RON: Reverse Connection with Objectness Prior Networks for Object Detection

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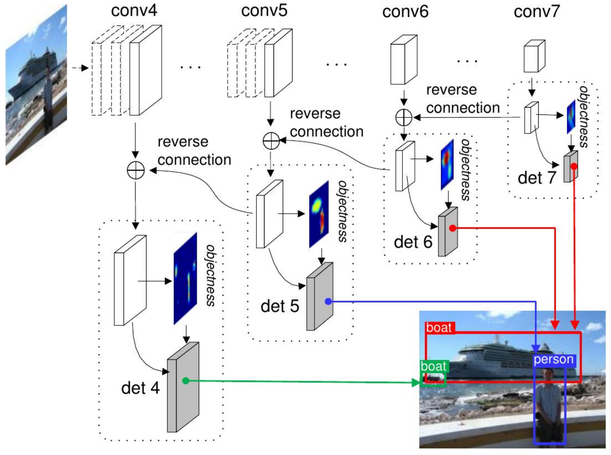
INTRODUCTION

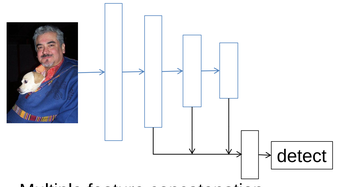
- √ Feature pyramid works better in locating all scales of objects from: SSD, HyperNet, ION, MR-CNN
- √ Using region proposal network to reduce searching space from: R-FCN, Faster R-CNN, Fast R-CNN
- √ A fully CNN pipeline with no repeated computation can achieve high detection performance. from: SSD, R-FCN

METHOD

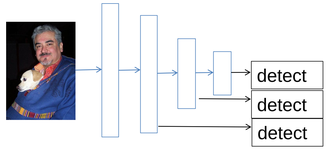


RON: Reverse Connection with Objectness Prior Networks

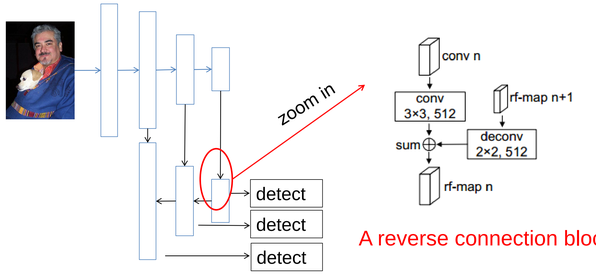
What is reverse connection and why?



Multiple feature concatenation (ION, HyperNet)

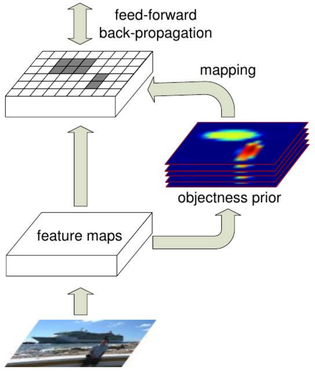


Exploring multiple feature directly (SSD)



A reverse connection block

From region propsoal boxes to region proposal maps



Objectness pior:

Share anchors between RPN and detector, make it posible to detect objects with fully ConvNet.

√ No repeated computations, much faster
√ The total network is fully convolutional
√ There are one map for each type of anchors different from these mask-based methods.

MAIN RESULTS

Method	mAP	aero	bike	bird	boat	bottle	bus	car	cat	chair	cow	table	dog	horse	mbike	person	plant	sheep	sofa	train	tv
Fast R-CNN[10]	70.0	77.0	78.1	69.3	59.4	38.3	81.6	78.6	86.7	42.8	78.8	68.9	84.7	82.0	76.6	69.9	31.8	70.1	74.8	80.4	70.4
Faster R-CNN[23]	73.2	76.5	79.0	70.9	65.5	52.1	83.1	84.7	86.4	52.0	**81.9**	65.7	84.8	84.6	77.5	76.7	38.8	73.6	73.9	83.0	72.6
SSD300[19]	72.1	75.2	79.8	70.5	62.5	41.3	81.1	80.8	86.4	51.5	74.3	72.3	83.5	84.6	80.6	74.5	46.0	71.4	73.8	83.0	69.1
SSD500[19]	75.1	79.8	79.5	74.5	63.4	51.9	84.9	**85.6**	87.2	56.6	80.1	70.0	85.4	84.9	80.9	78.2	49.0	**78.4**	72.4	84.6	75.5
RON320	74.2	75.7	79.4	74.8	66.1	53.2	83.7	83.6	85.8	55.8	79.5	69.5	84.5	81.7	83.1	76.1	49.2	73.8	75.2	80.3	72.5
RON384	75.4	78.0	82.4	76.7	67.1	56.9	85.3	84.3	86.1	55.5	80.6	71.4	84.7	84.8	82.4	76.2	47.9	75.3	74.1	83.8	74.5
RON320++	76.6	79.4	**84.3**	75.5	**69.5**	56.9	83.7	84.0	**87.4**	57.9	81.3	**74.1**	84.1	85.3	**83.5**	77.8	49.2	76.7	**77.3**	**86.7**	77.2
RON384++	**77.6**	**86.0**	82.5	**76.9**	69.1	**59.2**	**86.2**	85.5	87.2	**59.9**	81.4	73.3	**85.9**	**86.8**	82.2	**79.6**	**52.4**	78.2	76.0	86.2	**78.0**

