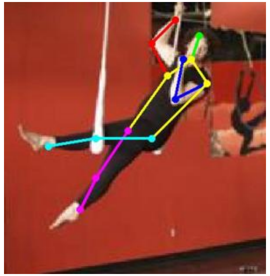
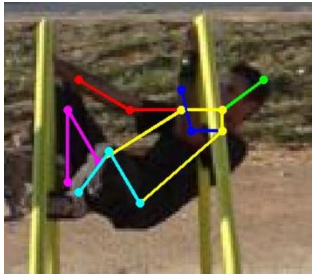
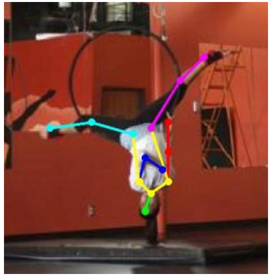
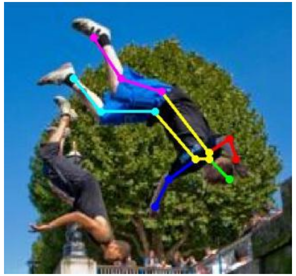


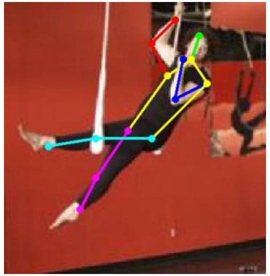
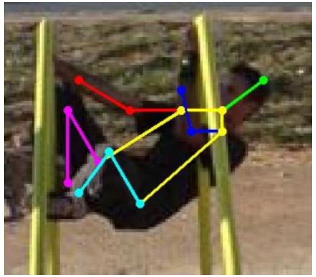
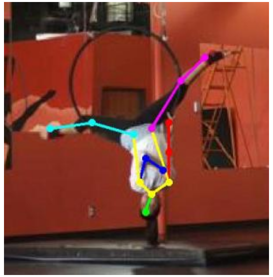
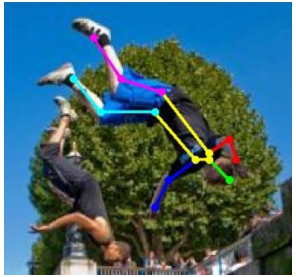
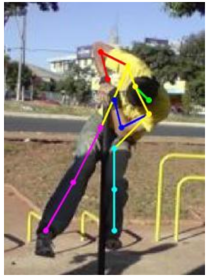





人体姿态识别年度总结

欧阳万里

香港中文大学

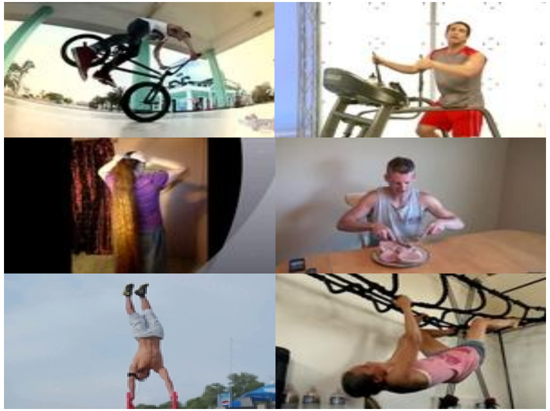
What is Human Pose Estimation?

Results are generated by our proposed methods (without temporal constraints).

Video Credit: Peter Jasko solo - M-idzomer 2013

Applications



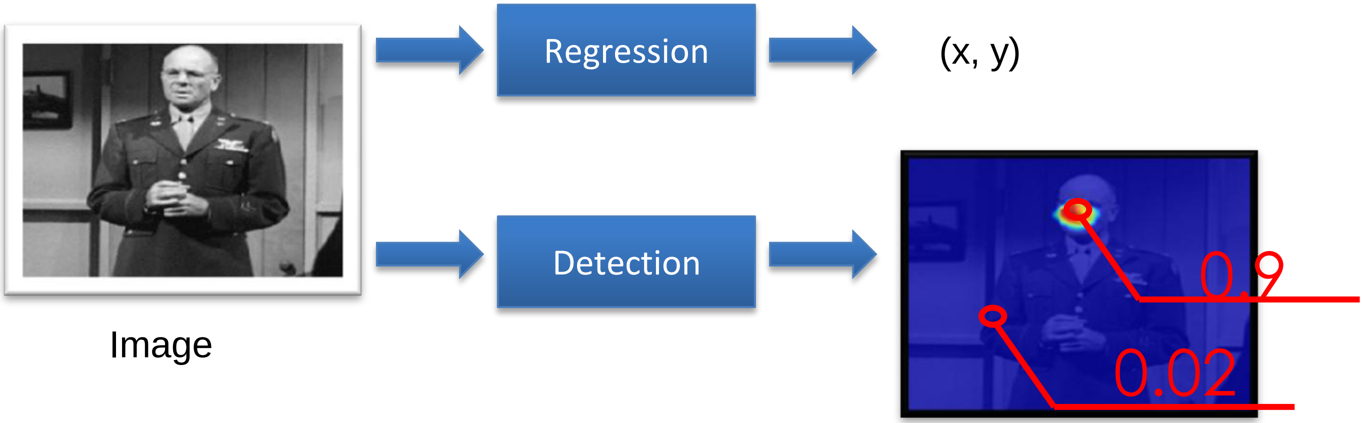
Action Recognition

HCI, Game and Animation

Clothing Parsing
[Yamaguchi et al. CVPR’14]

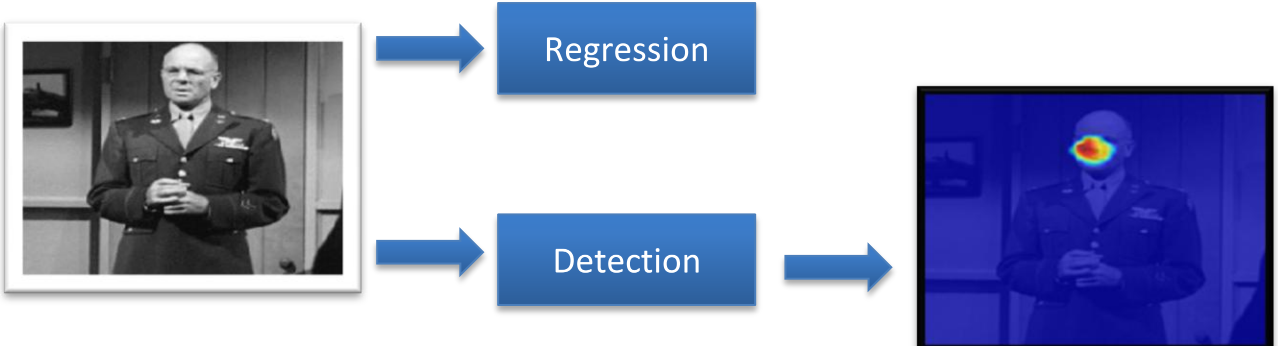
Regression or detection?

