

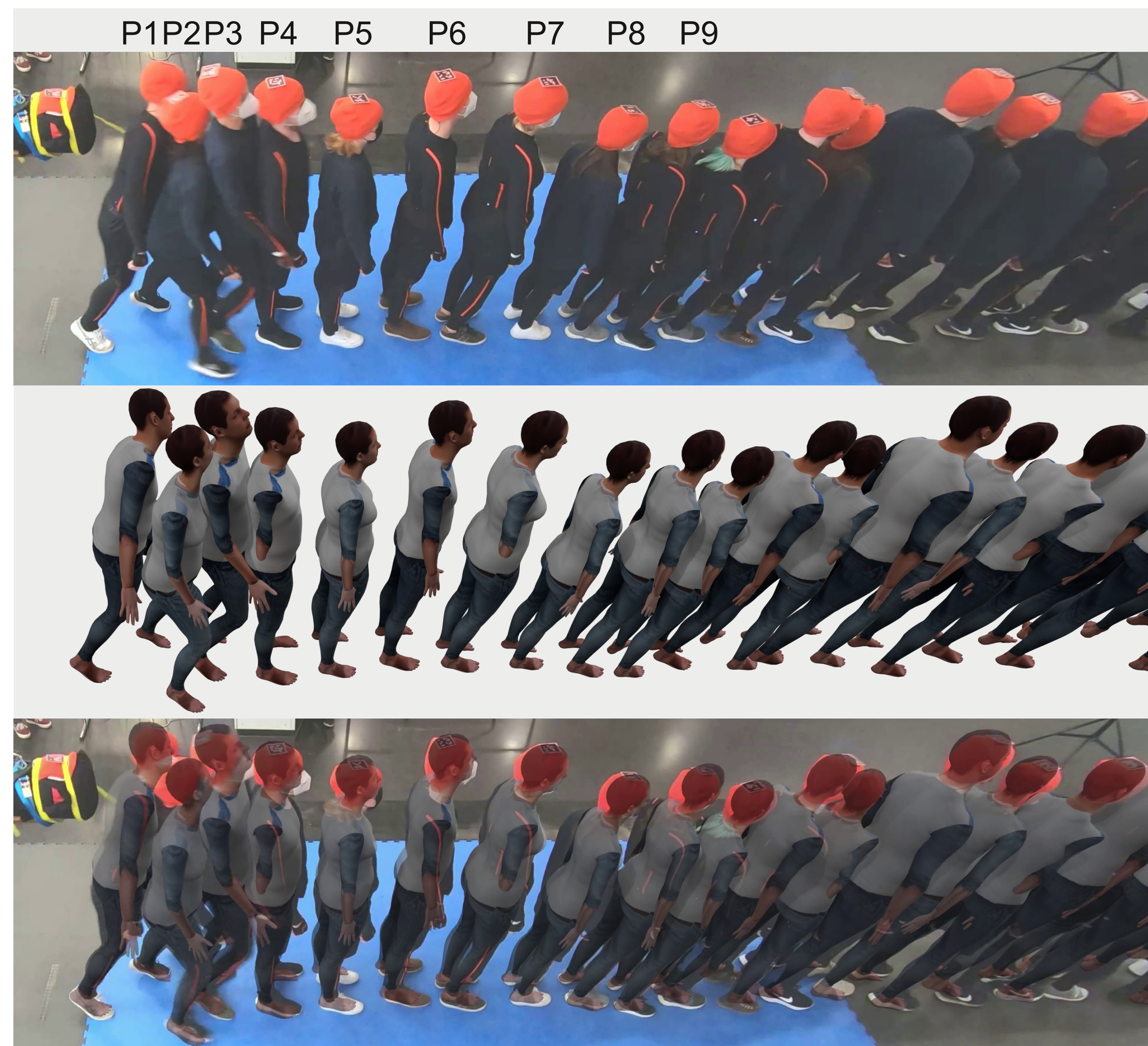
Using A Parametric Body Model to Determine Contacts in a Dense Crowd

