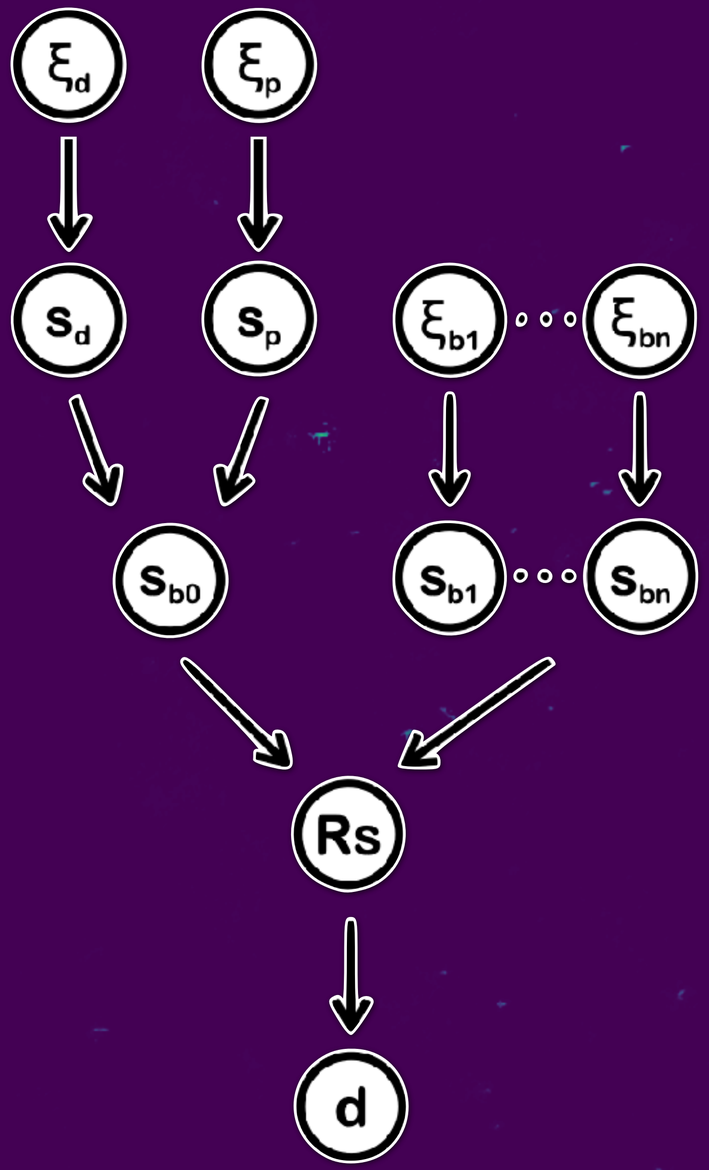
Data

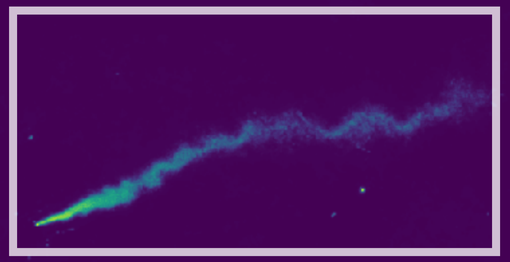
Flexible forward model

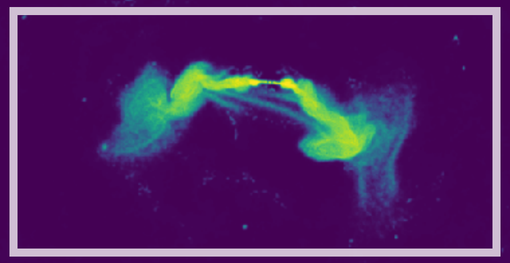
- Components
  - diffuse background
  - point sources
  - extended objects
- Add response functions

$$d = R\,s + n = \sum R_{b_i}\, s_{b_i} + n$$




ξd
ξp
sd
sp
ξb1
ξbn
sb0
sb1
sbn
Rs
d





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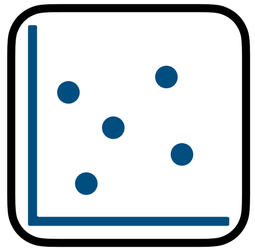
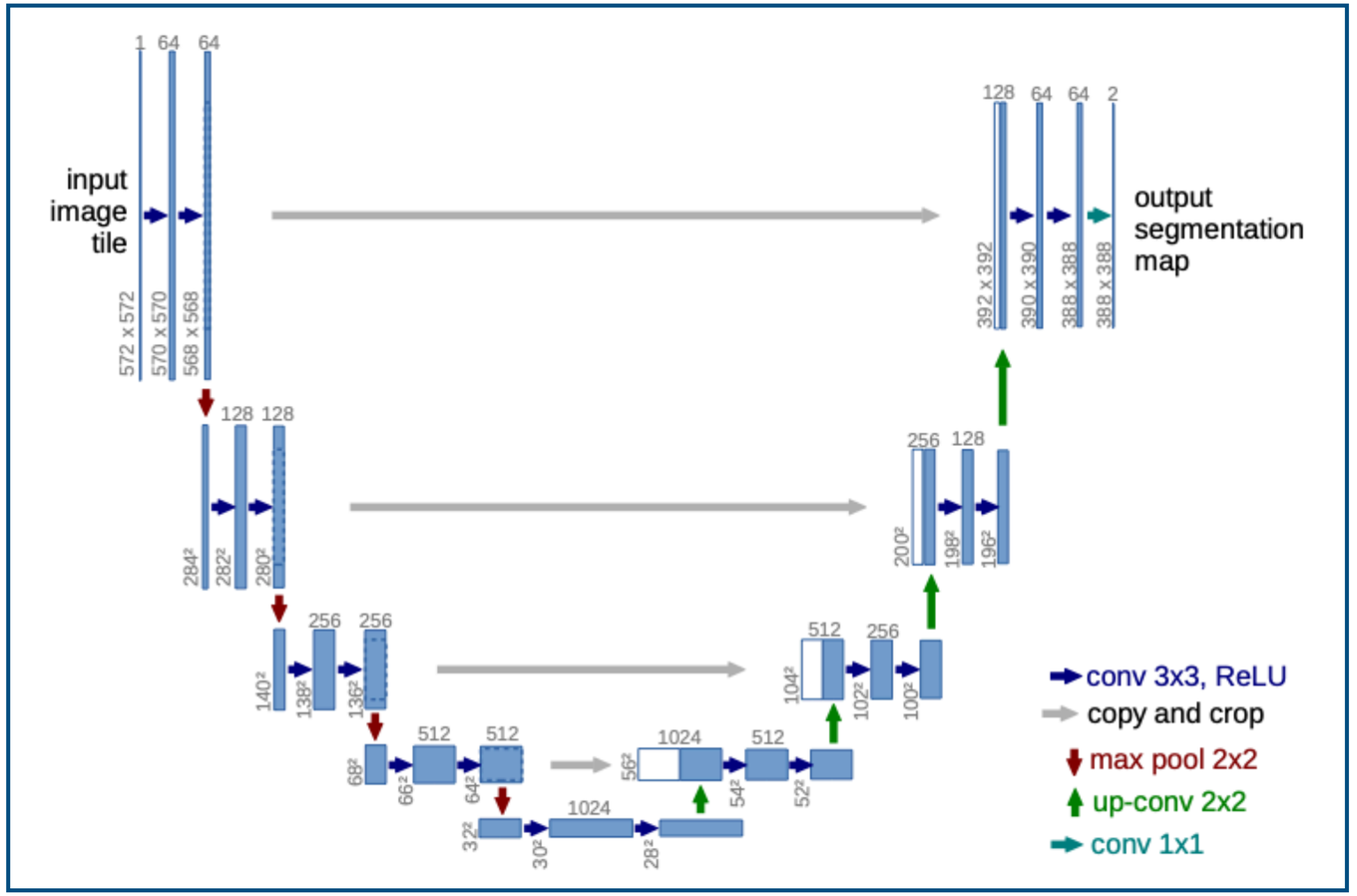


Data

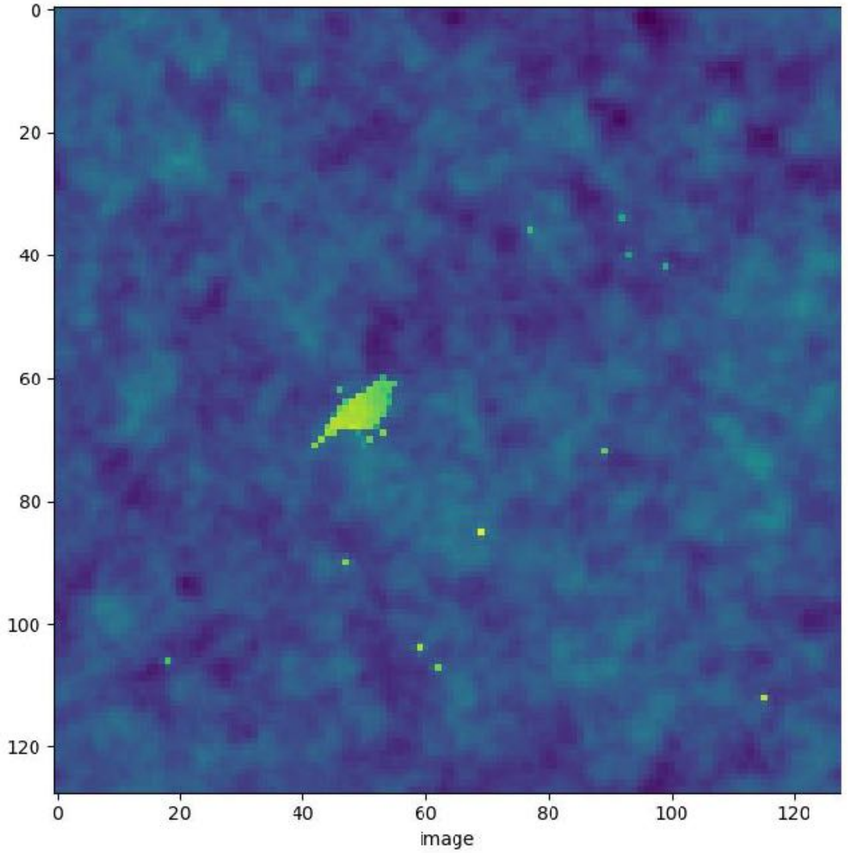
Detection

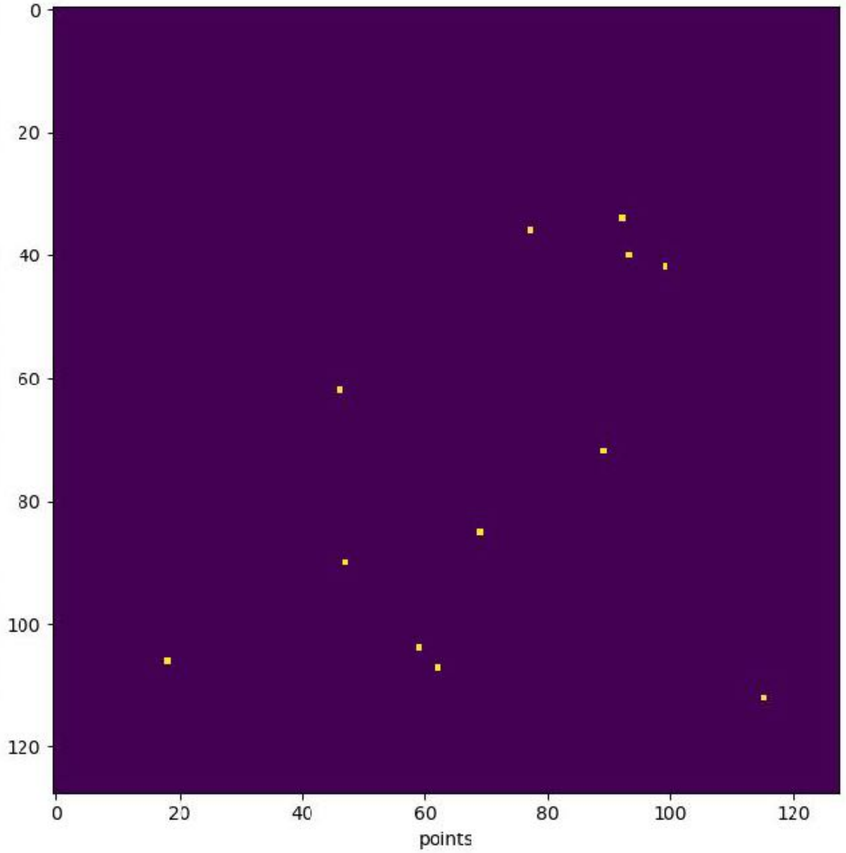
- U-Net
  - encoder-decoder architecture
  - skip connections
- Output segmentation maps
  - point sources
  - extended objects