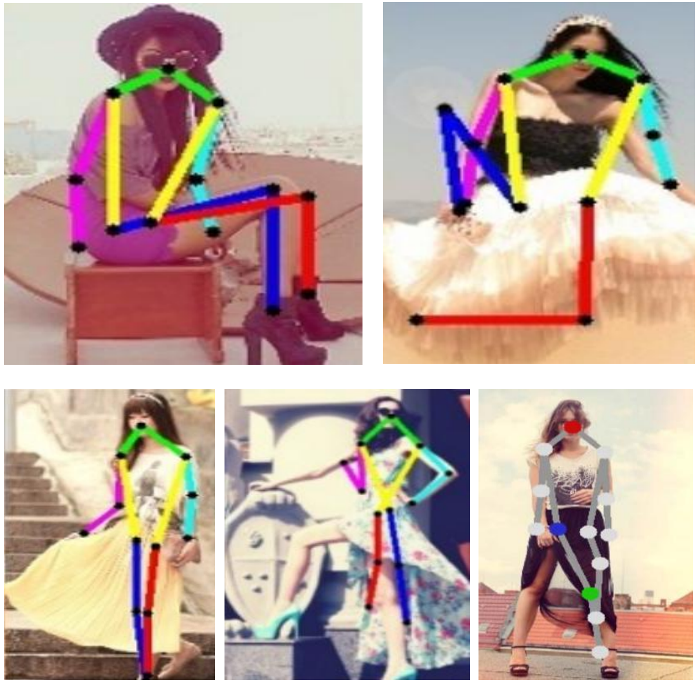
- Output coordinates
  - To regress the body locations
- Output heatmaps
  - To detect the body locations



Limitations

- Regression
  - Low accuracy in high precision region caused by flexible body movement
  - Hard to extend when pose estimation is used for unknown number of persons
- Detection





Dantone et al. CVPR 2013

Challenge

- Body movement
- Foreshortening
- Clothing

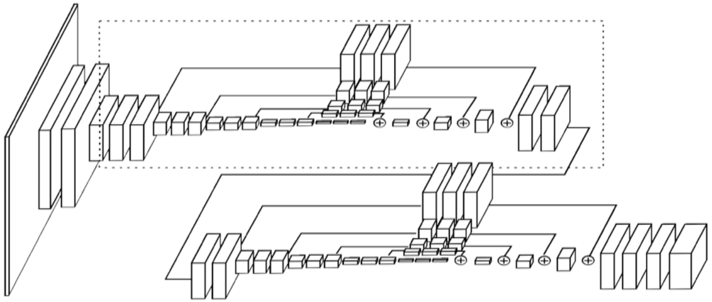
Can you tell which part is from an image patch?

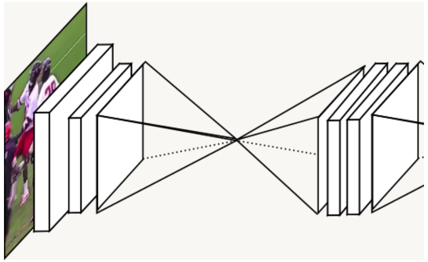
What about this patch?

- Local appearance is insufficient
- Global appearance is helpful

Stacked hourglass network

- Hourglass
  - Subsampling: lower resolution for less computation and larger receptive field
  - => upsampling: higher resolution for more accurate localization

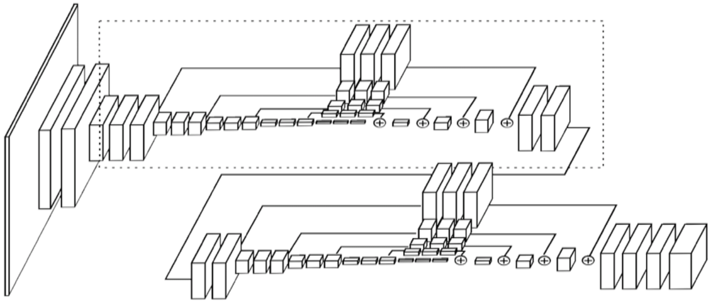


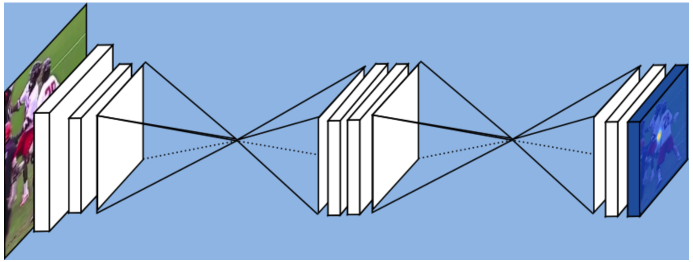


Newell, Alejandro, Kaiyu Yang, and Jia Deng. "Stacked hourglass networks for human pose estimation." *ECCV*, 2016. [@ University of Michigan]

Stacked hourglass network

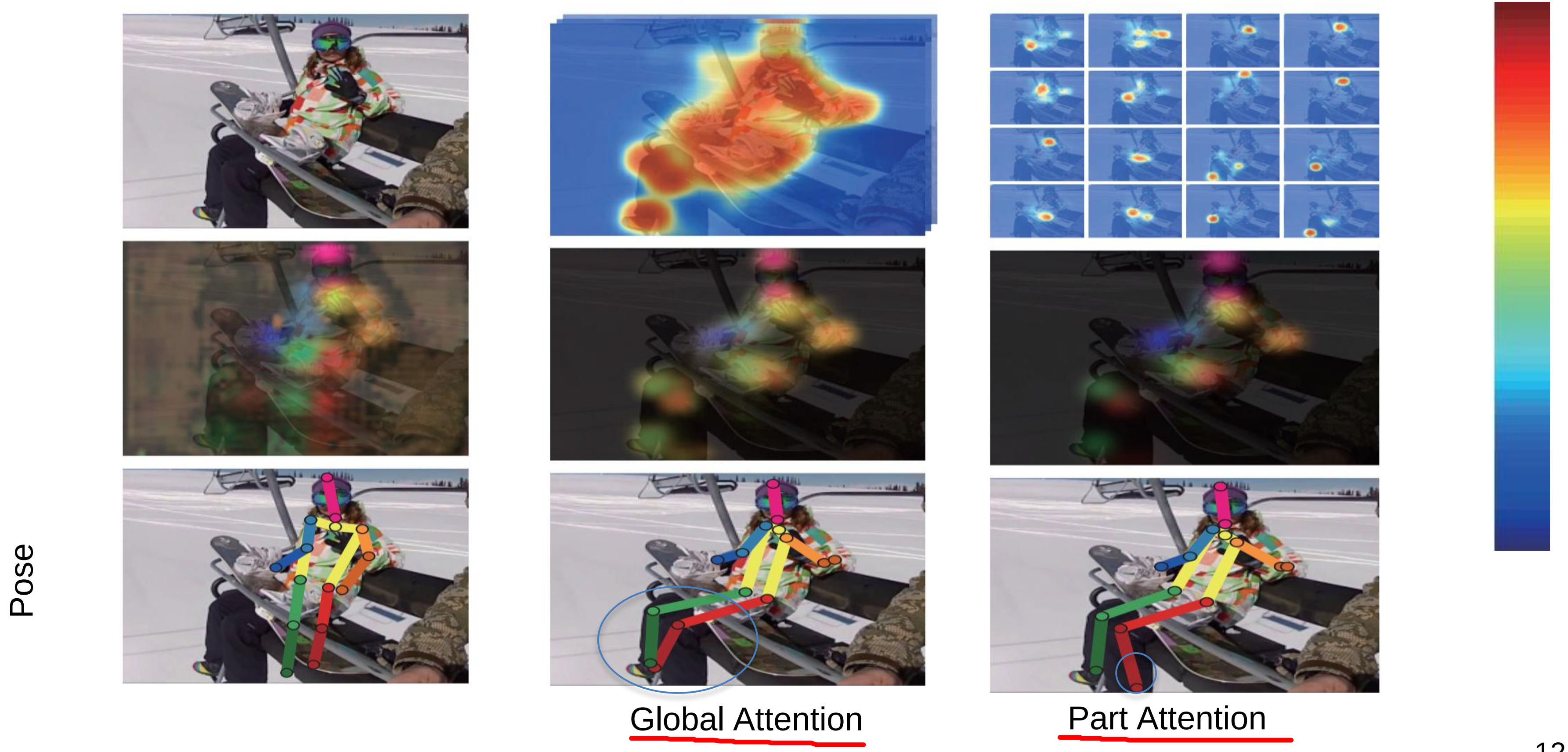
- ❖ Hourglass, subsampling => upsampling
- ❖ Stack multiple hourglass structures





