Multi-Person Pose Estimation using Part Affinity Fields

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Earlier This Year…

CVPR’16 Demo

Problem of Shipment

CVPR’16 Demo

Top-down Approach: Person Detection + Pose Estimation

Top-down

Top-down Approach: Person Detection + Pose Estimation

Top-down

Top-down Approach: Person Detection + Pose Estimation

Top-down

Top-down Approach: Person Detection + Pose Estimation

Top-down

Top-down Approach: Person Detection + Pose Estimation

Top-down

Our Method: Parts Detection + Parts Association

Top-down

Ours

Our Method: Parts Detection + Parts Association

Top-down

Ours

Our Method: Parts Detection + Parts Association

Top-down

Ours

Our Method: Parts Detection + Parts Association

Top-down

Ours

Our Method: Parts Detection + Parts Association

Top-down

Our Method: Parts Detection + Parts Association

Top-down

Part Affinity Fields

Our Method: Parts Detection + Parts Association

Top-down

Our Method: Parts Detection + Parts Association

Top-down

Part Affinity Fields

Our Method: Parts Detection + Parts Association

Top-down

Ours

Novelty: Jointly Learning Parts Detection and Parts Association

Novelty: Jointly Learning Parts Detection and Parts Association

Sequential Prediction with Learned Spatial Context

Right shoulder

Right wrist

Right knee

⋮

Convolutional Pose Machines, Wei, Ramakrishna, Kanade, Sheikh, CVPR 2016

Sequential Prediction with Learned Spatial Context

Convolutional Pose Machines, Wei, Ramakrishna, Kanade, Sheikh, CVPR 2016

Sequential Prediction with Learned Spatial Context

Right Wrist - Stage 1

Sequential Prediction with Learned Spatial Context

Right Wrist - Stage 1

Sequential Prediction with Learned Spatial Context

Sequential Prediction with Learned Spatial Context

Parts Score Maps Prediction from Image Sequence

Jointly Learning Parts Detection and Parts Association

Part-Person Association for Multi-Person Pose Estimation

Elbow

Wrist

⋮

Part-Person Association for Multi-Person Pose Estimation

Part-to-Part Association for Multi-Person Pose Estimation

Elbow

Wrist

Part Affinity Score Guides the Connection

Elbow

Wrist

Part Affinity Score Guides the Connection

Elbow

Wrist

Part Affinity Score Guides the Connection

Elbow

Wrist

How to Obtain the Part Affinity Score

Elbow

Wrist

Part Affinity Score is Dependent on Visual Appearance

Part Affinity Score is Dependent on Visual Appearance

Key Idea: Encode the Part Affinity Score on the Image Plane

Part Affinity Fields
encode **direction** and **position**

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Part Affinity Fields
encode **direction** and **position**

Midpoint Score Map for Part-to-Part Association

part1

part2

Midpoint Score Map for Part-to-Part Association

Midpoint Score Map for Part-to-Part Association

Affinity score between part1 and part2
= confidence score of the midpoint

Spatial Ambiguity of the Midpoint Representation

— Correct Connection

Spatial Ambiguity of the Midpoint Representation

— Correct Connection
— Wrong Connection

Spatial Ambiguity of the Midpoint Representation

— Correct Connection
— Wrong Connection

Increasing Midpoint Number Cannot Solve The Problem

Part Affinity Fields for Part-to-Part Association

Part Affinity Fields for Part-to-Part Association

Affinity score between p_1 and p_2
= sum($\vec{v} \cdot \overrightarrow{p_1 p_2}$)

Part Affinity Fields Avoid Spatial Ambiguity

Jointly Learning Parts Detection and Parts Association

Jointly Learning Parts Detection and Parts Association

Bkg

PAFs

Greedy Algorithm for Body Parts Association

Elbow

Wrist

Greedy Algorithm for Body Parts Association

Elbow

Wrist

Greedy Algorithm for Body Parts Association

Elbow

Shoulder

Greedy Algorithm for Body Parts Association

Results on COCO Challenge Validation Set

Top-down

Method	AP on val
GT bbox + CPM [1]	63
SSD [2] **+ CPM** [1]	53
Our Method	58.5
Ours + Refinement	61

[1] Convolutional Pose Machines [Wei et al. 2016]
[2] SSD: Single Shot MultiBox Detector [Liu et al. 2015]

Jointly Learning Parts Detection and Parts Association

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Please come to our **demo session** at **D-2A-49** (the 4th floor under oral paper posters) on **Wednesday, October 12; 11:00 – 12:30**

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