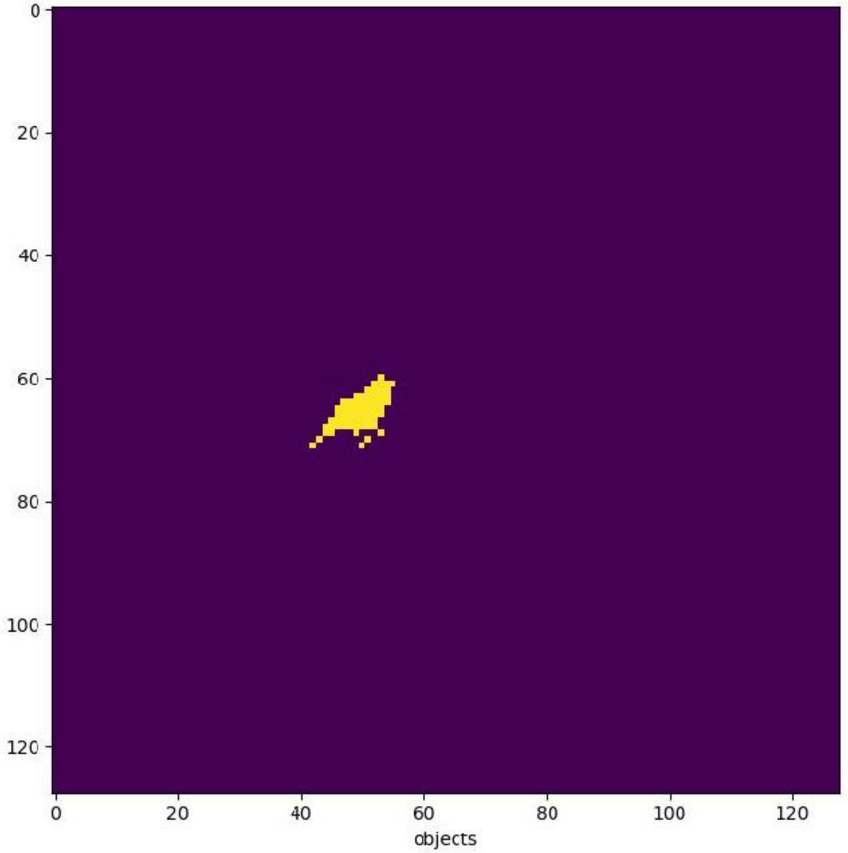


https://arxiv.org/abs/1505.04597

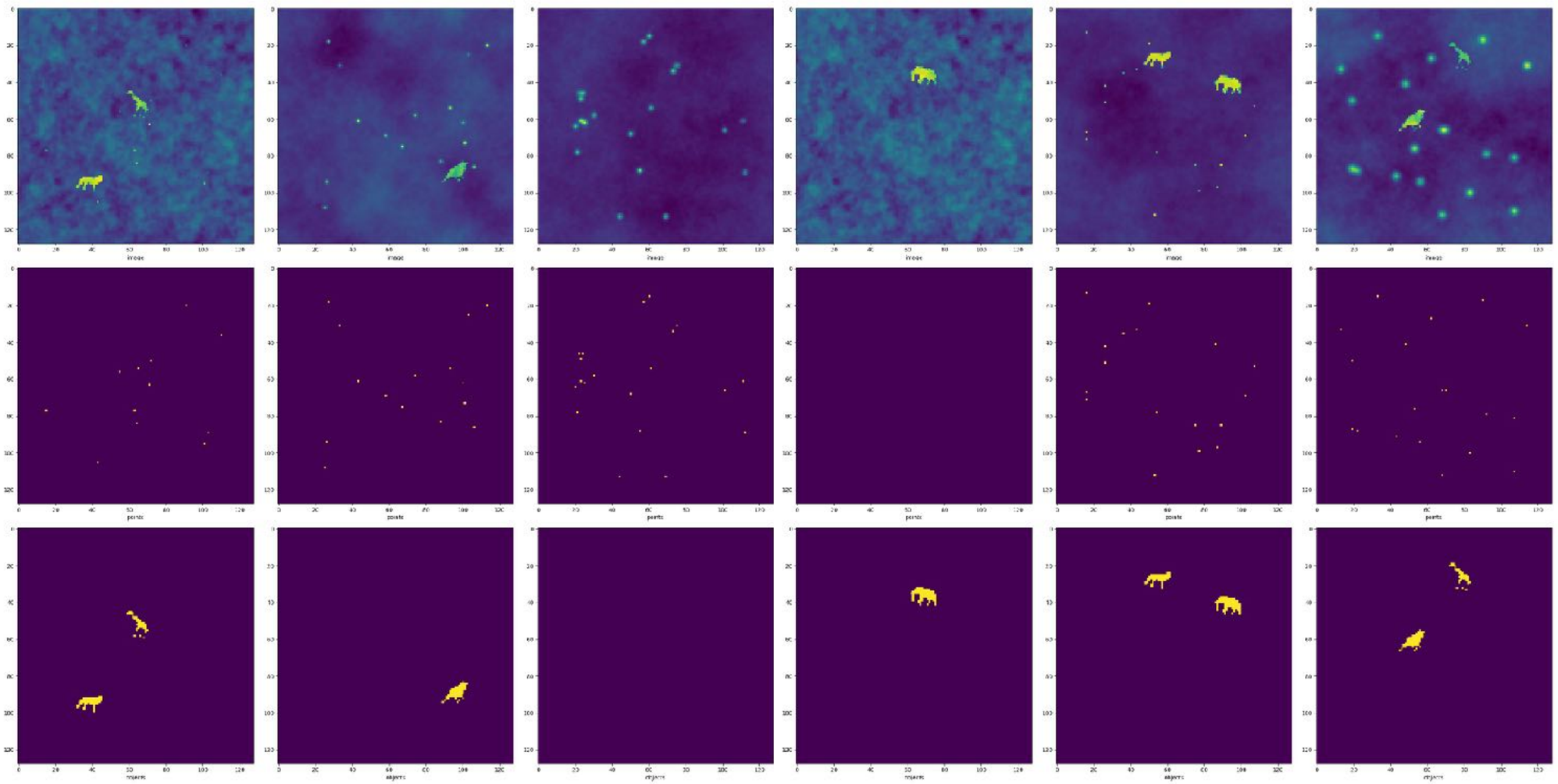
Training data







Training data



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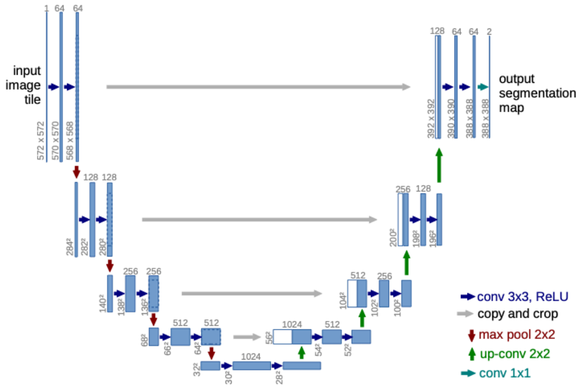
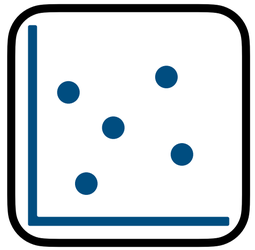
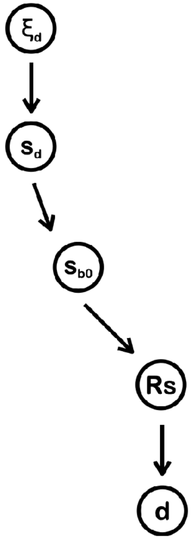
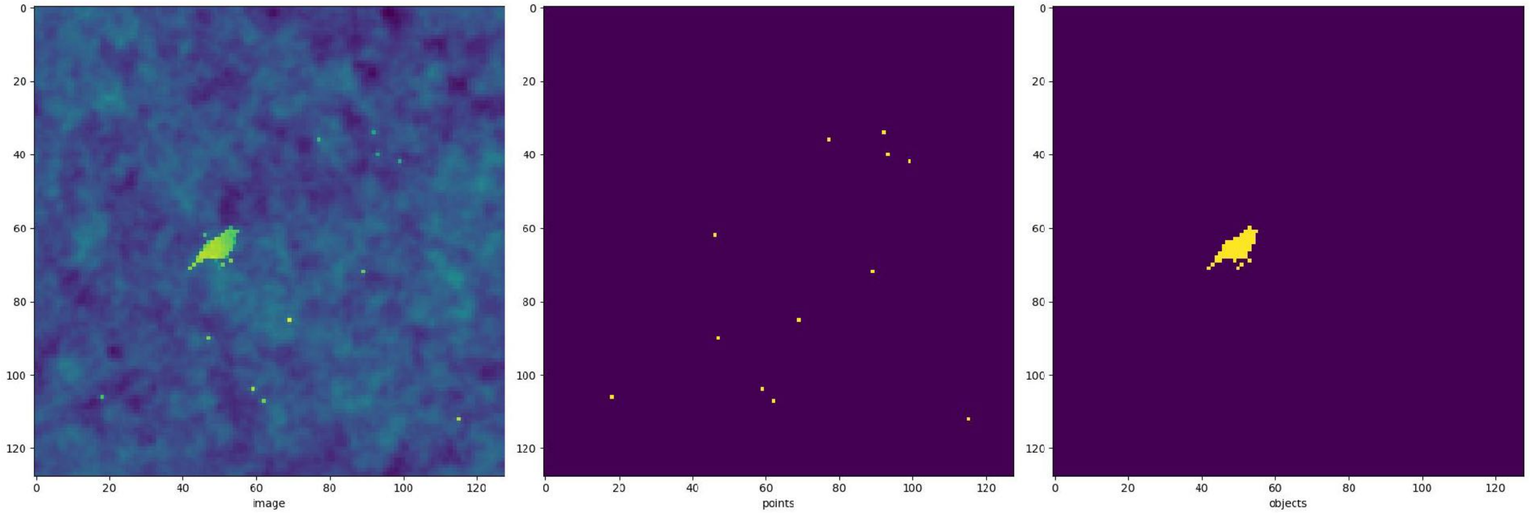




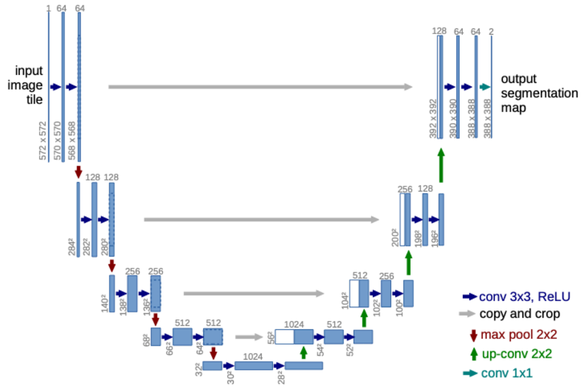
Data

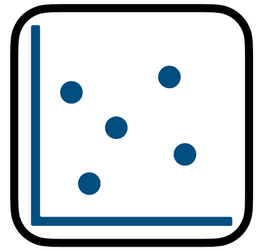
Simple Model → Imaging → First Image → Detection → Enhanced Model → Imaging → • • •