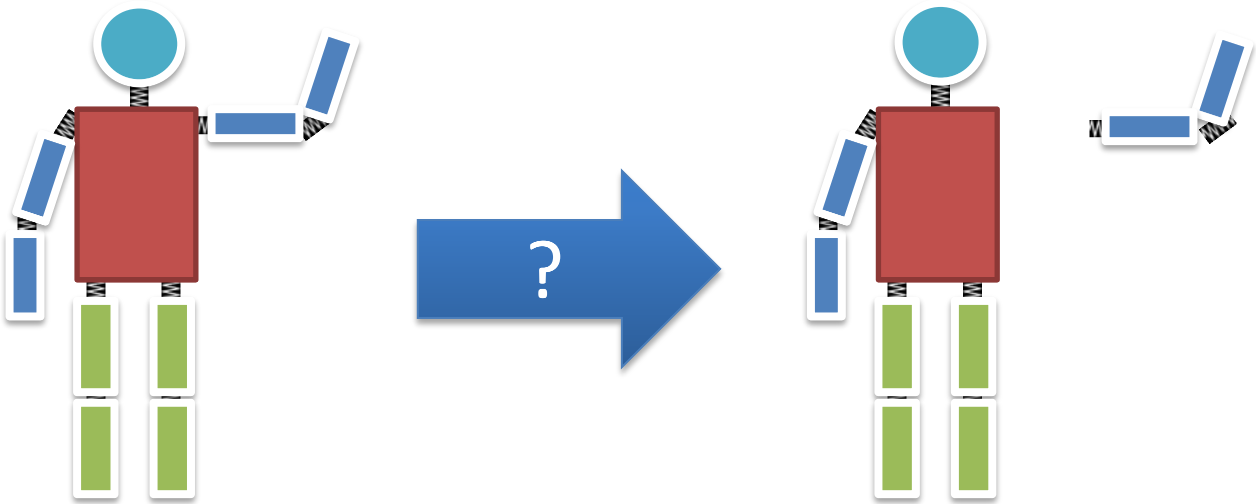
Newell, Alejandro, Kaiyu Yang, and Jia Deng. "Stacked hourglass networks for human pose estimation." *ECCV*, 2016. [@ University of Michigan]

How attention helps human pose estimation?

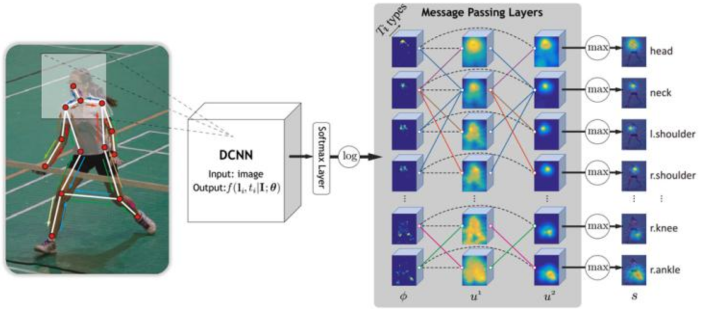


X. Chu, W. Yang, W. Ouyang , X. Wang, A. Yuille. "Multi-Context Attention for Human Pose Estimation", *Proc. CVPR* , 2017.

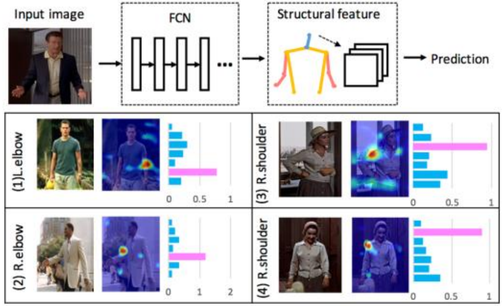
Structure also matters...



Structure also matters...