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Motivation

- Dense crowds lead to physical contacts
 - Contacts prerequisite for force transfer
 - Forces can lead to loss of balance
- Need knowledge about space occupancy and contacts
- Idea: Work with parametric body model to recreate crowd

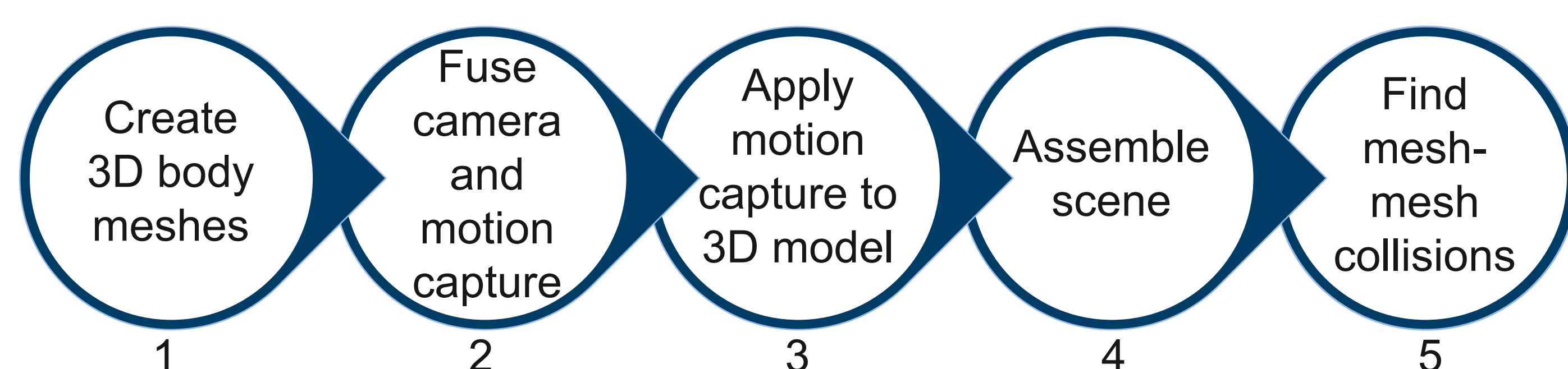


Dataset

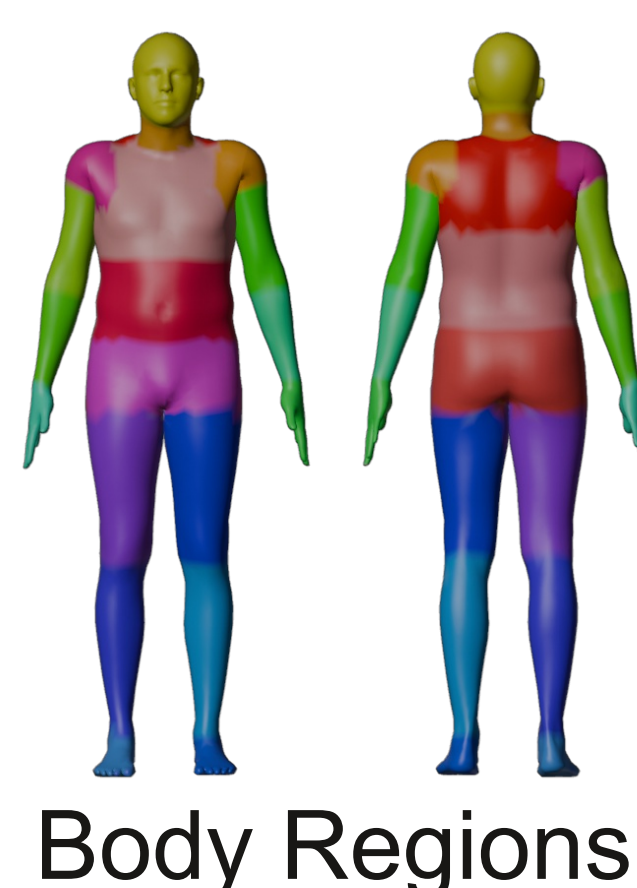
- Dataset from "Impulse propagation through a small standing crowd" [3]
- Focusing on a single row perturbation:
 - Allows visual inspection
 - Strong push that leads to contacts
 - Elbow-distance at beginning, i.e. contacts happen due to perturbation