Automatic pipeline





Data

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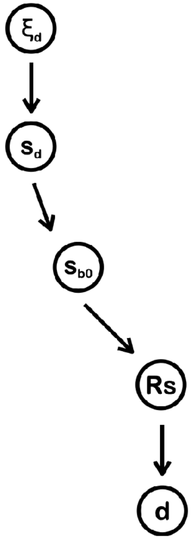
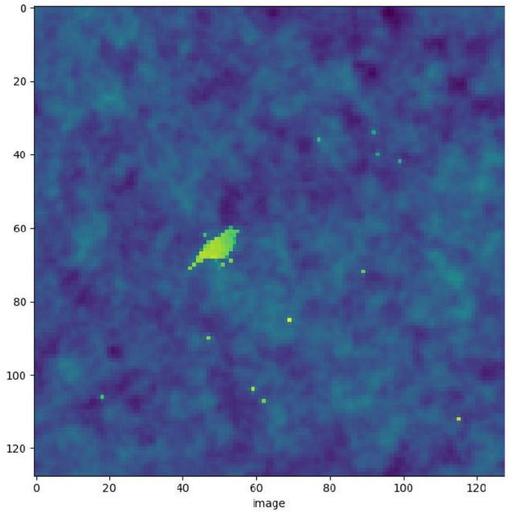
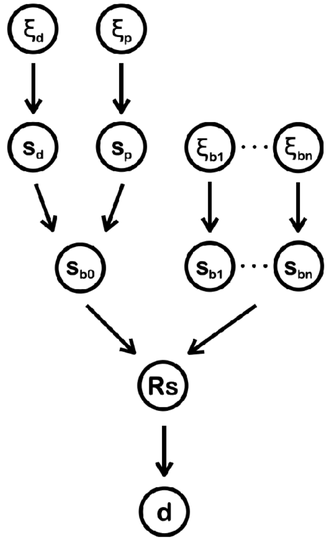
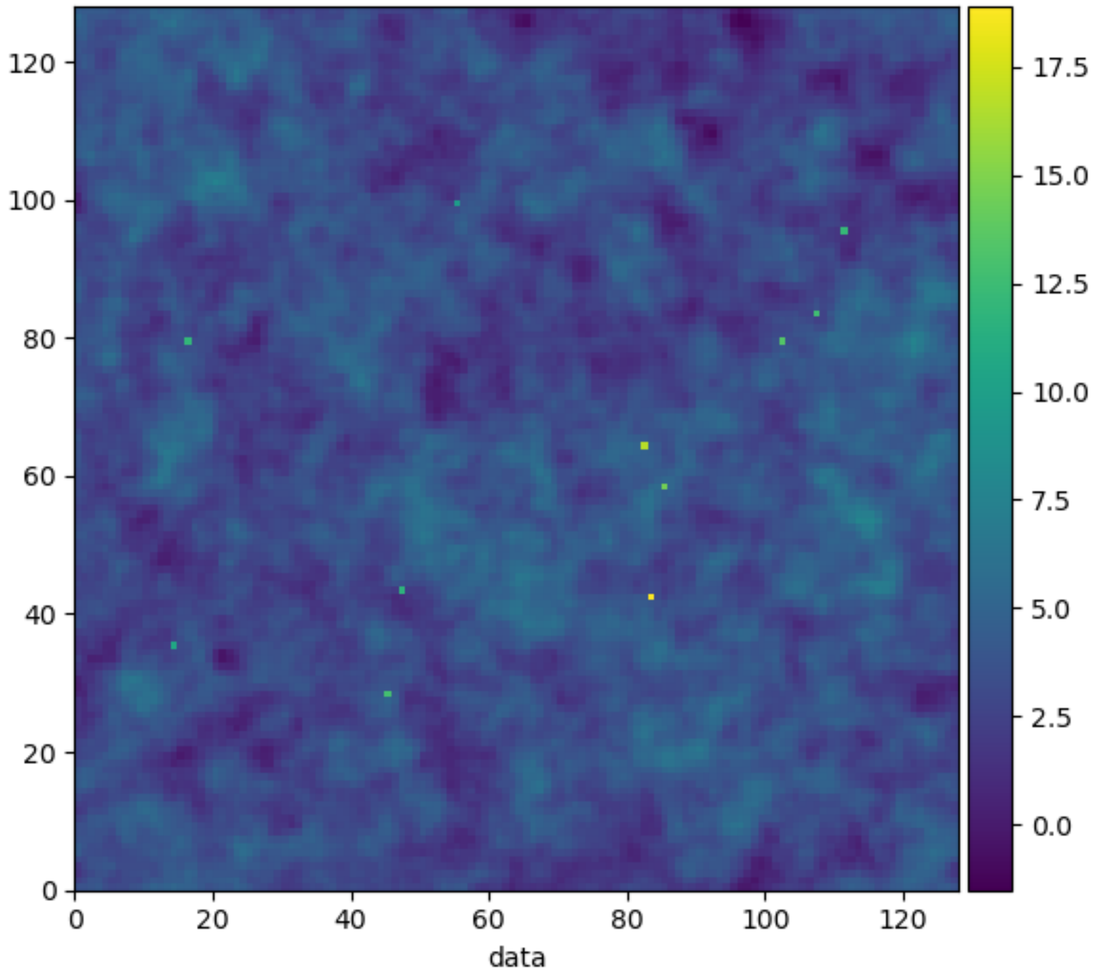






Point source detection

$$s = e^{f(\xi)} \mid R = 1$$



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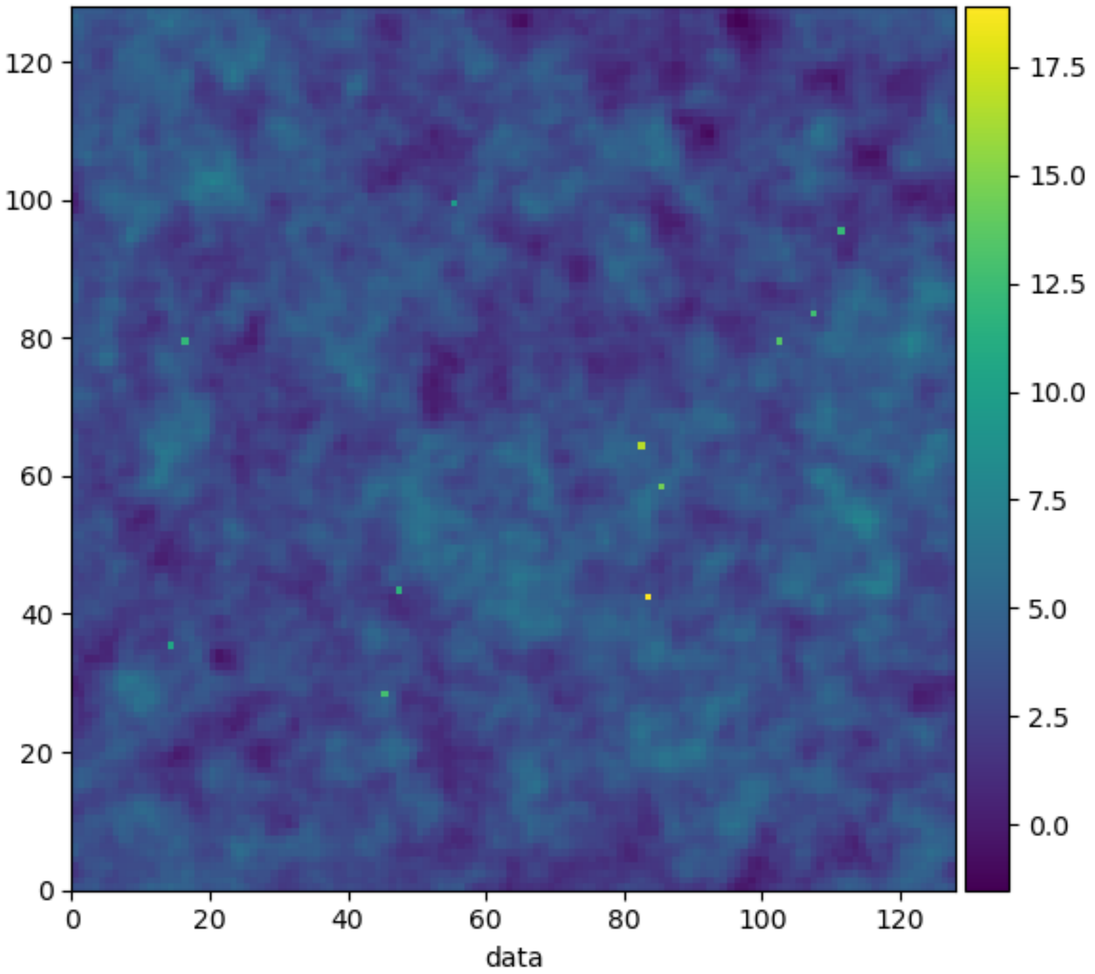

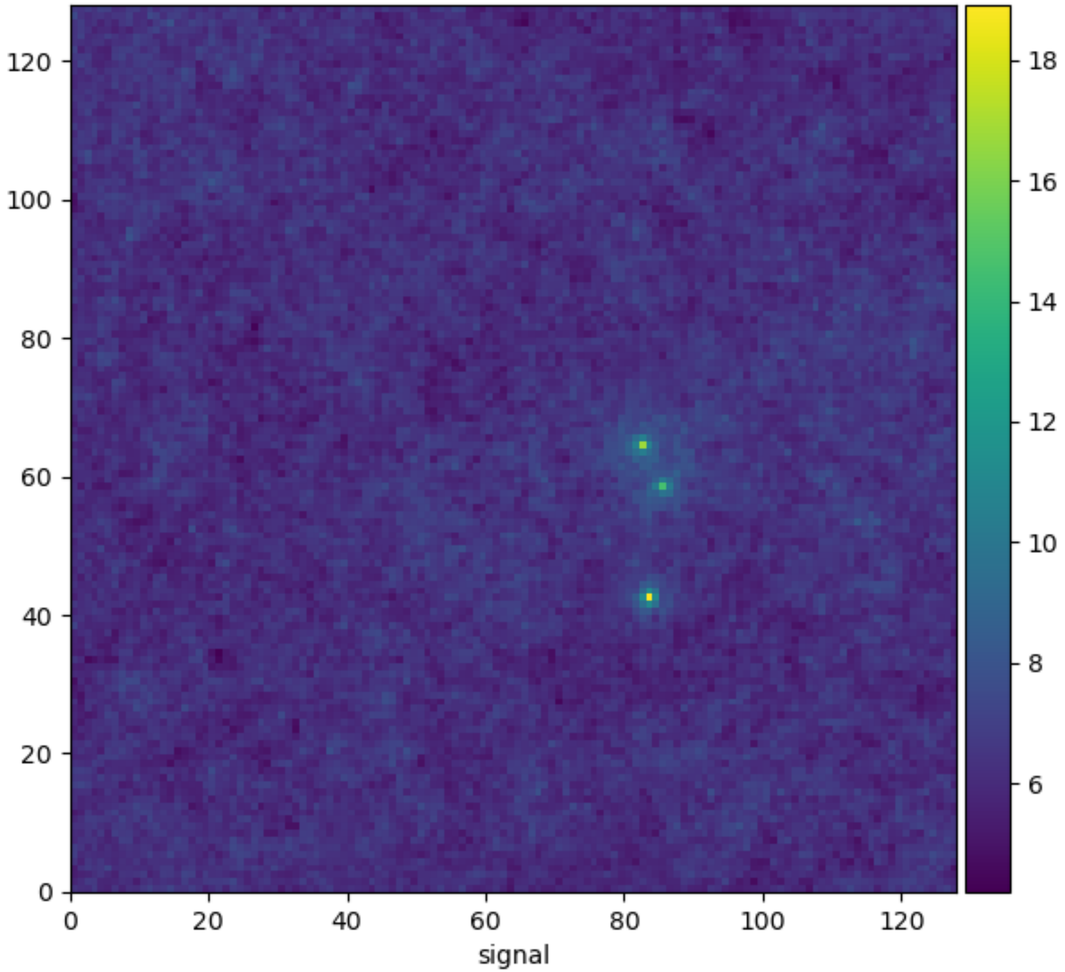

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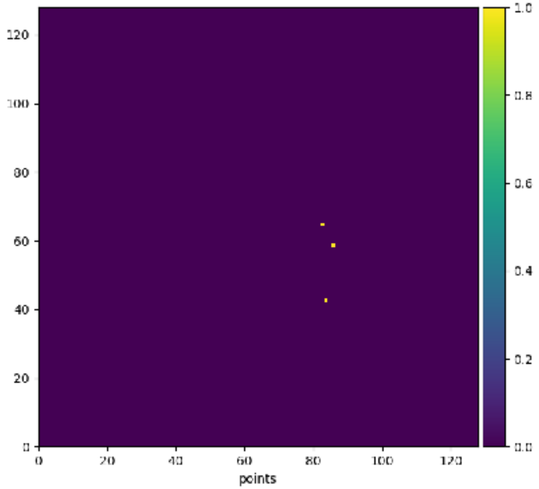