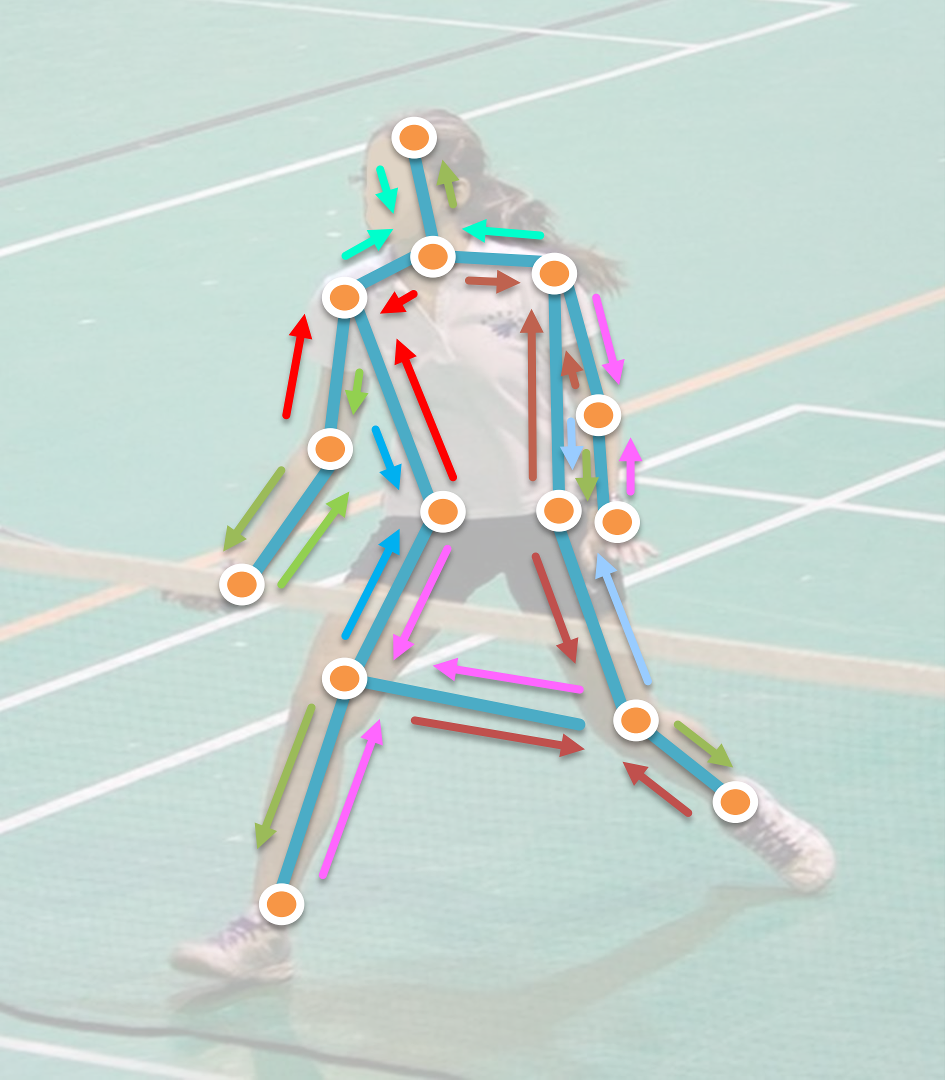
Deep Mixture of Parts



Structured Feature Learning

(source code provided)

Wei Yang, Wanli Ouyang, Hongsheng Li and Xiaogang Wang "End-to-End Learning of Deformable Mixture of Parts and Deep Convolutional Neural Networks for Human Pose Estimation", In *Proc. CVPR* 2016 (Oral).
X. Chu, Wanli Ouyang , H. Li, and X. Wang. "Structured feature learning for pose estimation", In *Proc. CVPR* 2016.

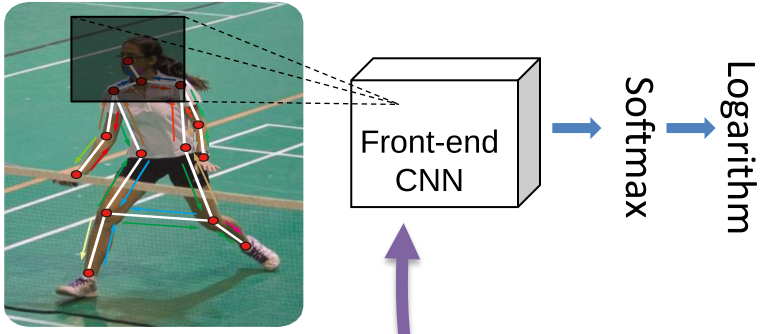


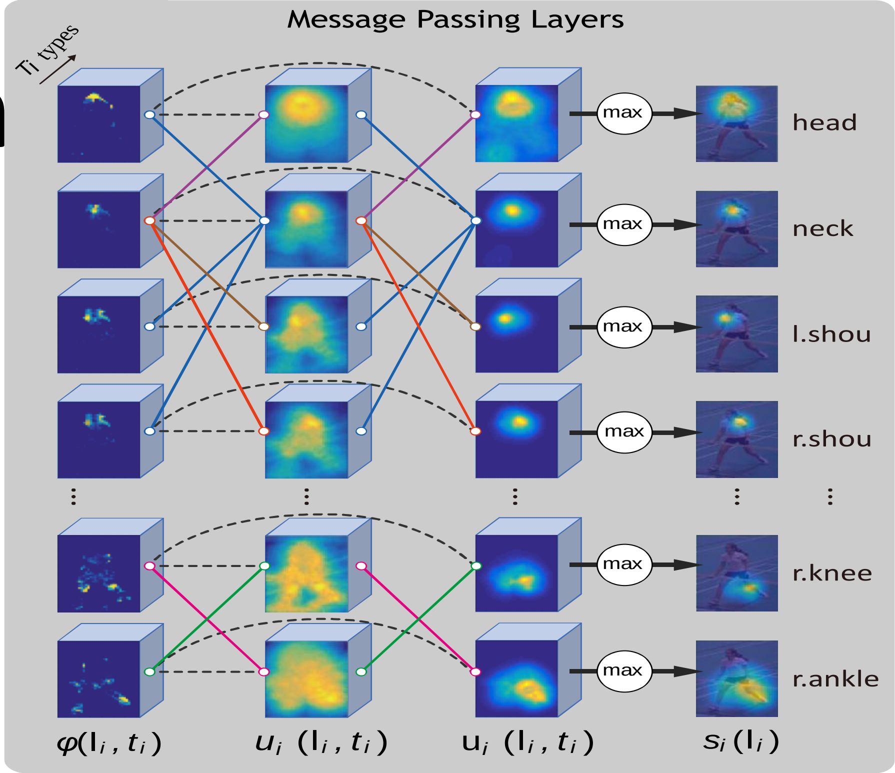
Graph model

$G = (V, E)$

- **Vertices**
  - Locations and mixture types of body parts
  - Modeled by a front-end CNN
- **Edges** message passing
  - Pairwise spatial relationships between body parts
  - Modeled by message passing layers

