

# Musculoskeletal-based upper limb force feasible set estimation

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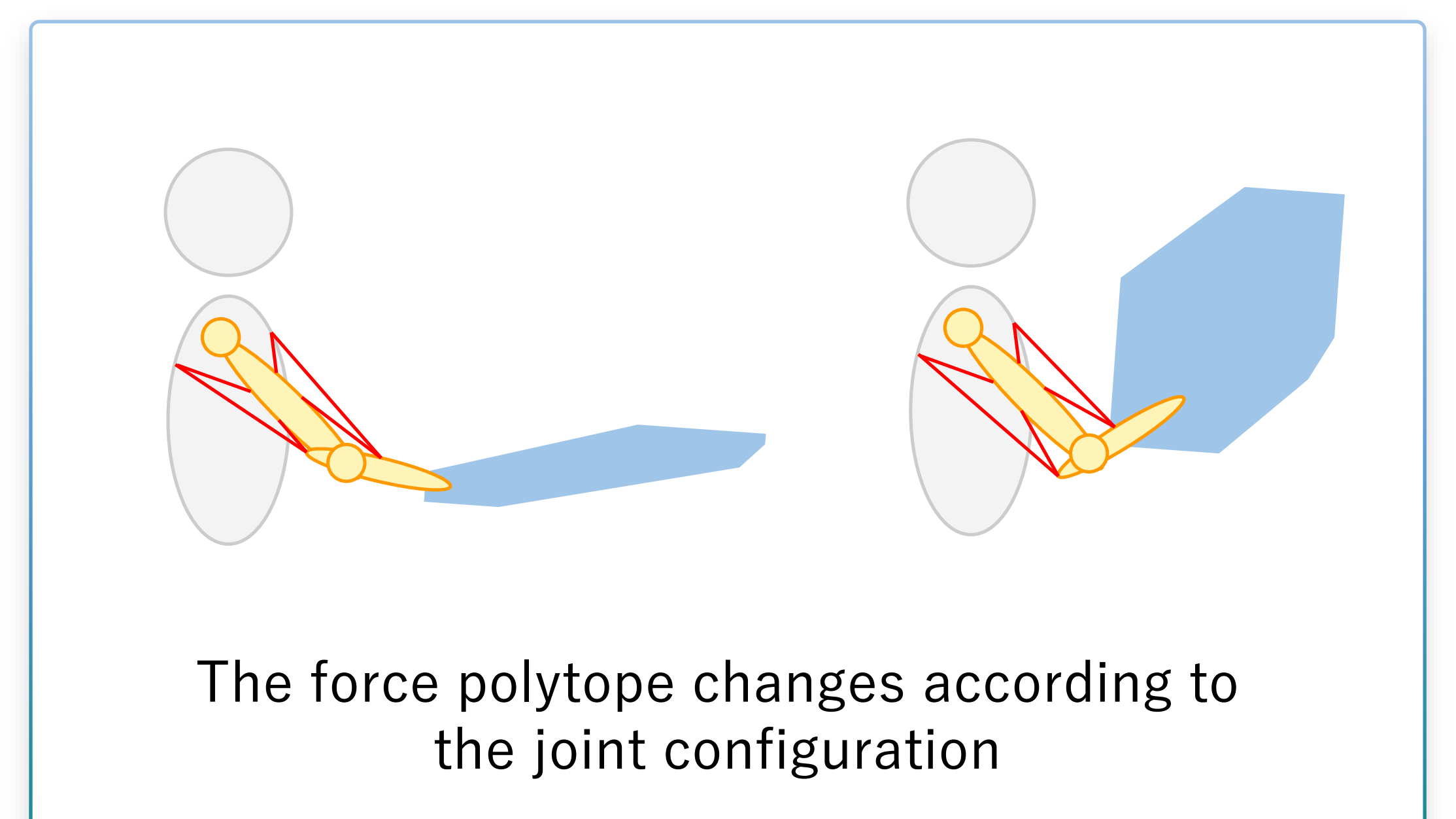