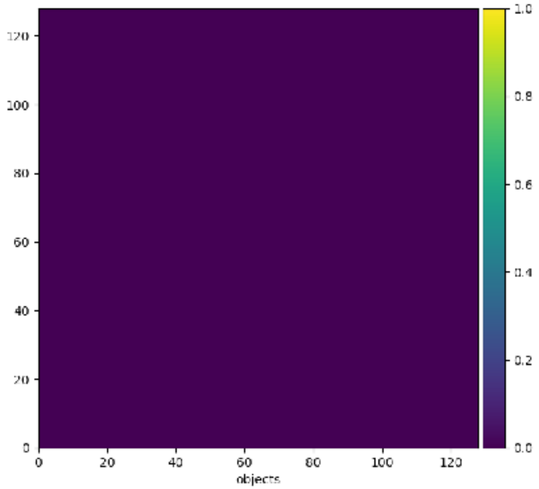

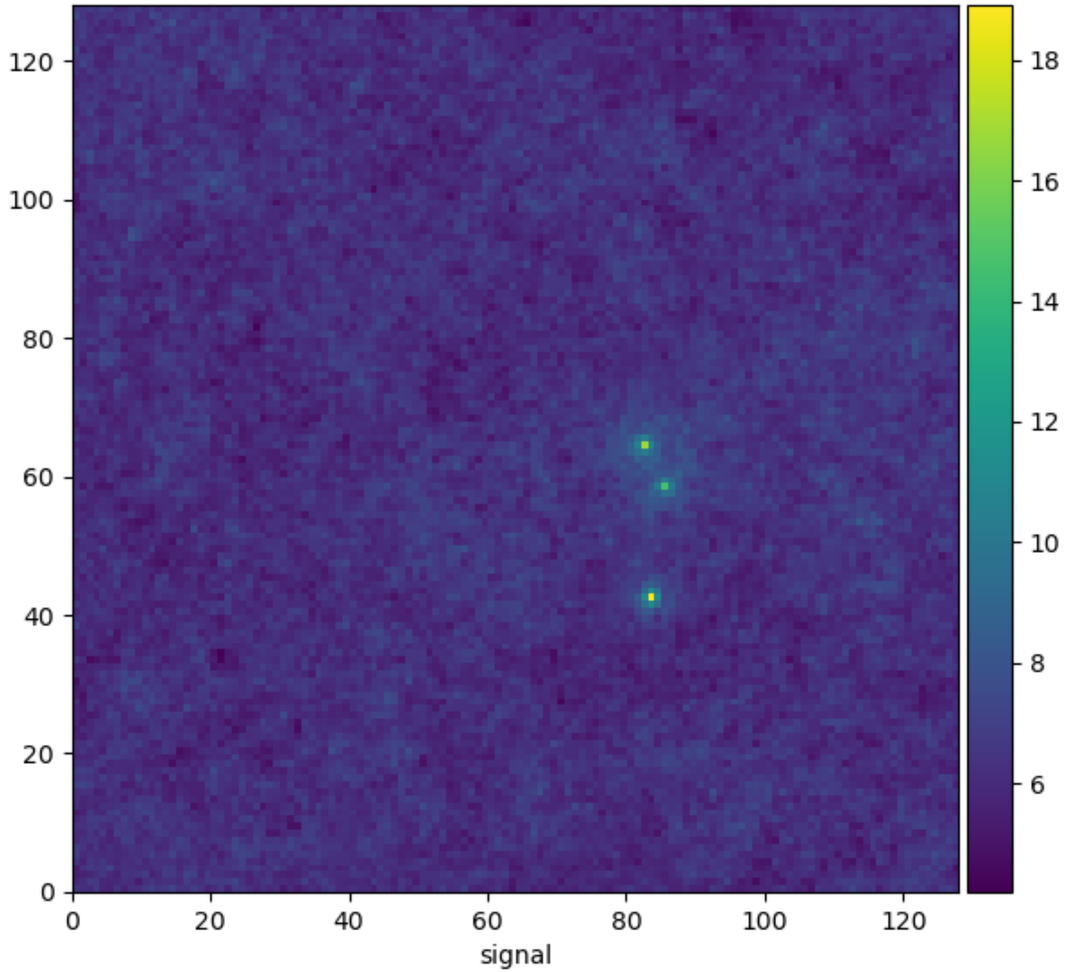

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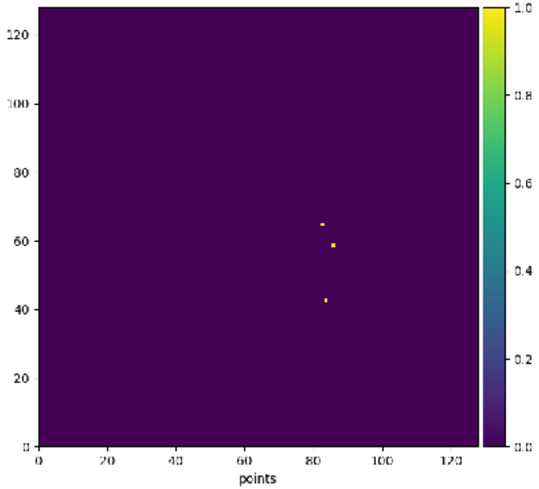

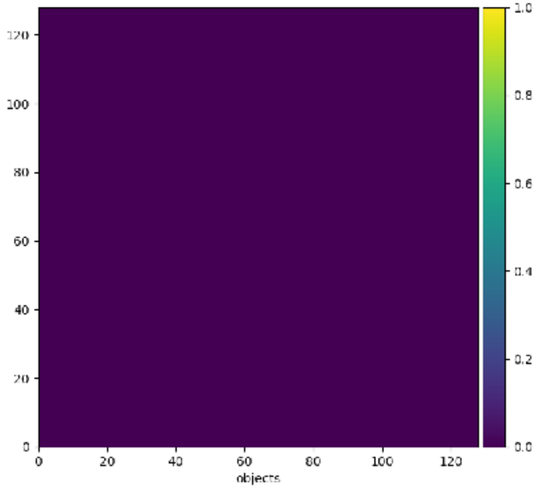

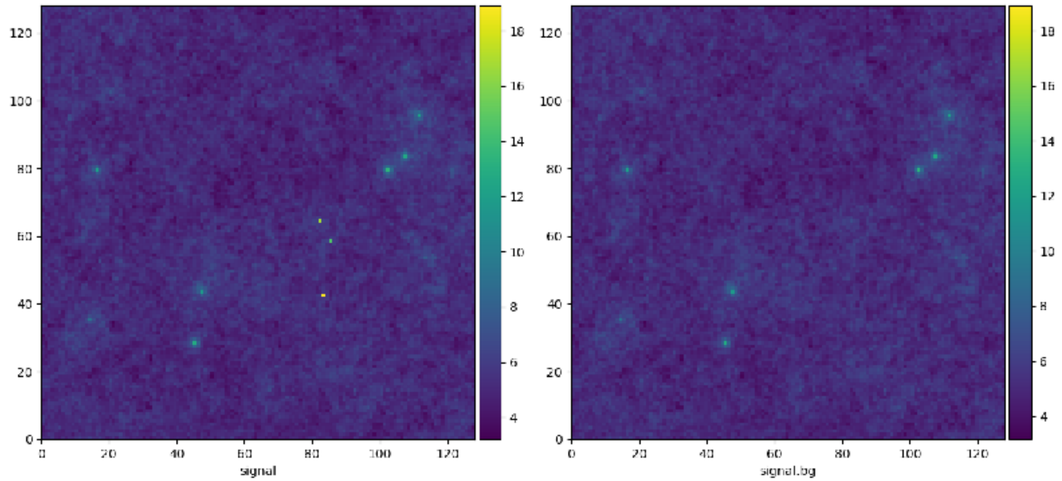

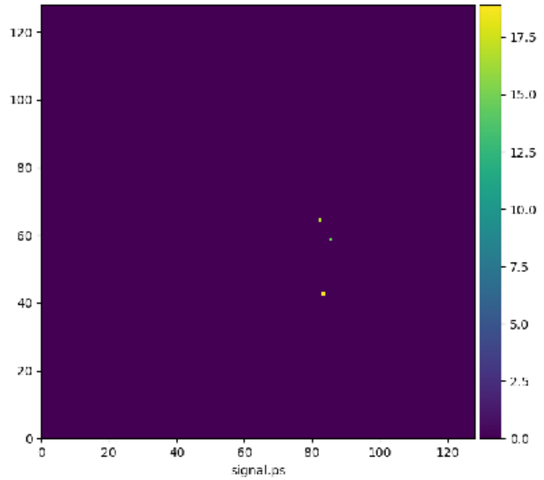

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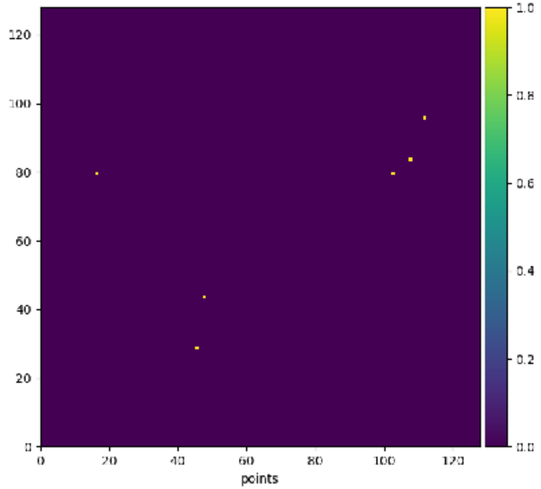