Fram

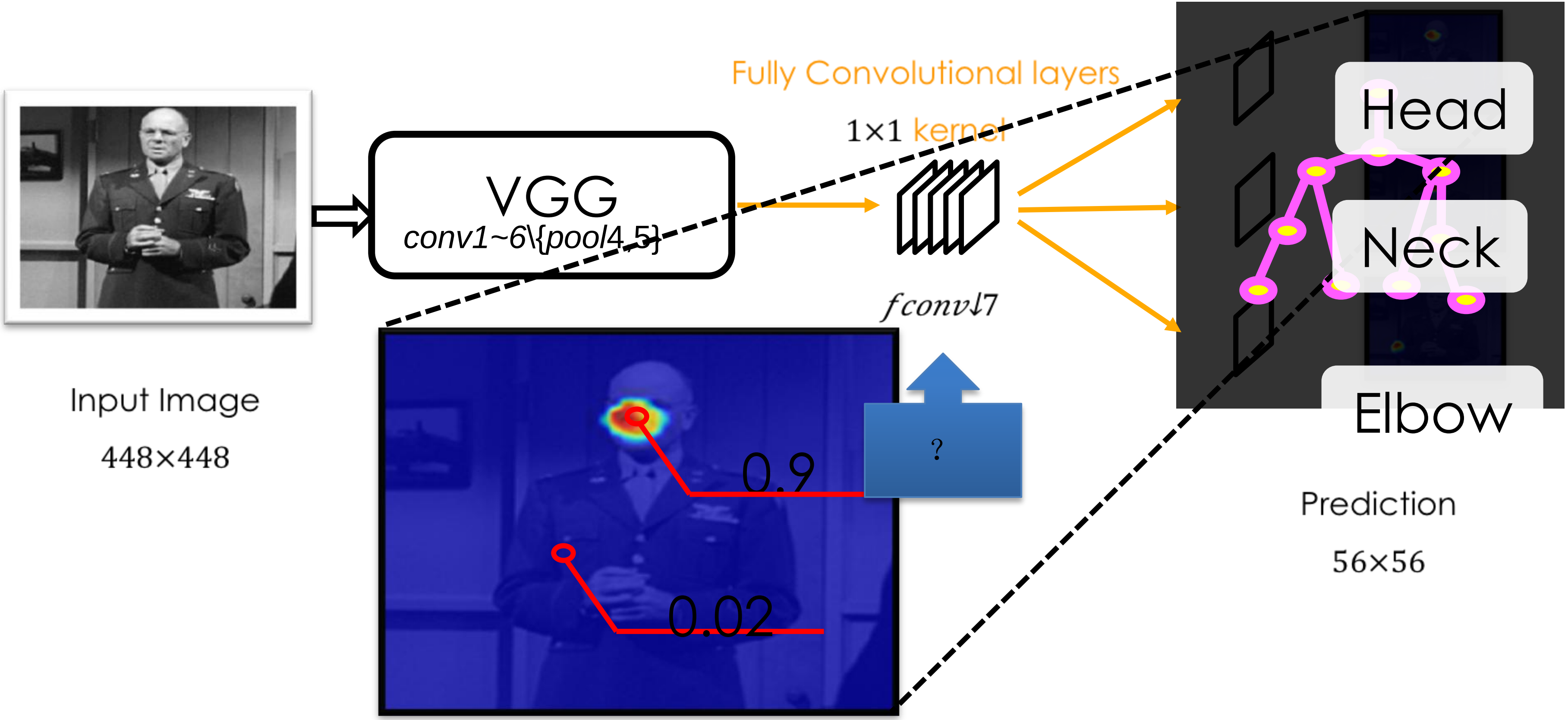




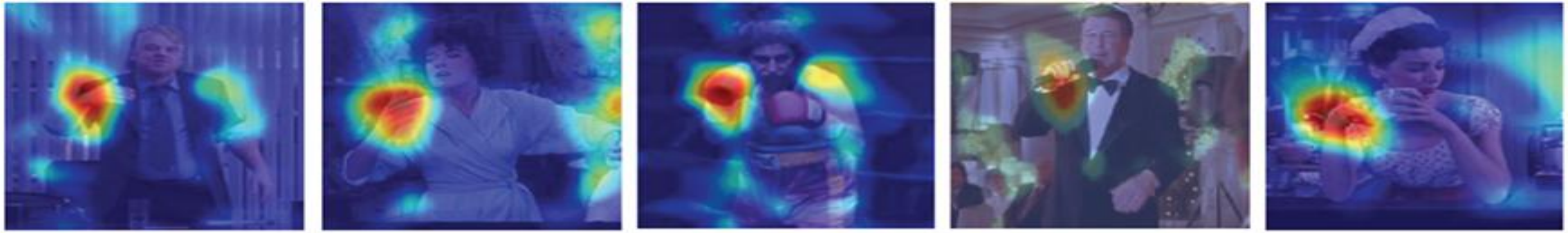
$$F(\boldsymbol{l}, \mathbf{t}|I;\boldsymbol{\theta},\boldsymbol{\omega}) = \sum_{i\in V} \phi(l_i, t_i|I;\theta) + \sum_{(i,j)\in E} \psi(l_i, l_j, t_i, t_j|I;\omega_{i,j}^{t_i,t_j})$$

Wei Yang, Wanli Ouyang, Hongsheng Li and Xiaogang Wang "End-to-End Learning of Deformable Mixture of Parts and Deep Convolutional Neural Networks for Human Pose Estimation", In *Proc. CVPR* 2016 (Oral).