Kinematic Contact Detection Method



- Create 3D body meshes
 - Use body measurements to regress parameters of parametric human model following [1]
- Fuse relative-position motion capture data with absolute-position camera data following [2]
- Apply motion capture movement to 3D body meshes
- Assemble 3D scene
 - Currently needs manual corrections
- Determine mesh-mesh collisions as points of contact
 - Enlarge meshes by 1 cm to reduce false-negative rate
 - Determine body region for each contact



Body Regions

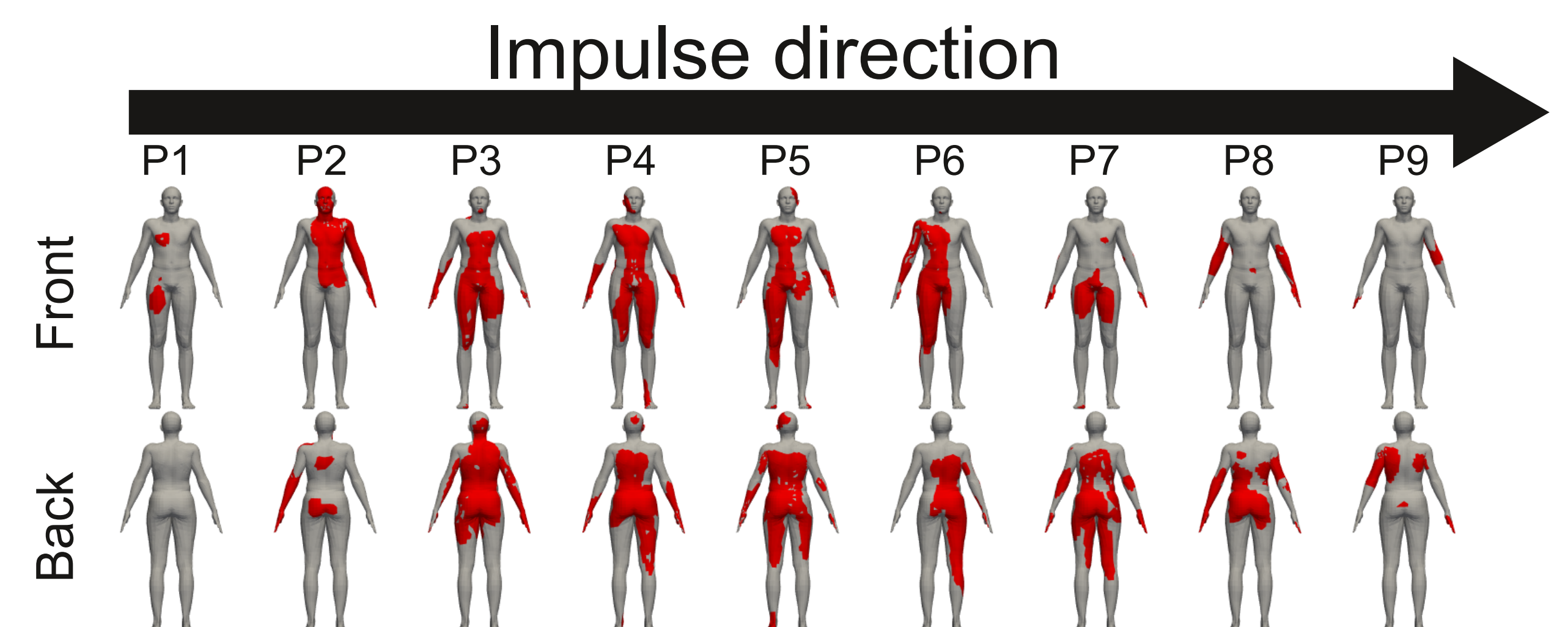
Result: Spatio-temporal contact information

References:

- [1] S. Pujades et al., "The Virtual Caliper: Rapid Creation of Metrically Accurate Avatars from 3D Measurements," IEEE transactions on visualization and computer graphics, vol. 25, no. 5, pp. 1887–1897, 2019, doi: 10.1109/TVCG.2019.2898748.
[2] M. Boltes, J. Adrian, and A.-K. Raytarowski, "A Hybrid Tracking System of Full-Body Motion Inside Crowds," Sensors, vol. 21, no. 6, p. 2108, Jan. 2021, doi: 10.3390/s21062108.
[3] S. Feldmann et al., "Impulse propagation through a small standing crowd." Forschungszentrum Jülich, 2022. doi: 10.34735/PED.2022.6.