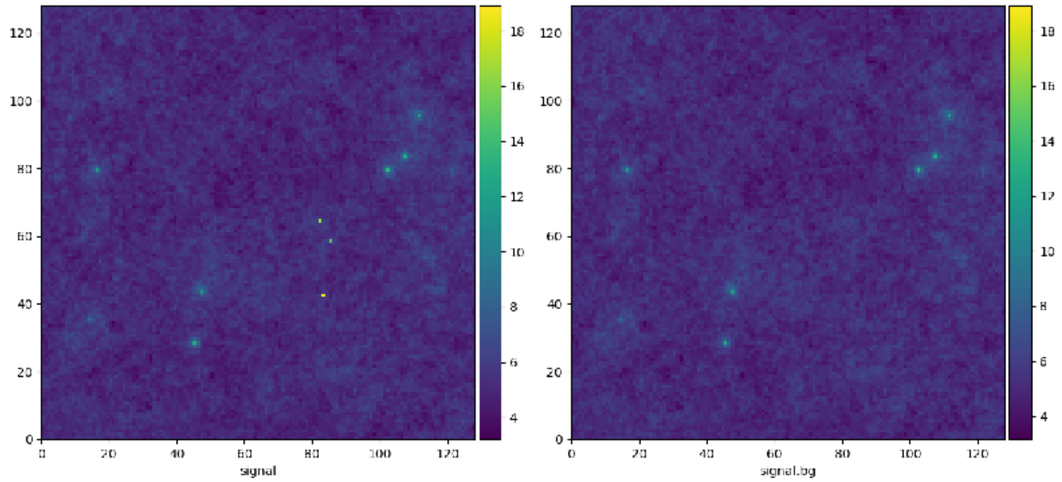

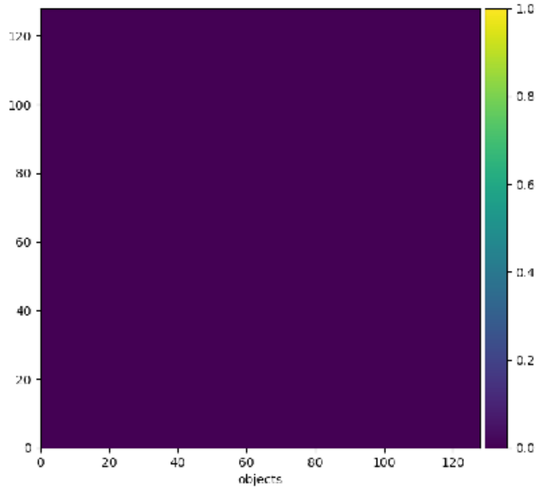

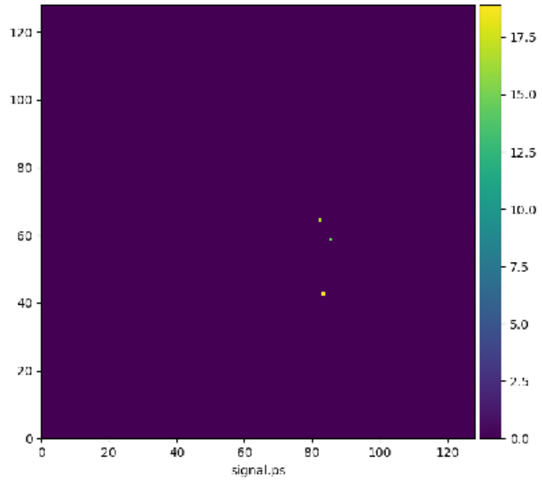

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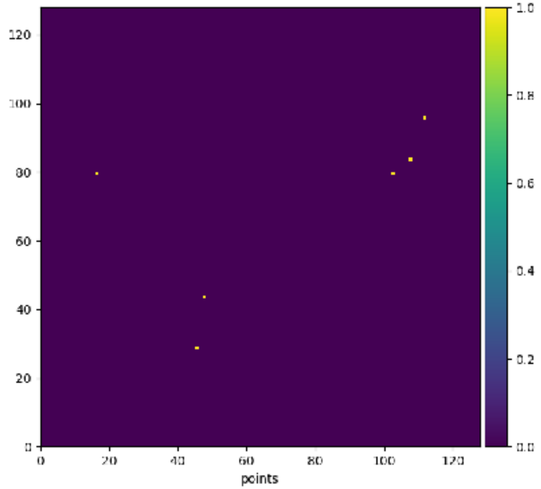
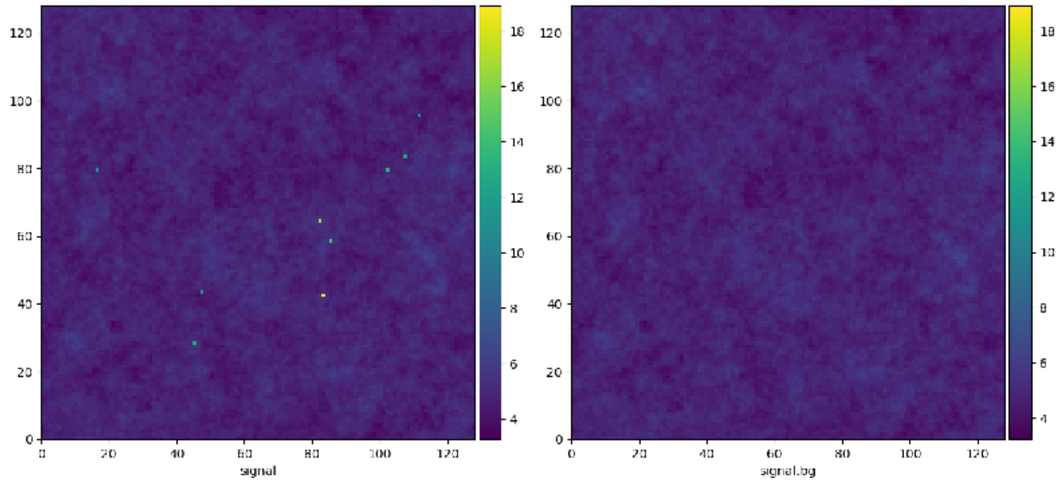
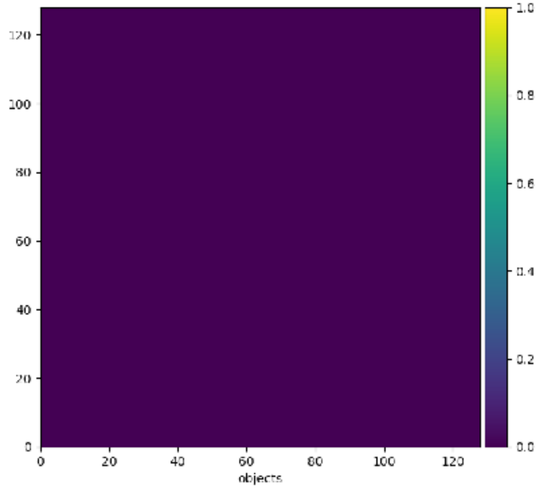
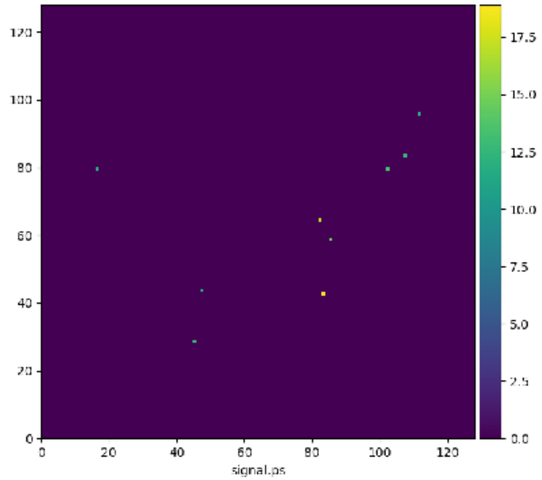


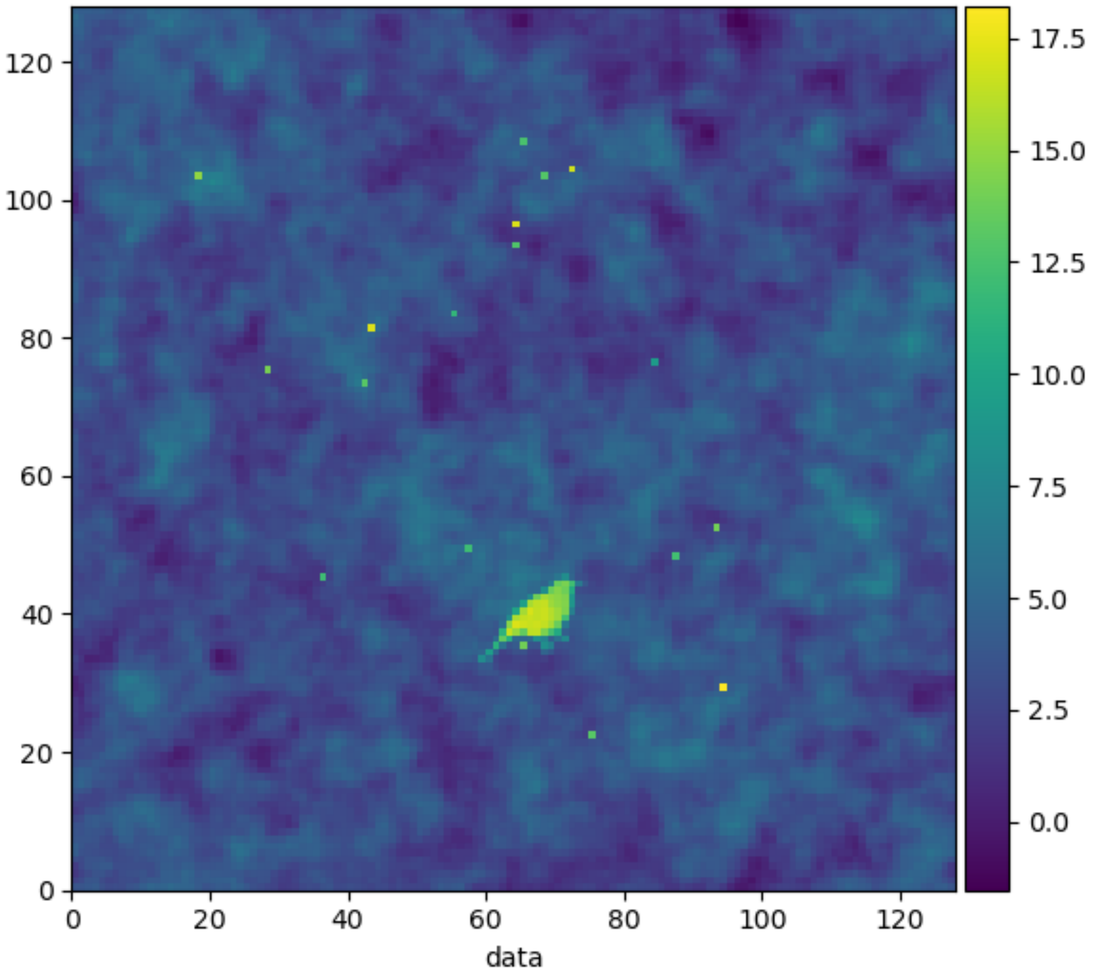






Object detection

$$s = e^{f(\xi)} \mid R = 1$$



Object detection

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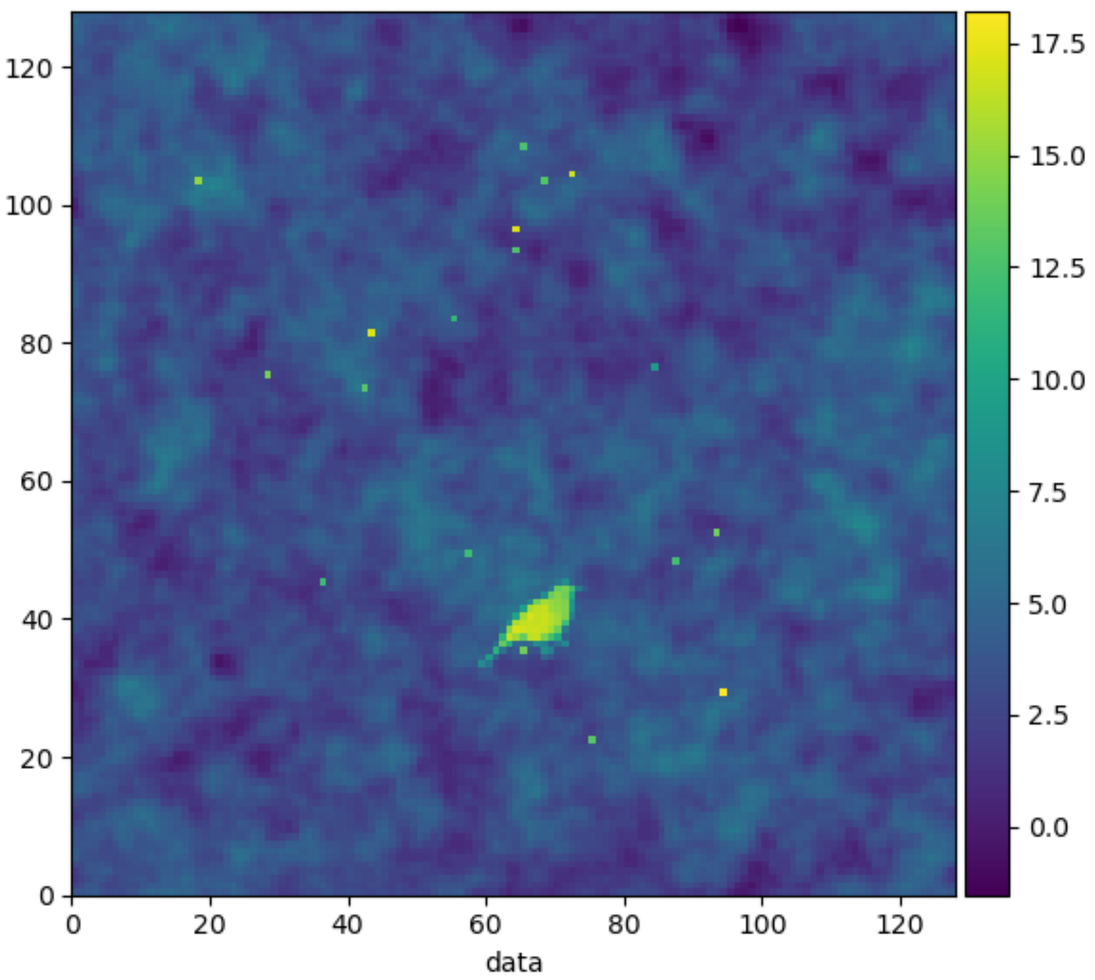

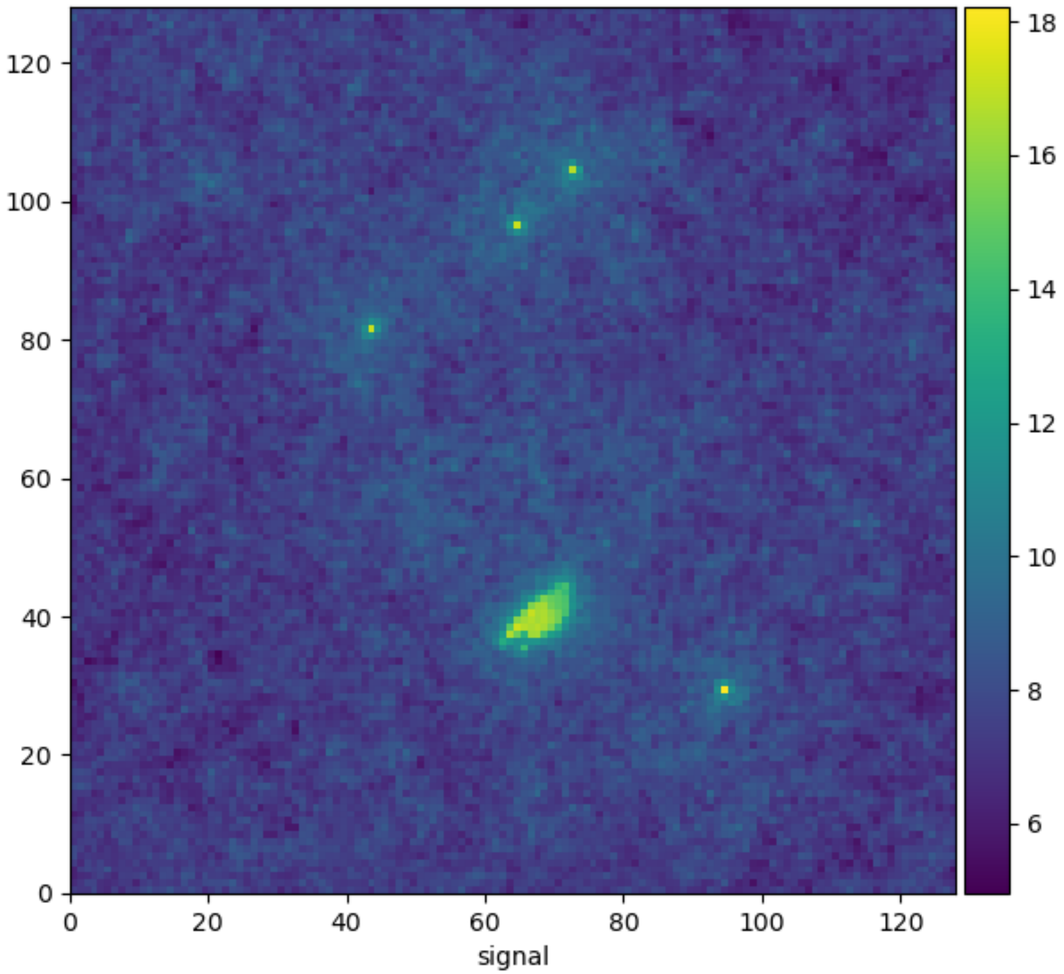

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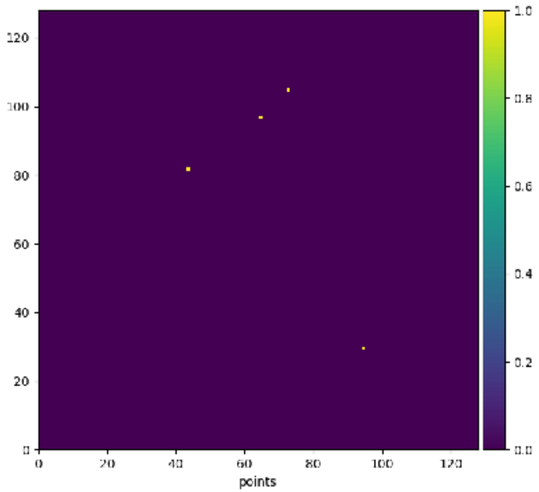