Fully convolutional net for Human pose estimation

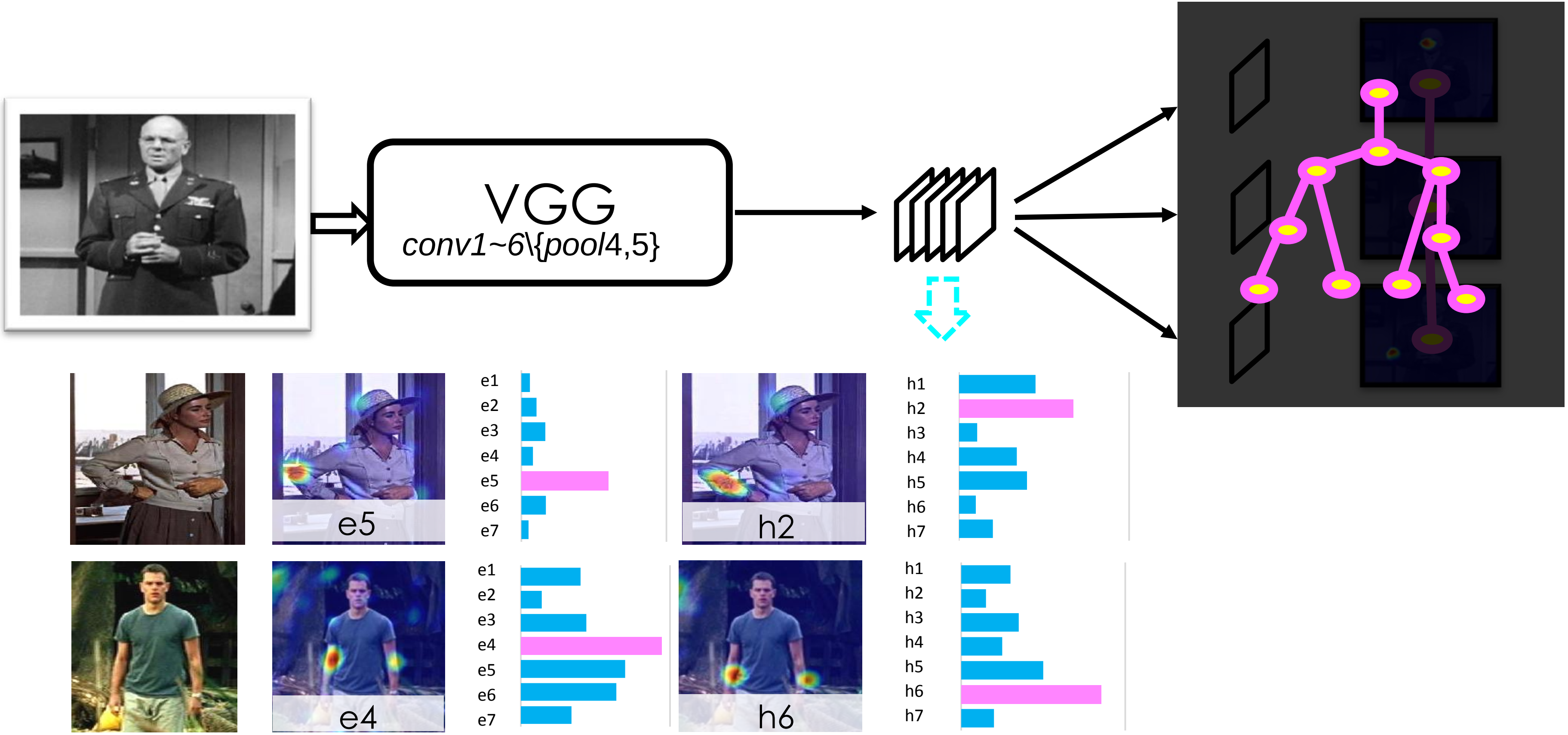


High responding images for channel 1 for neck

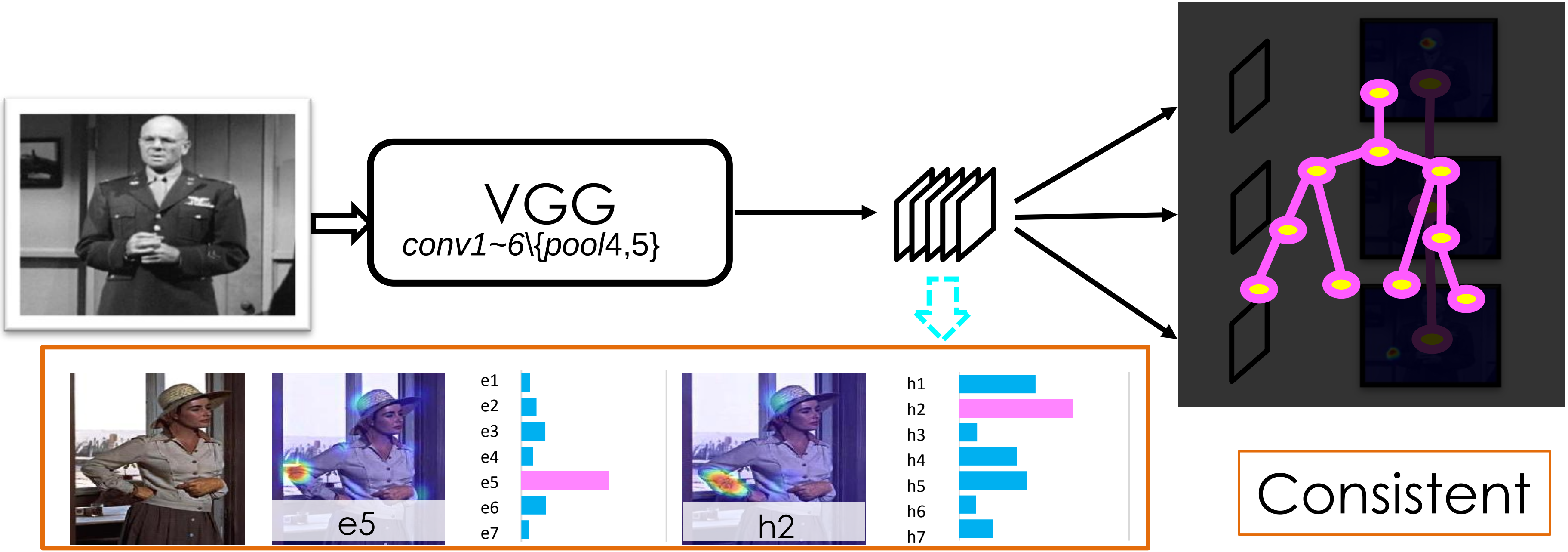


High responding images for channel 2 for left shoulder

Fully convolutional net for Human pose estimation

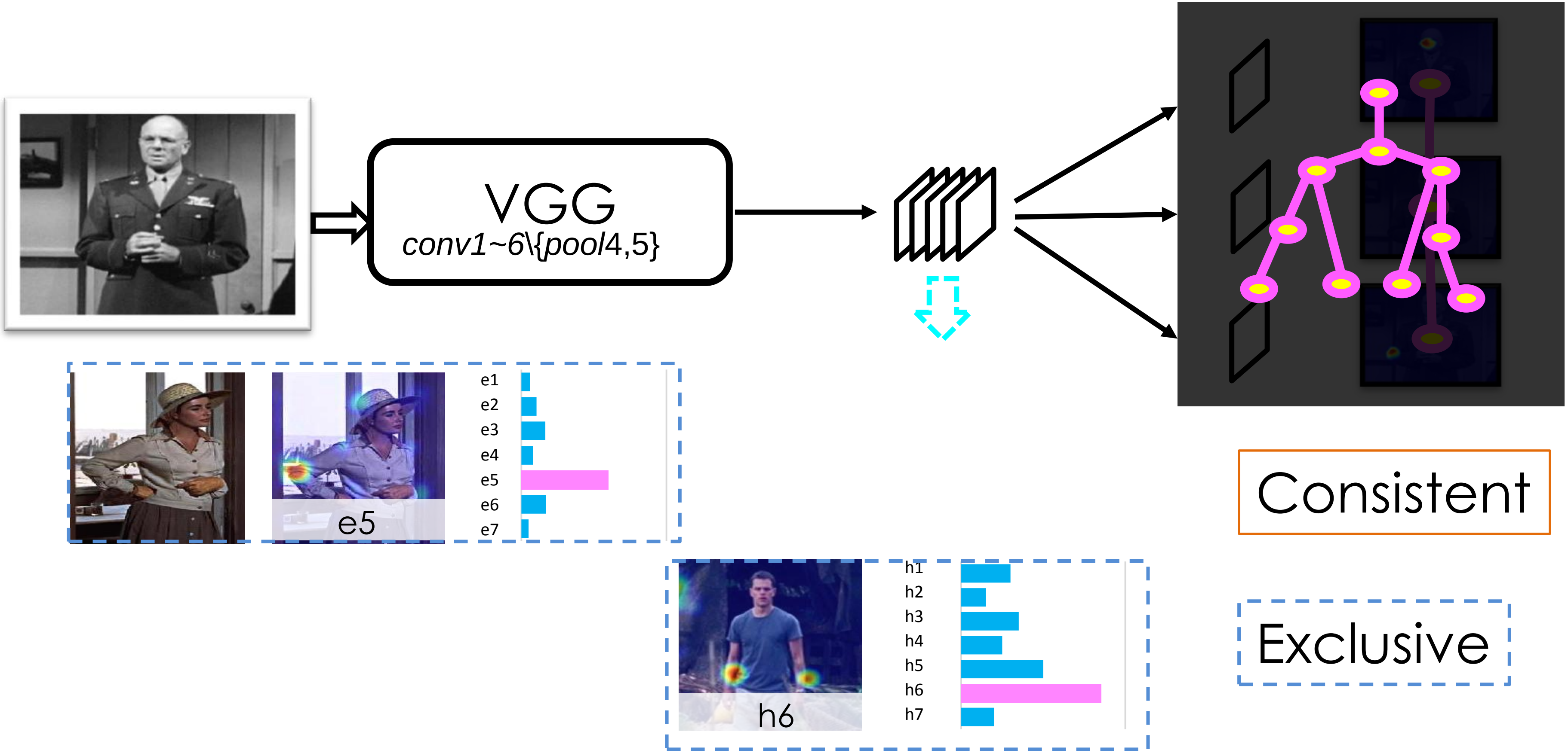


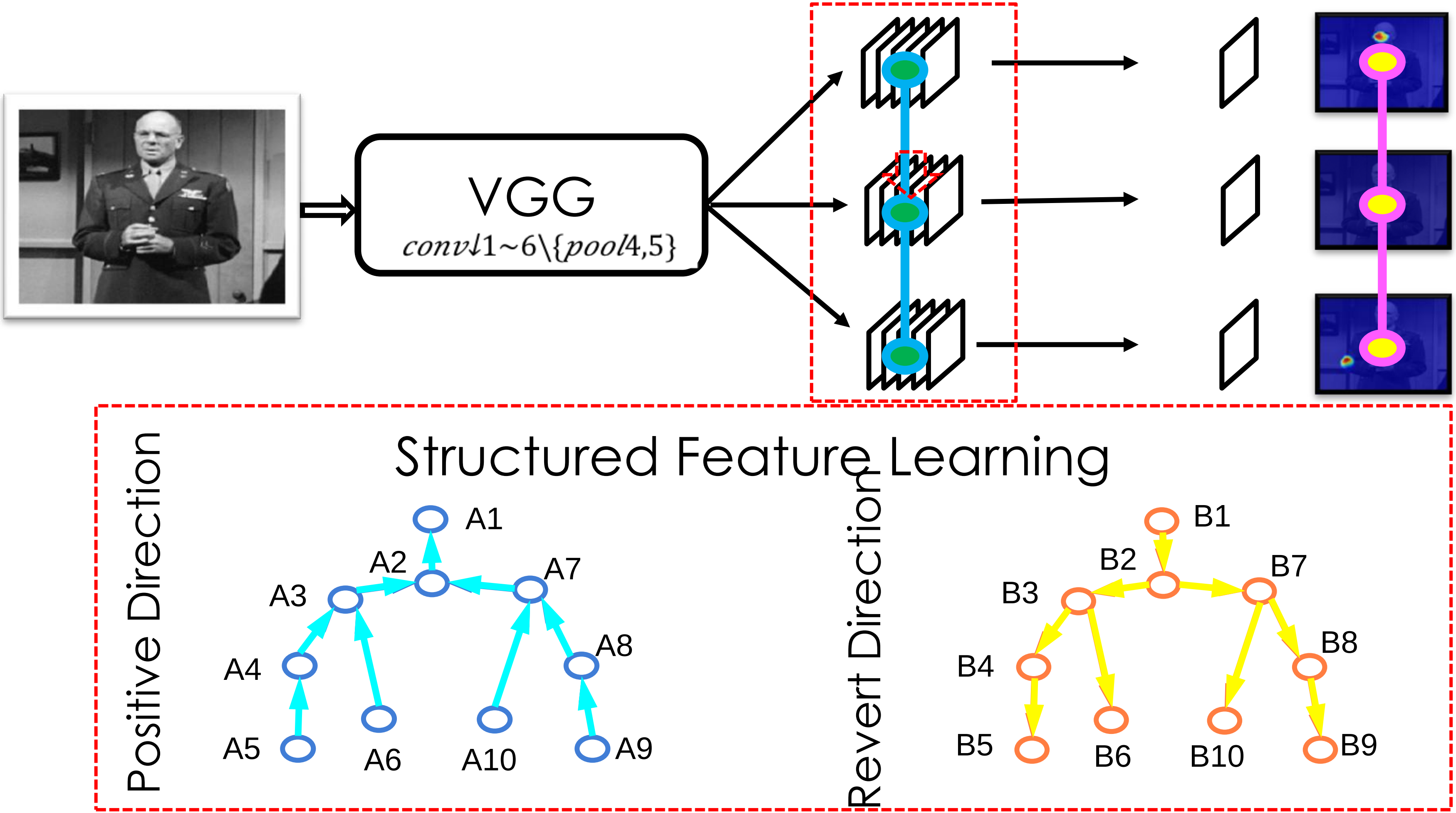