Spatio-Temporal Contact Data

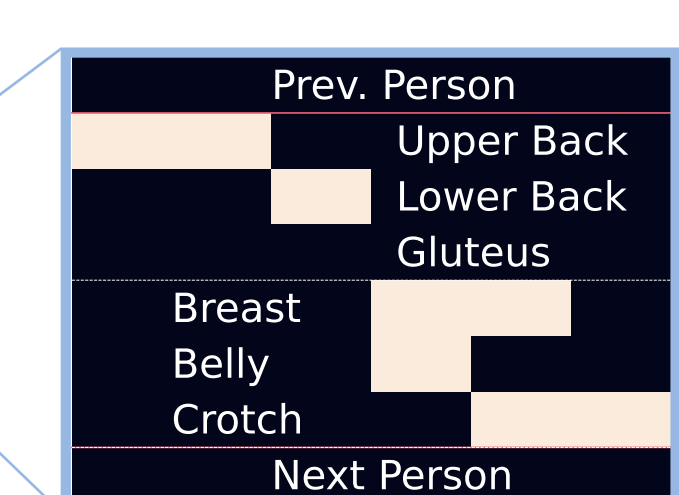
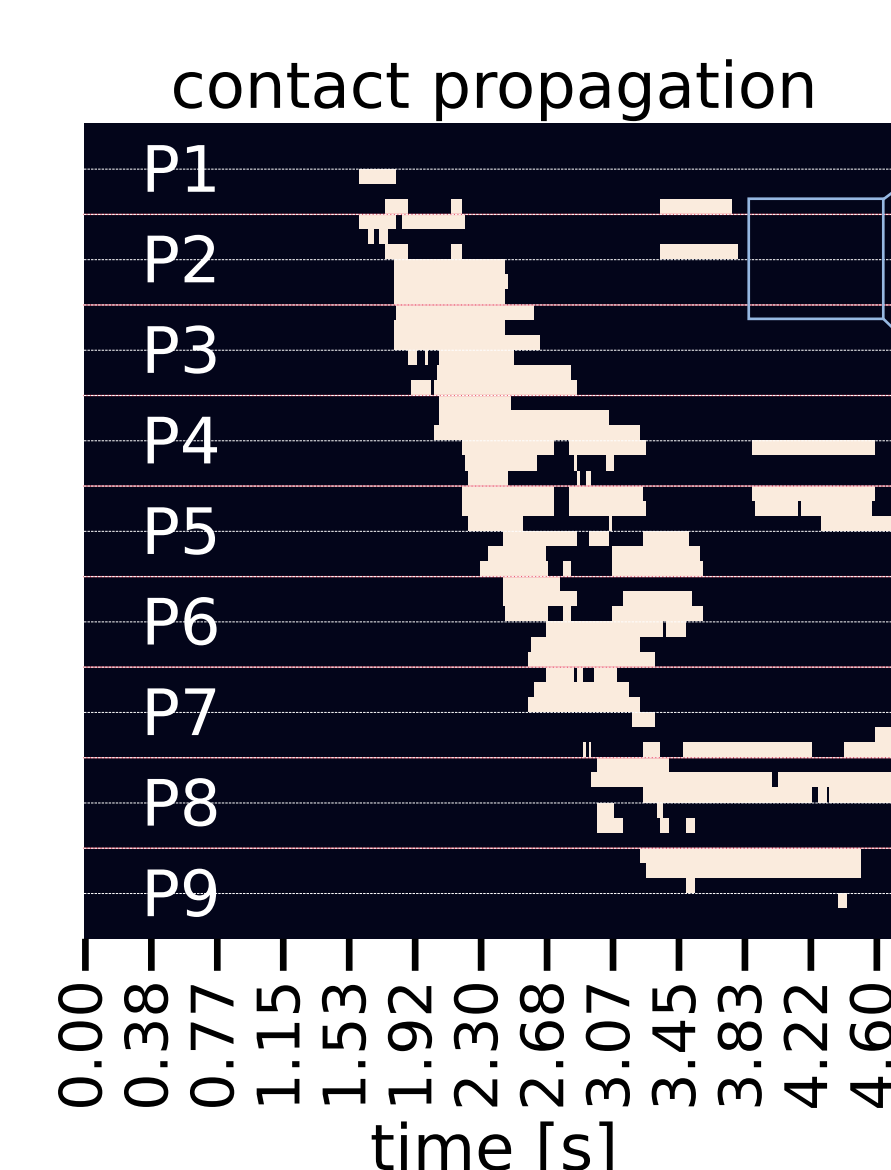
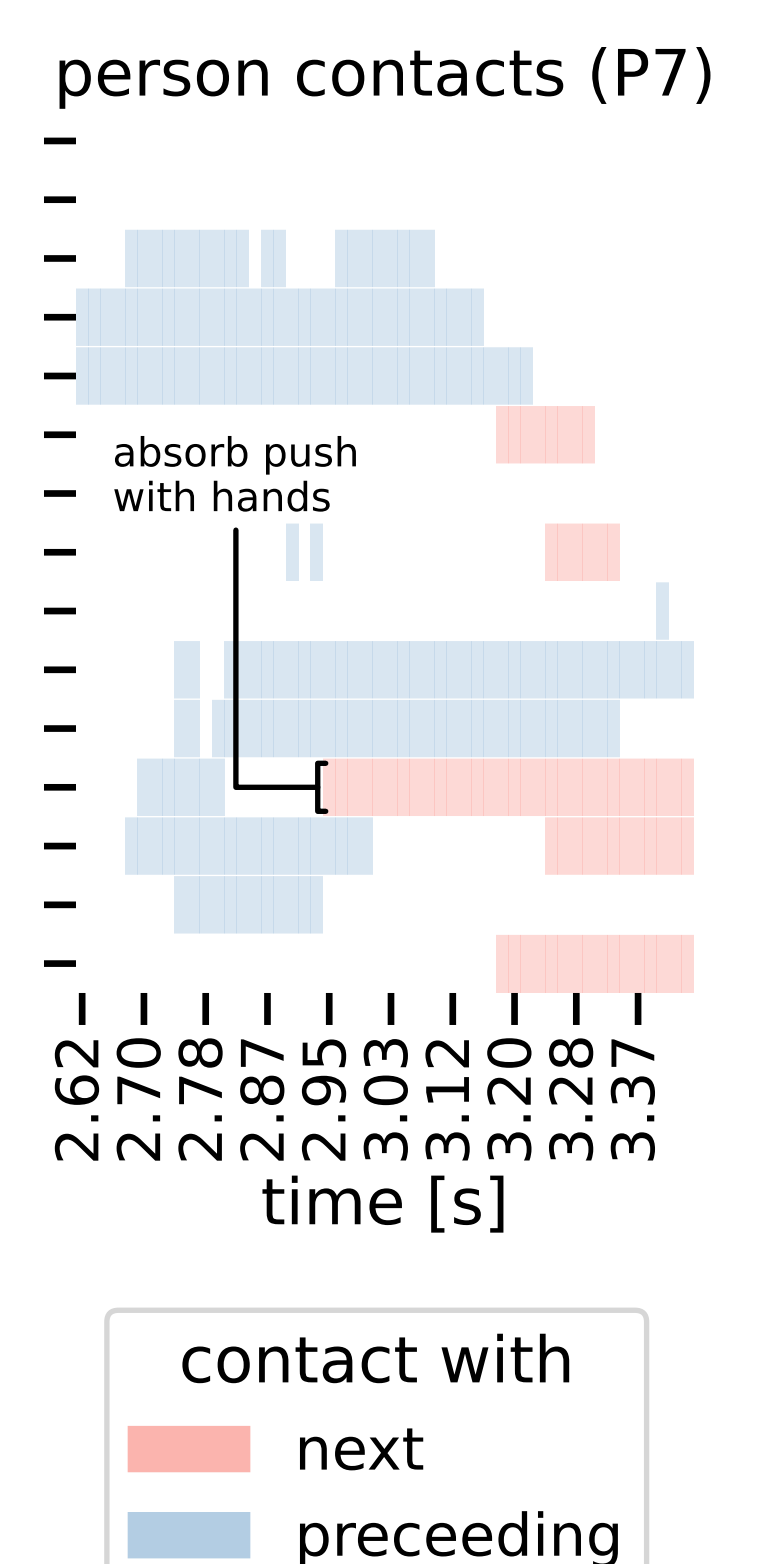