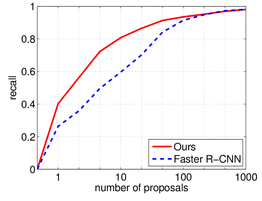
Table 1. Detection results on PASCAL VOC 2007 test set. The entries with the best APs for each object category are bold-faced.

Method	mAP	aero	bike	bird	boat	bottle	bus	car	cat	chair	cow	table	dog	horse	mbike	person	plant	sheep	sofa	train	tv
Fast R-CNN[10]	68.4	82.3	78.4	70.8	52.3	38.7	77.8	71.6	89.3	44.2	73.0	55.0	87.5	80.5	80.8	72.0	35.1	68.3	65.7	80.4	64.2
OHEM[26]	71.9	83.0	81.3	72.5	55.6	49.0	78.9	74.7	89.5	52.3	75.0	61.0	**87.9**	80.9	82.4	76.3	47.1	72.5	67.3	80.6	**71.2**
Faster R-CNN[23]	70.4	84.9	79.8	74.3	53.9	49.8	77.5	75.9	88.5	45.6	77.1	55.3	86.9	81.7	80.9	79.6	40.1	72.6	60.9	81.2	61.5
HyperNet[16]	71.4	84.2	78.5	73.6	55.6	53.7	78.7	79.8	87.7	49.6	74.9	52.1	86.0	81.7	83.3	**81.8**	48.6	73.5	59.4	79.9	65.7
SSD300[19]	70.3	84.2	76.3	69.6	53.2	40.8	78.5	73.6	88.0	50.5	73.5	61.7	85.8	80.6	81.2	77.5	44.3	73.2	66.7	81.1	65.8
SSD500[19]	73.1	84.9	82.6	74.4	55.8	50.0	80.3	78.9	88.8	53.7	76.8	59.4	87.6	83.7	82.6	81.4	47.2	75.5	65.6	84.3	68.1
RON320	71.7	84.1	78.1	71.0	56.8	46.9	79.0	74.7	87.5	52.5	75.9	60.2	84.8	79.9	82.9	78.6	47.0	75.7	66.9	82.6	68.4
RON384	73.0	85.4	80.6	71.9	56.3	49.8	80.6	76.8	88.2	53.6	78.1	60.4	86.4	81.5	83.8	79.4	48.6	77.4	67.7	83.4	69.5
RON320++	74.5	**87.1**	81.0	74.6	58.8	51.7	**82.1**	77.0	89.7	57.2	79.9	**62.6**	87.2	83.2	**85.0**	80.5	51.4	76.7	68.5	**84.8**	70.4
RON384++	**75.4**	86.5	**82.9**	**76.6**	**60.9**	**55.8**	81.7	**80.2**	**91.1**	**57.3**	**81.1**	60.4	87.2	**84.8**	84.9	81.7	**51.9**	**79.1**	**68.6**	84.1	70.3

Table 2. Results on PASCAL VOC 2012 test set. All methods are based on the pre-trained VGG-16 networks.

Method	Train Data	Average Precision		
		0.5	0.75	0.5:0.95
Fast R-CNN[10]	train	35.9	-	19.7
OHEM[26]	trainval	42.5	22.2	22.6
OHEM++[26]	trainval	45.9	26.1	25.5
Faster R-CNN[23]	trainval	42.7	-	21.9
SSD300[19]	trainval35k	38.0	20.5	20.8
SSD500[19]	trainval35k	43.7	24.7	24.4
RON320	trainval	44.7	22.7	23.6
RON384	trainval	46.5	25.0	25.4
RON320++	trainval	47.5	25.9	26.2
RON384++	trainval	**49.5**	**27.1**	**27.4**

Table 3. MS COCO test-dev2015 detection results.



CONCLUSION

- We presented RON, an efficient and effective object detection framework.
- We design the reverse connection to enable the network to detect objects on multi-levels of CNNs. And the objectness prior is also proposed to guide the search of objects.
- We optimize the whole networks by a multi-task loss function, thus the networks can directly predict final detection results. On standard benchmarks, RON achieves state-of-the-art object detection performance.

Check out the code/models
https://github.com/taokong/RON/