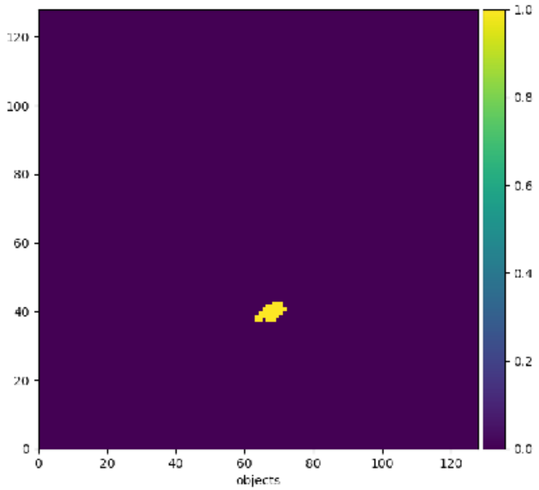

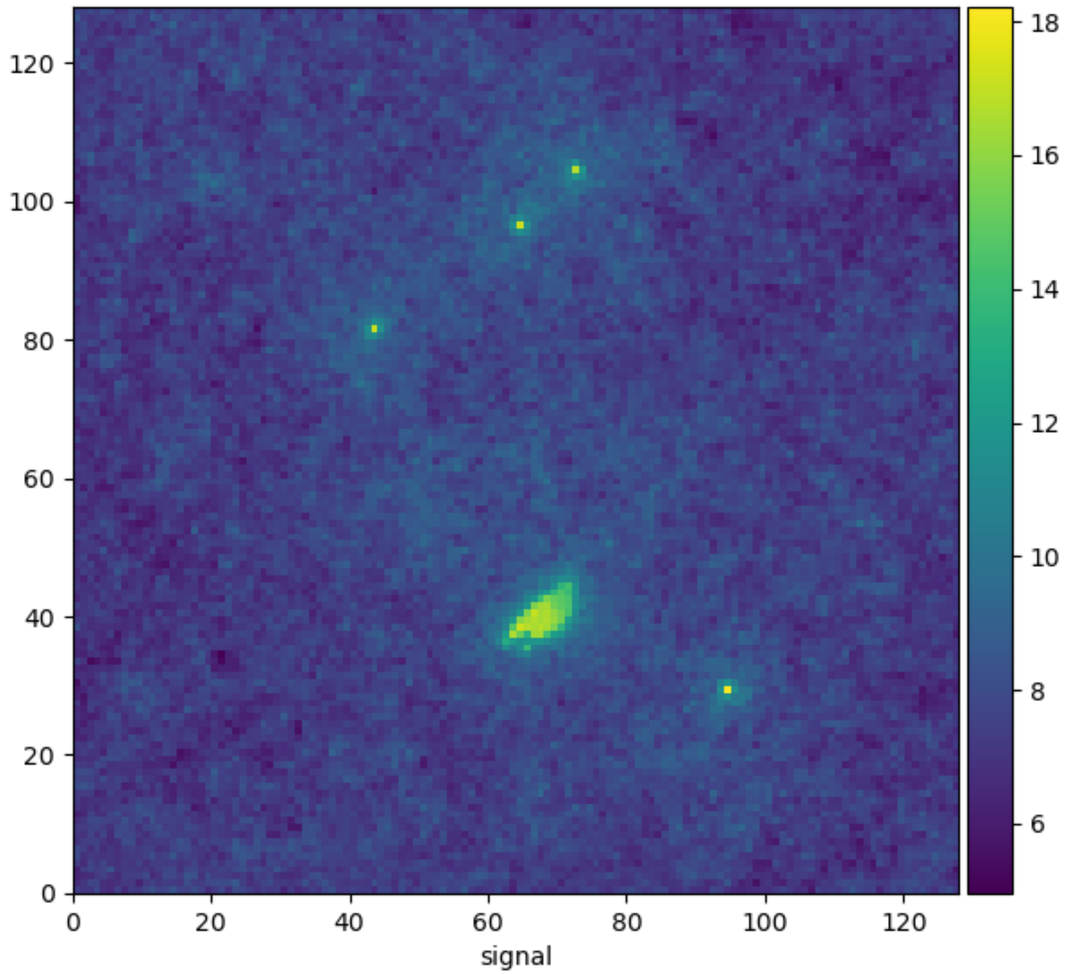

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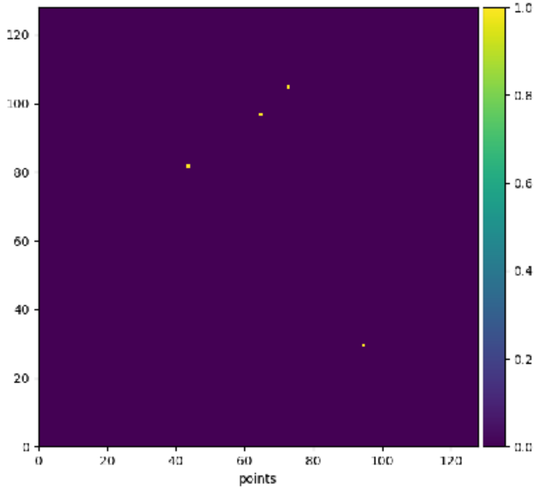
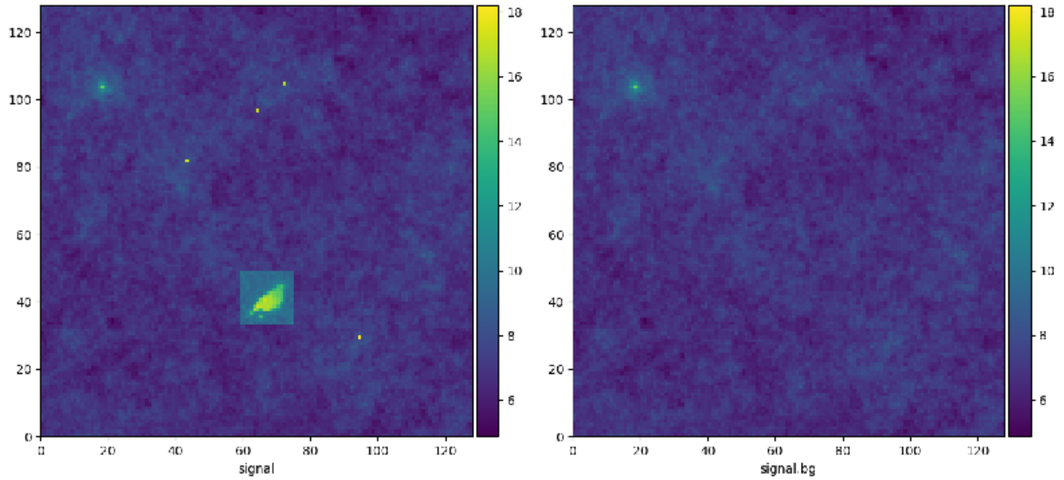
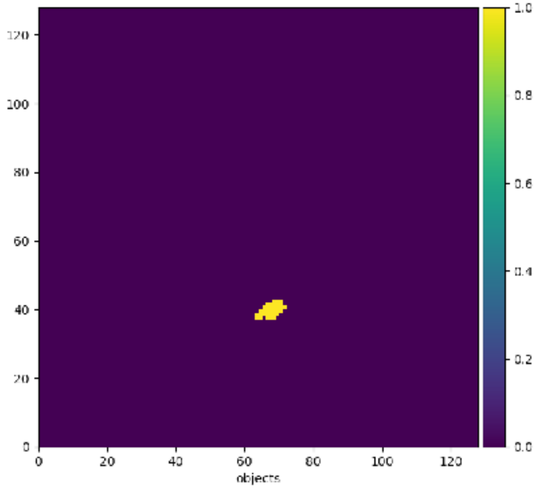
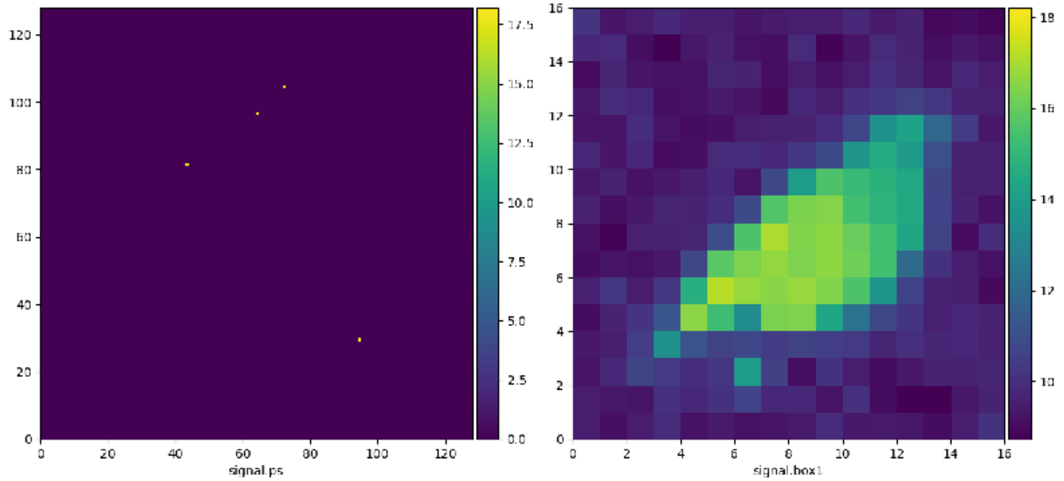