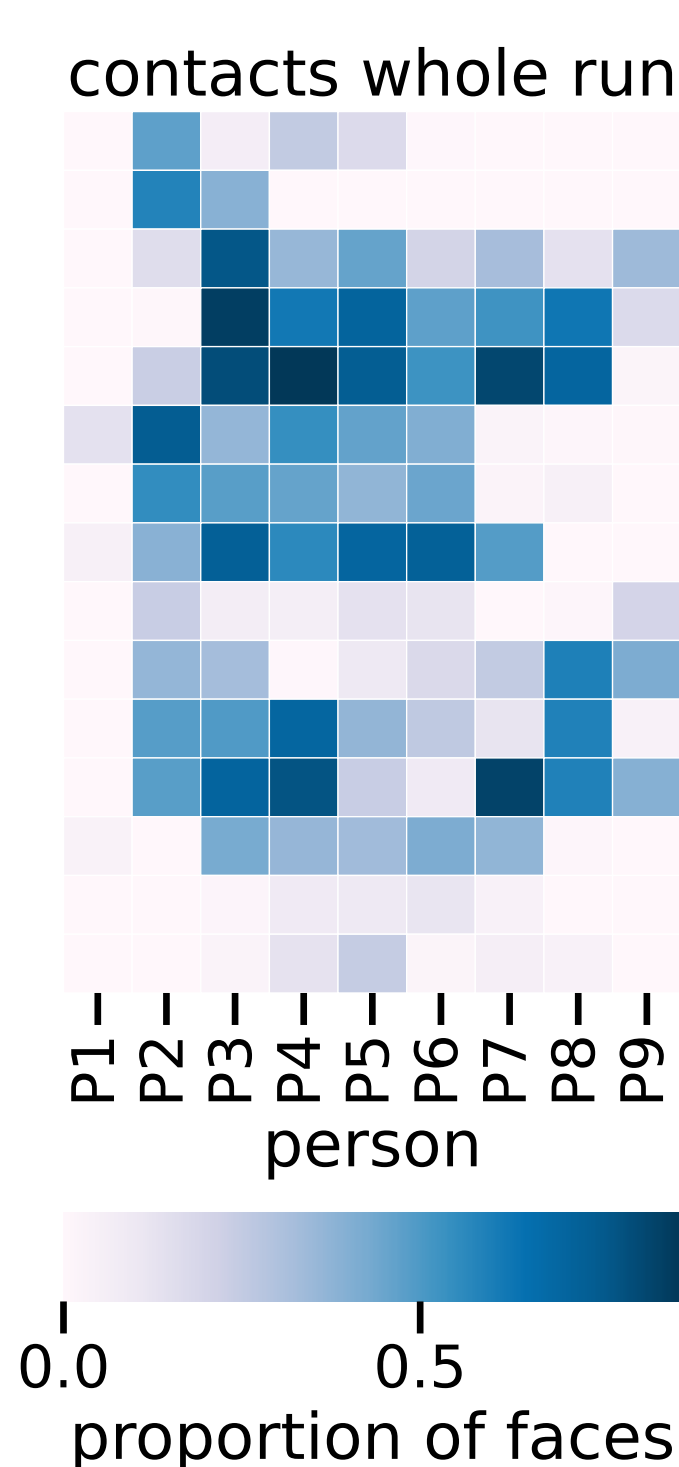
- Our method gives contacts between persons over space & time
- Plausible results
- Exception: first person P1
 - Nothing at back because perturbation device not modeled
 - Barely something at front due to erroneous pose