Fully convolutional net for Human pose estimation



Consistent

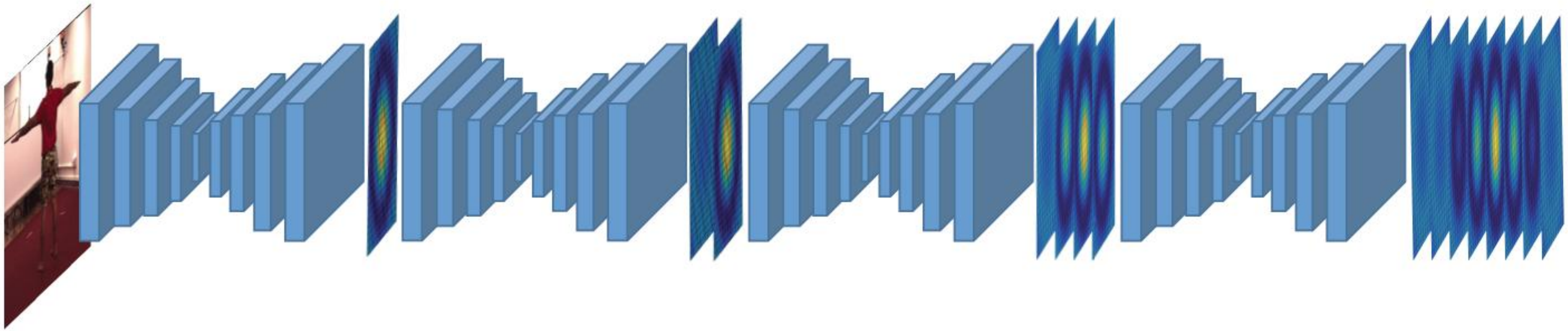
Fully convolutional net for Human pose estimation





X. Chu, W. Ouyang , H. Li, and X. Wang. "Structured feature learning for pose estimation", In *Proc. CVPR* 2016.

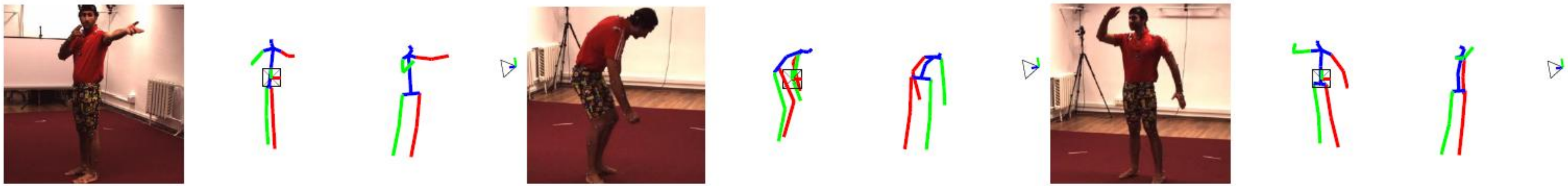
2D pose to 3D pose (from image)