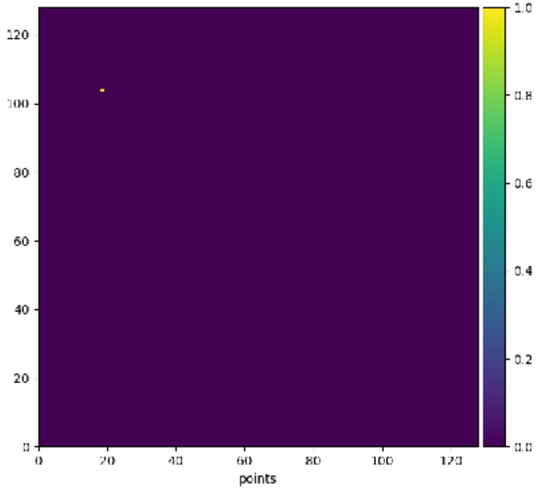


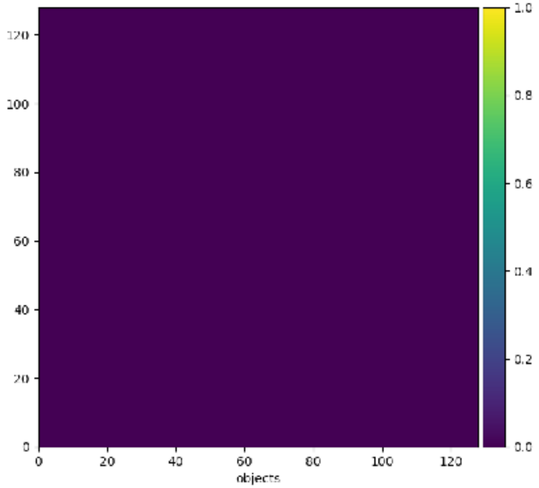


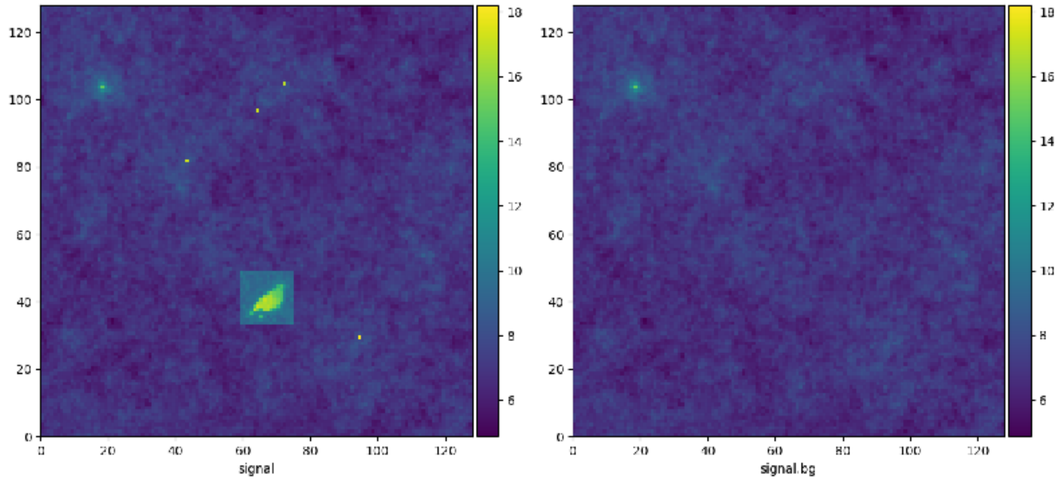


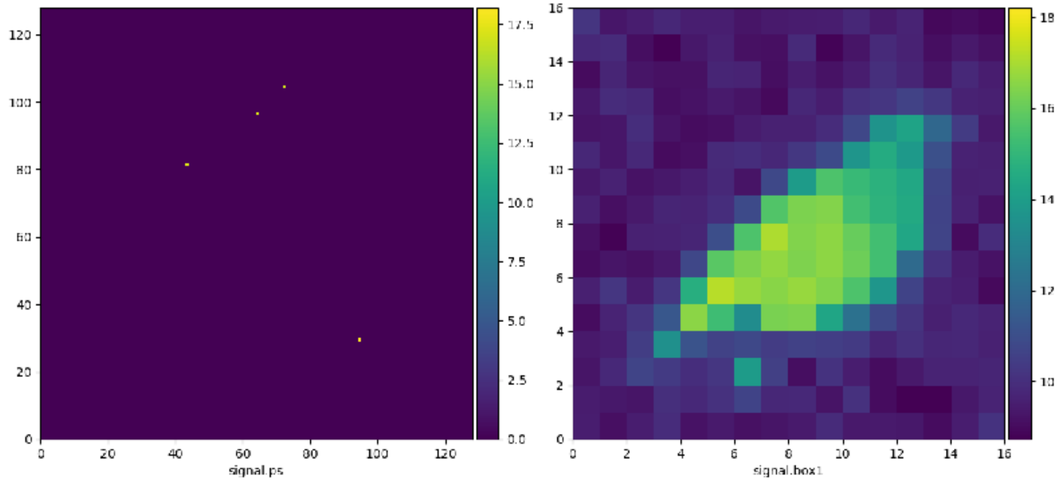
Object detection

$$s = e^{f(\xi)} \mid R = 1$$



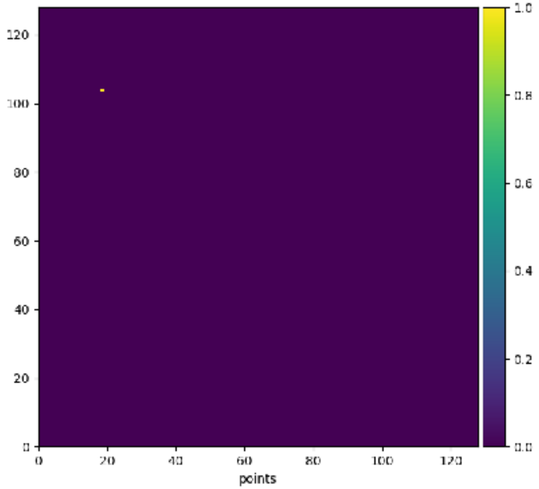


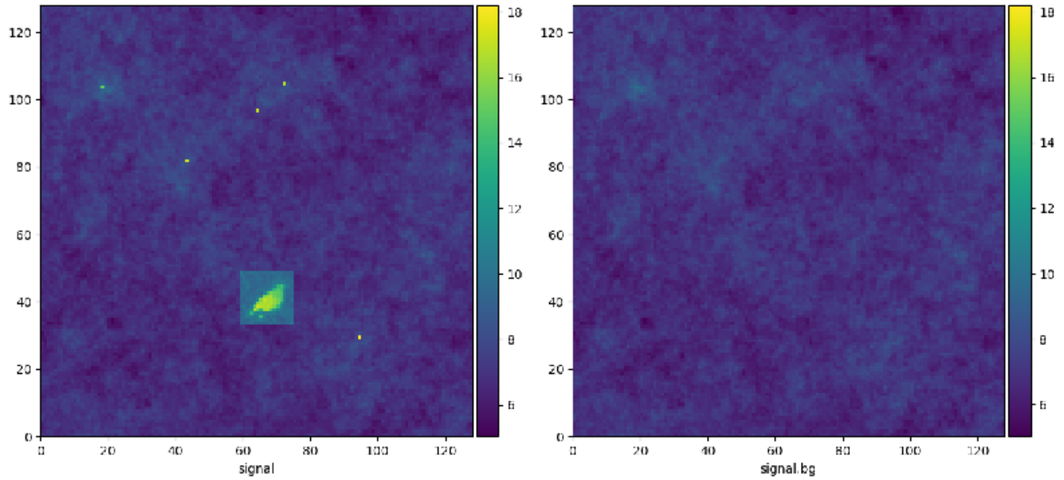


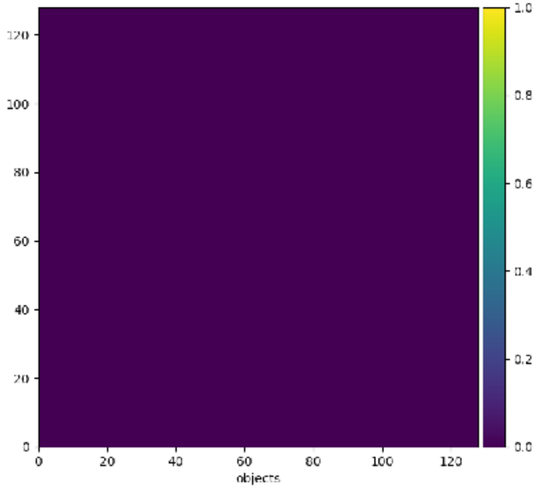


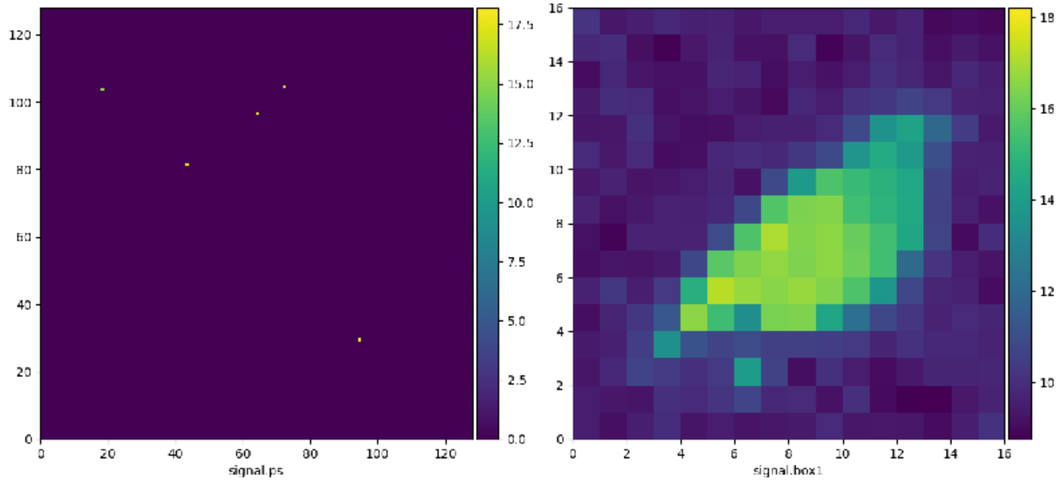
Object detection

$$s = e^{f(\xi)} \mid R = 1$$



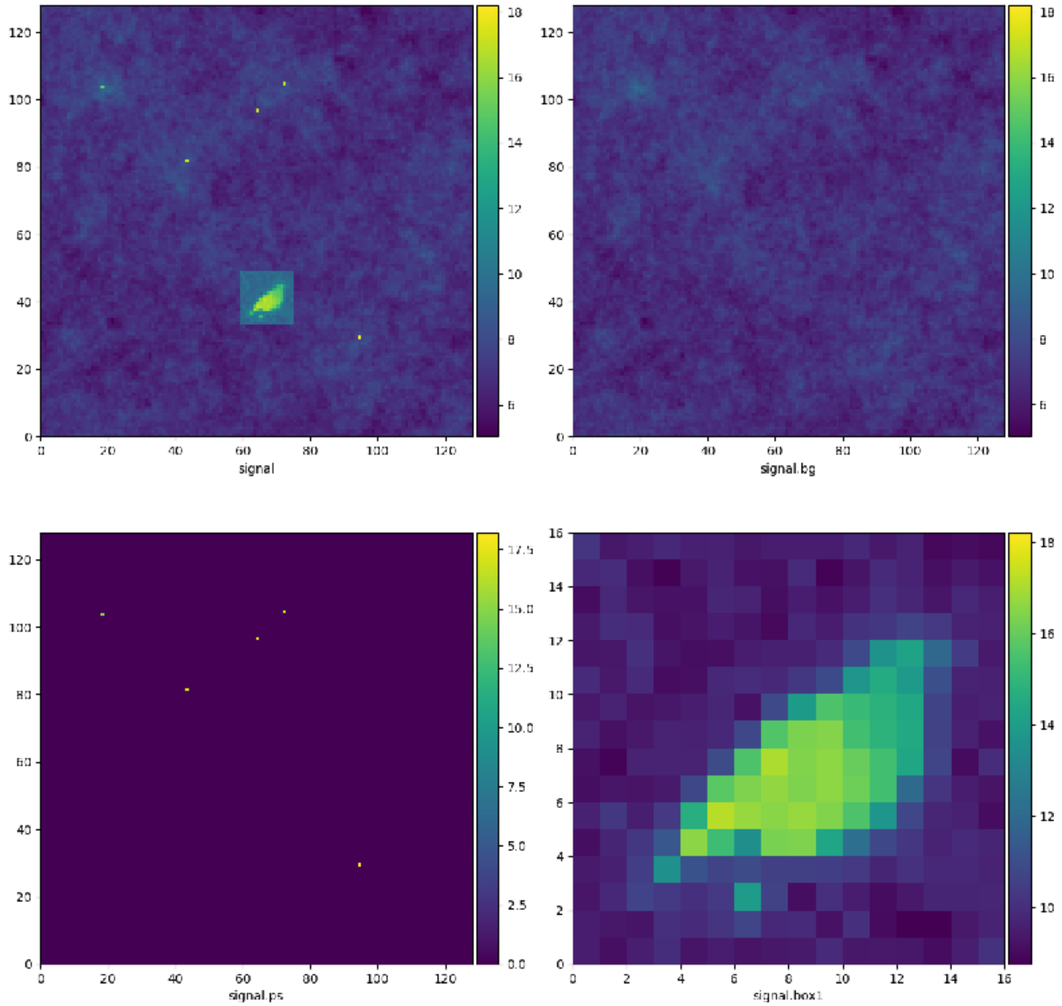






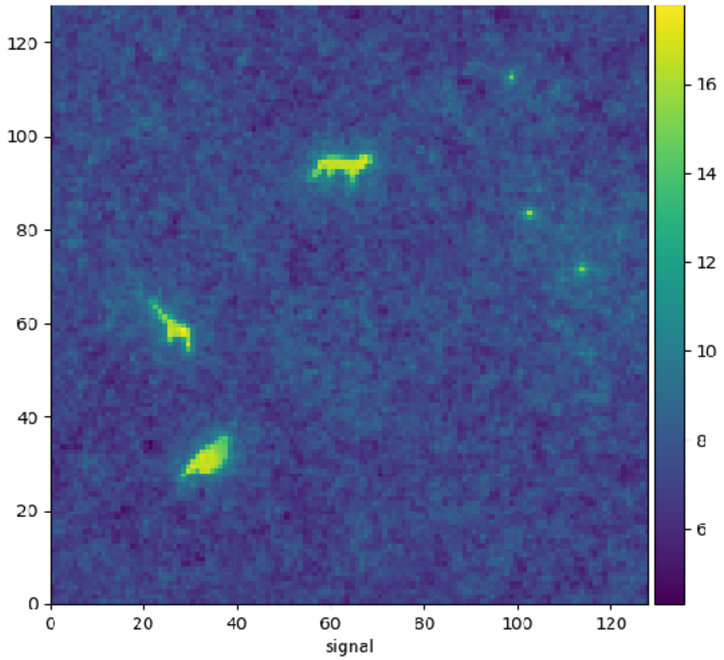
To Do

- **Boxes with different resolution**



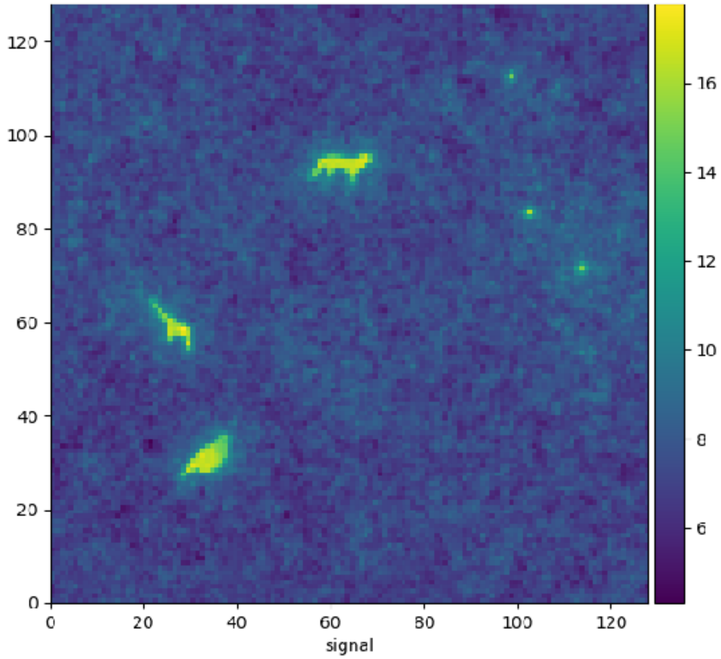
To Do

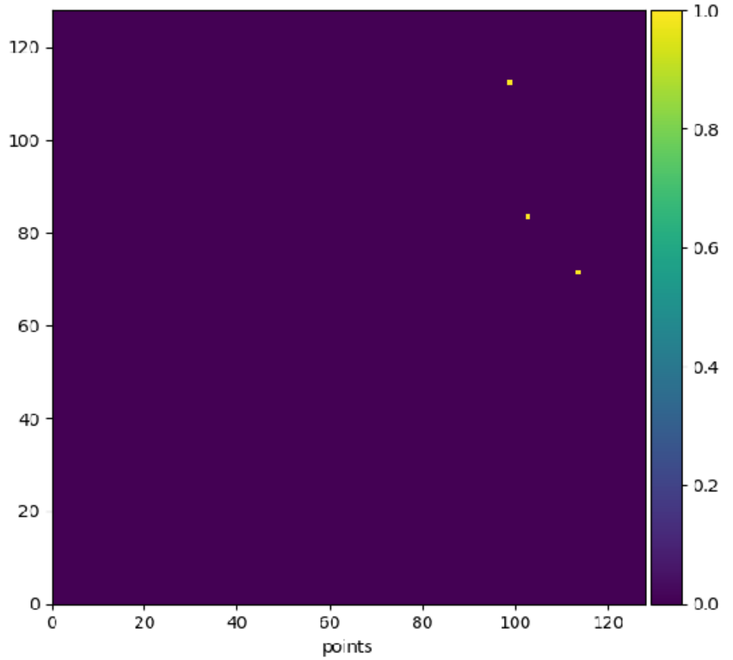
- **Boxes with different resolution**
- **Several extended objects**

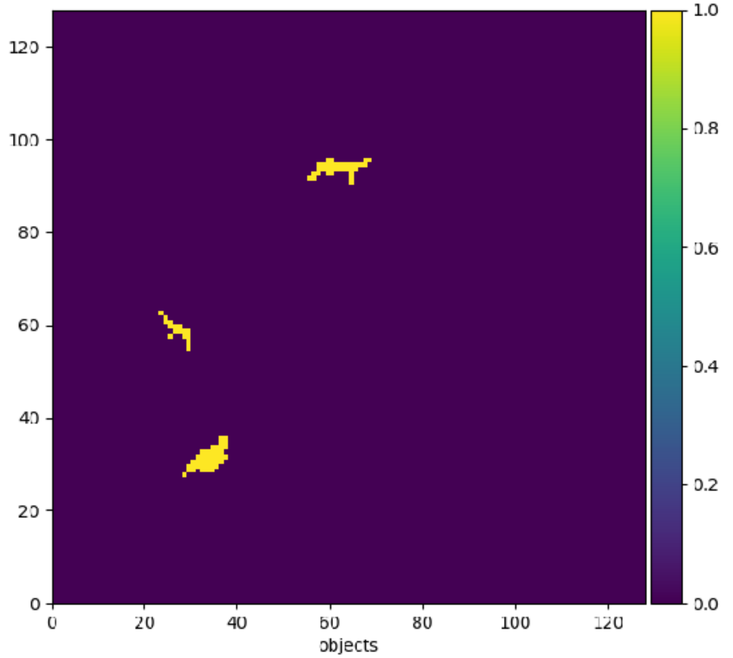