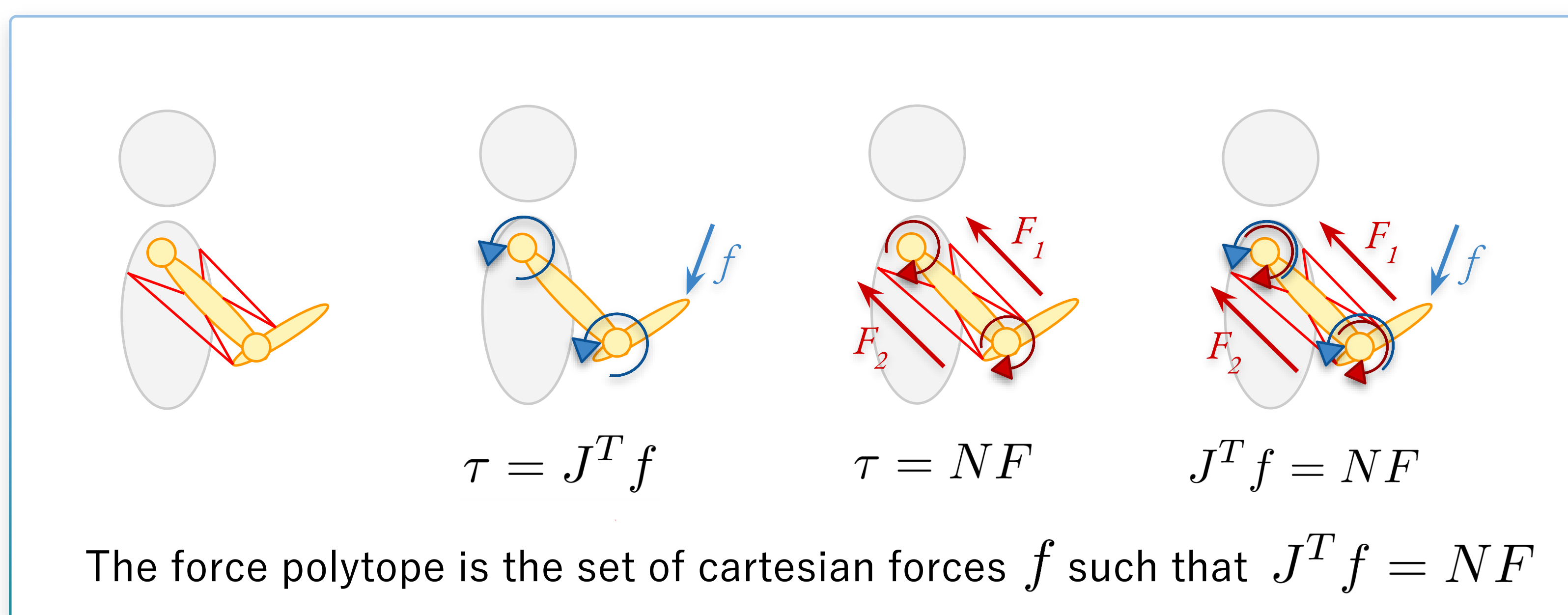
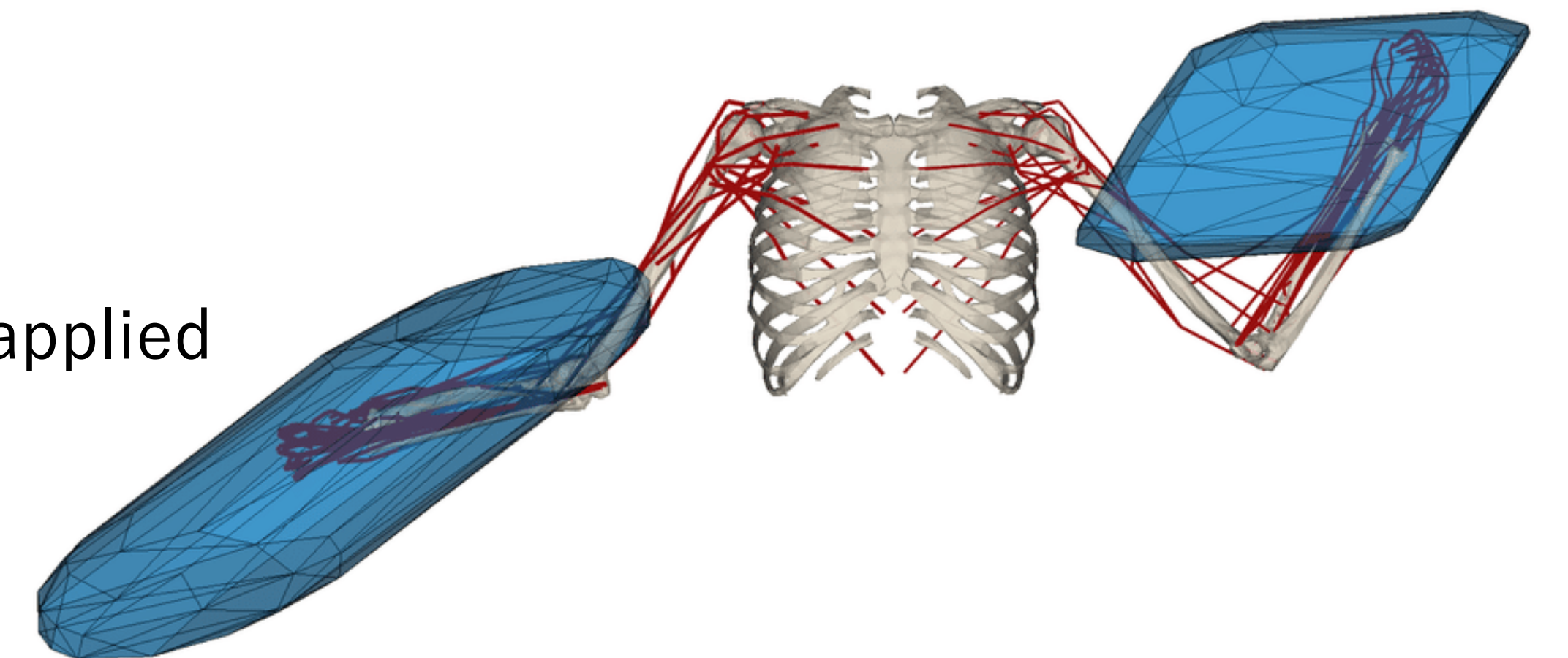
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## Thesis goal