2D pose

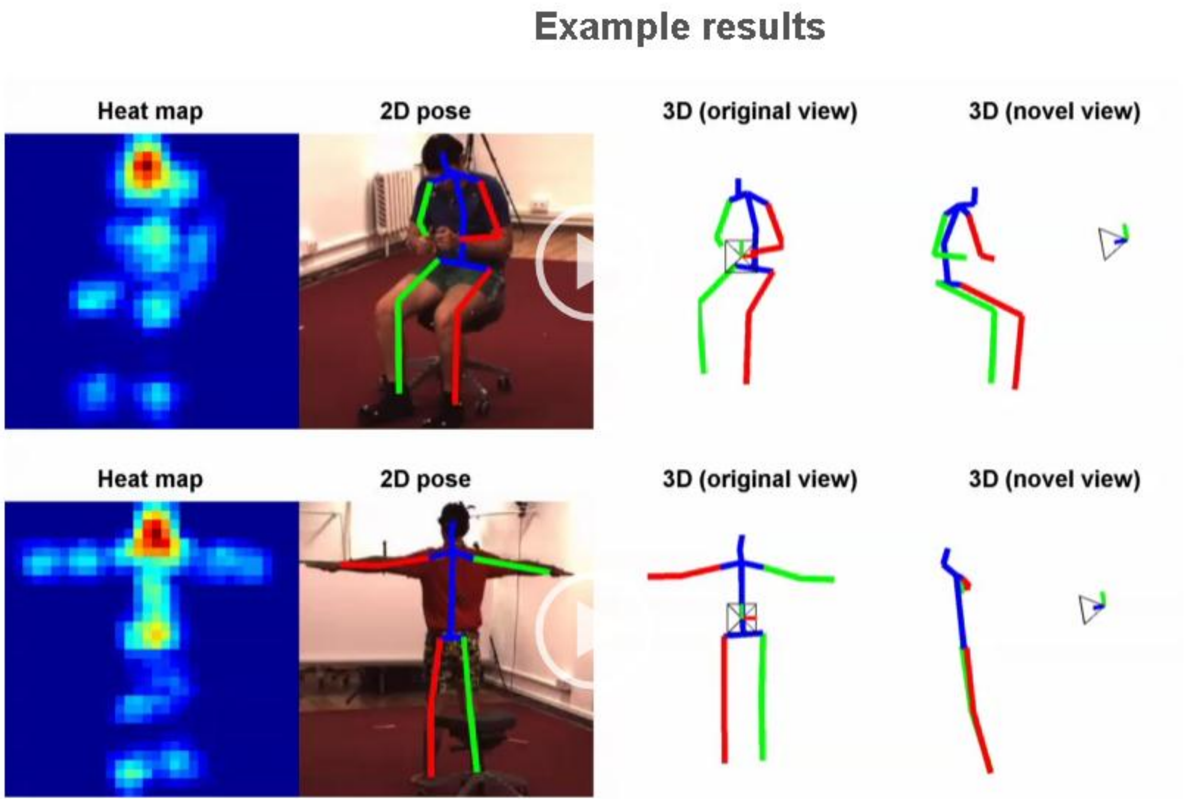
Coarse 3D pose

Fine 3D pose



Pavlakos, Georgios, et al. "Coarse-to-Fine Volumetric Prediction for Single-Image 3D Human Pose." *CVPR,* 2017.

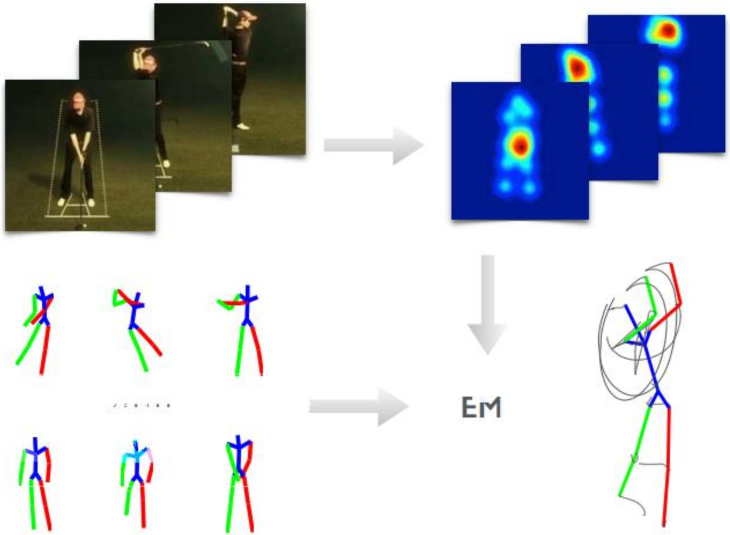
2D pose to 3D pose (from video)



Zhou, Xiaowei, et al. "Sparseness meets deepness: 3D human pose estimation from monocular video." *CVPR*, 2016.

2D pose to 3D pose (from video)

- Sparsity-driven 3D geometric prior
  - 3D pose can be represented as a linear combination of predefined basis poses
- Temporal smoothness
  - Poses are similar in adjacent frames



Zhou, Xiaowei, et al. "Sparseness meets deepness: 3D human pose estimation from monocular video." *CVPR*, 2016.

Other interesting papers

- Toshev, Alexander, and Christian Szegedy. "Deeppose: Human pose estimation via deep neural networks." CVPR 2014.
- Tompson, Jonathan J., et al. "Joint training of a convolutional network and a graphical model for human pose estimation." NIPS, 2014.
- Chen, Xianjie, and Alan L. Yuille. "Articulated pose estimation by a graphical model with image dependent pairwise relations." NIPS, 2014.
- Jain, Arjun, et al. "Learning human pose estimation features with convolutional networks." ICLR, 2014.
- Jain, Arjun, et al. "Modeep: A deep learning framework using motion features for human pose estimation." ACCV, 2014.
- Tompson, Jonathan, et al. "Efficient object localization using convolutional networks." CVPR. 2015.
- Fan, Xiaochuan, et al. "Combining local appearance and holistic view: Dual-source deep neural networks for human pose estimation." CVPR, 2015.
- Pfister, Tomas, James Charles, and Andrew Zisserman. "Flowing convnets for human pose estimation in videos." ICCV, 2015.
- Chu, Xiao, et al. "Structured feature learning for pose estimation." CVPR, 2016.
- Yang, Wei, et al. "End-to-end learning of deformable mixture of parts and deep convolutional neural networks for human pose estimation." CVPR, 2016.
- Xiao Chu, Wei Yang, W. Ouyang , Xiaogang Wang, Alan Yuille. ”Multi-Context Attention for Human Pose Estimation”, *Proc. CVPR* , 2017.
- Gkioxari, Georgia, Alexander Toshev, and Navdeep Jaitly. "Chained Predictions Using Convolutional Neural Networks." ECCV,2016.
- J. Charles, et al, Personalizing Human Video Pose Estimation, CVPR16
- Carreira, Joao, et al. "Human pose estimation with iterative error feedback.” CVPR 2016.
- Insafutdinov E, Pishchulin L, Andres B, et al. DeeperCut: A Deeper, Stronger, and Faster Multi-person Pose Estimation Model. ECCV 2016.
- Pishchulin, L., Insafutdinov, E., Tang, S., Andres, B., Andriluka, M., Gehler, P., & Schiele, B. DeepCut: Joint Subset Partition and Labeling for Multi Person Pose Estimation, CVPR 2016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