Want to see it move?

Motion Analysis

- Focus on perturbed participants (first 9)
- Starts with whole-body contact, mellows out as hands and arms are used to shield contact with the person in front
 - less contact on breast, belly and crotch
 - still contacts on upper and lower back (with preceeding hands/arms)
- Contacts from kinematic instead of force data allow attribution



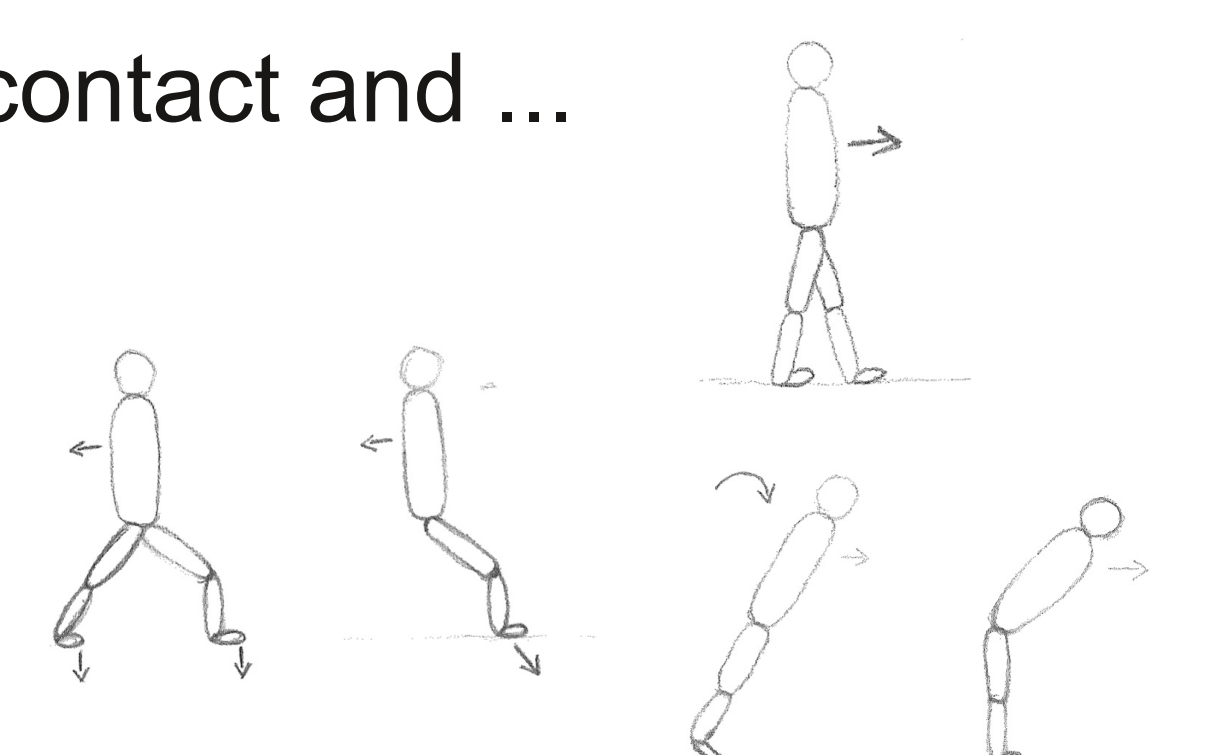
- Contacts of back and front of torso allow view on impulse propagation

Detect defensive movement?

- E.g. Who can use hands to shield themselves?
- Look at hand and torso contacts with next person
 - Hand first: P7, P8
 - Only hand: P9
 - Torso first; no shielding: rest

Outlook

- Find connections between areas of contact and ...
 - balance recovery strategy
 - strength of push/position in queue
 - relative height of participants
 - relative position of participants (in 2D formations)



Acknowledgement

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