To Do

- **Boxes with different resolution**
- **Several extended objects**

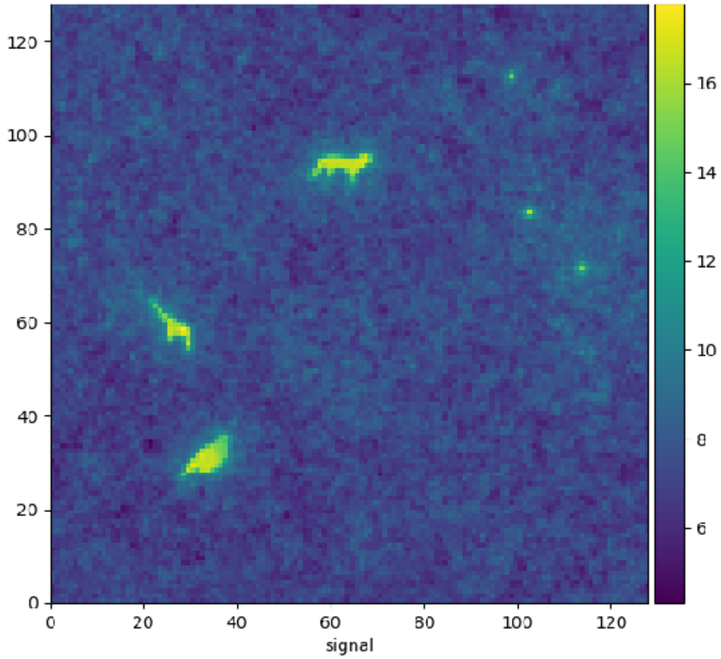


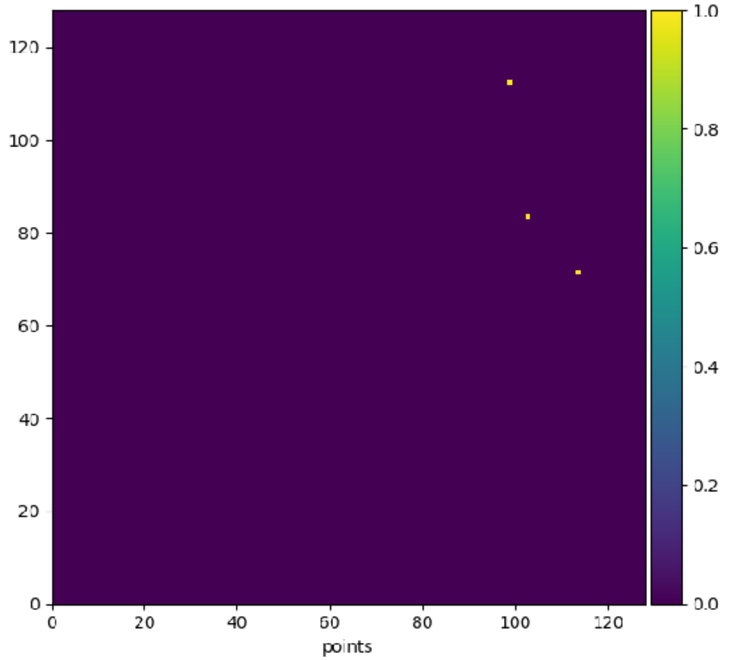


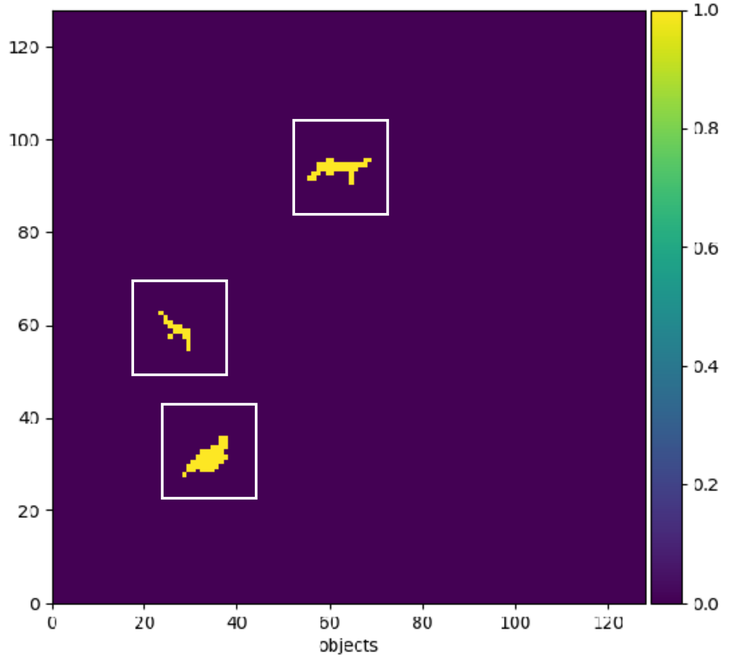


To Do

- **Boxes with different resolution**
- **Several extended objects**

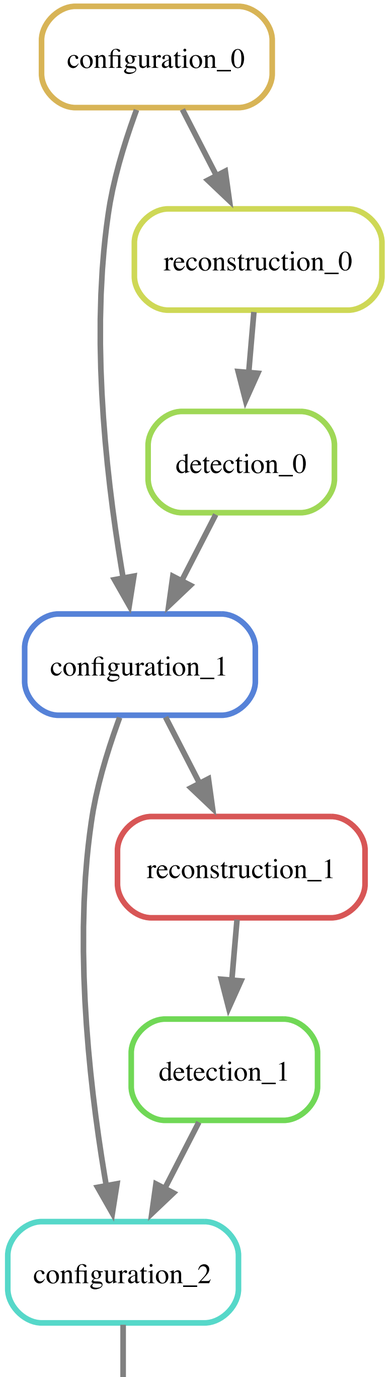






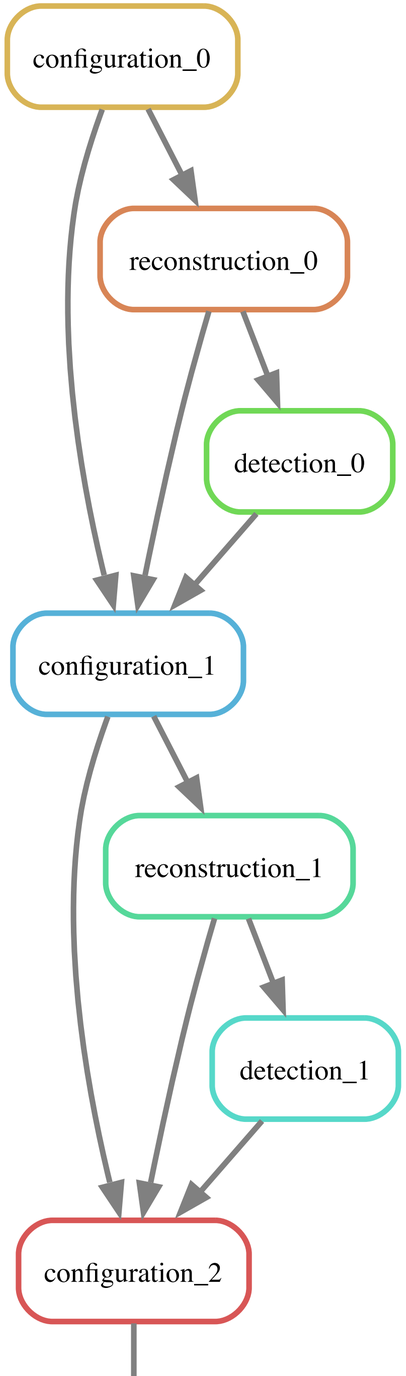
To Do

- Boxes with different resolution
- Several extended objects
- Continue from previous reconstruction



To Do

- Boxes with different resolution
- Several extended objects
- Continue from previous reconstruction



To Do

- Boxes with different resolution
- Several extended objects
- Continue from previous reconstruction

  …

- Real data (e.g. radio observations)