Develop personalized musculoskeletal models which accurately represent the upper limb force capacities of a subject for given static postures. However, the force capacities are extremely sensitive to muscular parameters and to joint configurations.

## Force feasible set

The force capacities of an individual are the maximal forces which can be applied by the individual to the environment in any task space direction for a given static posture. Determined from a musculoskeletal model, the force feasible set is represented by a convex polytope called the **force polytope**.

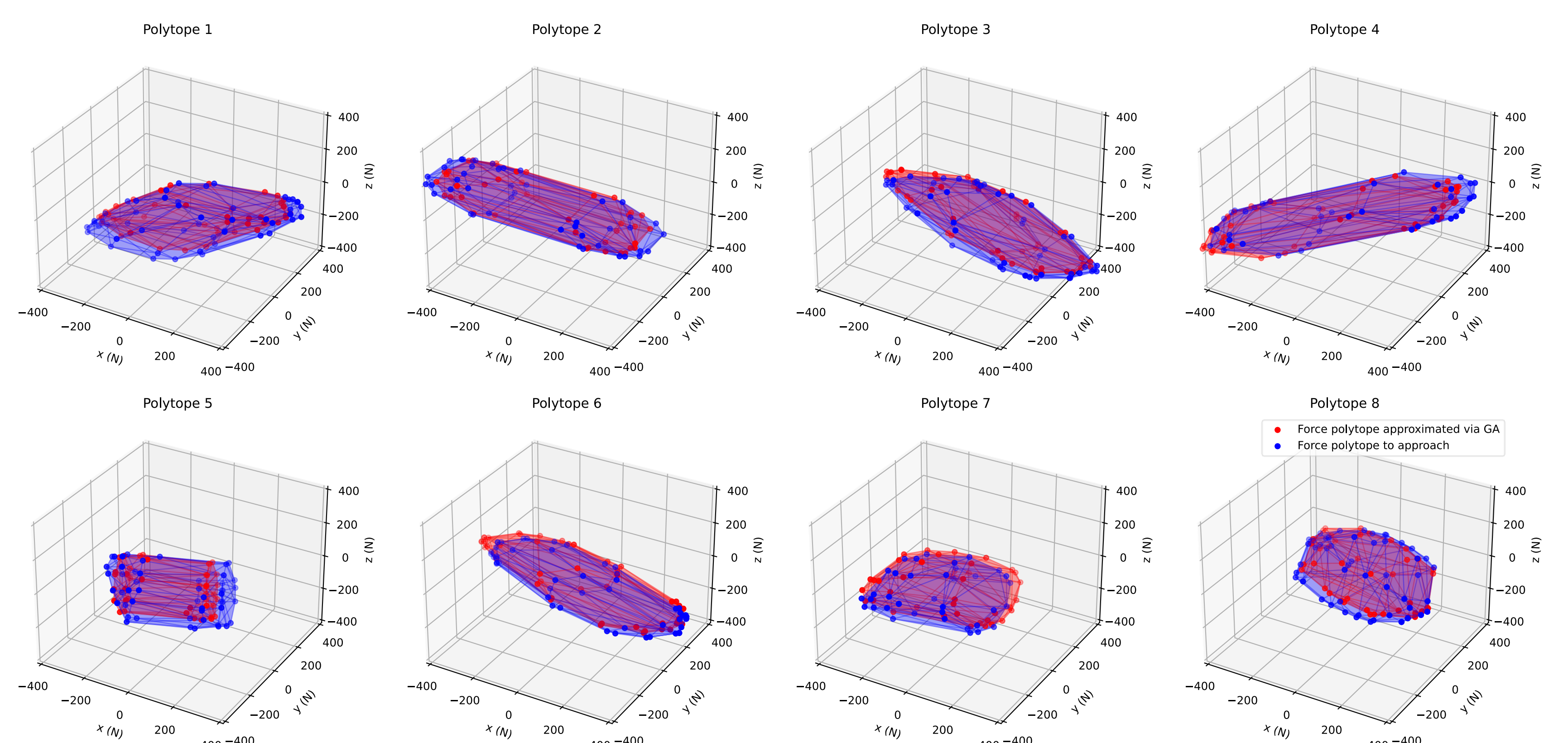
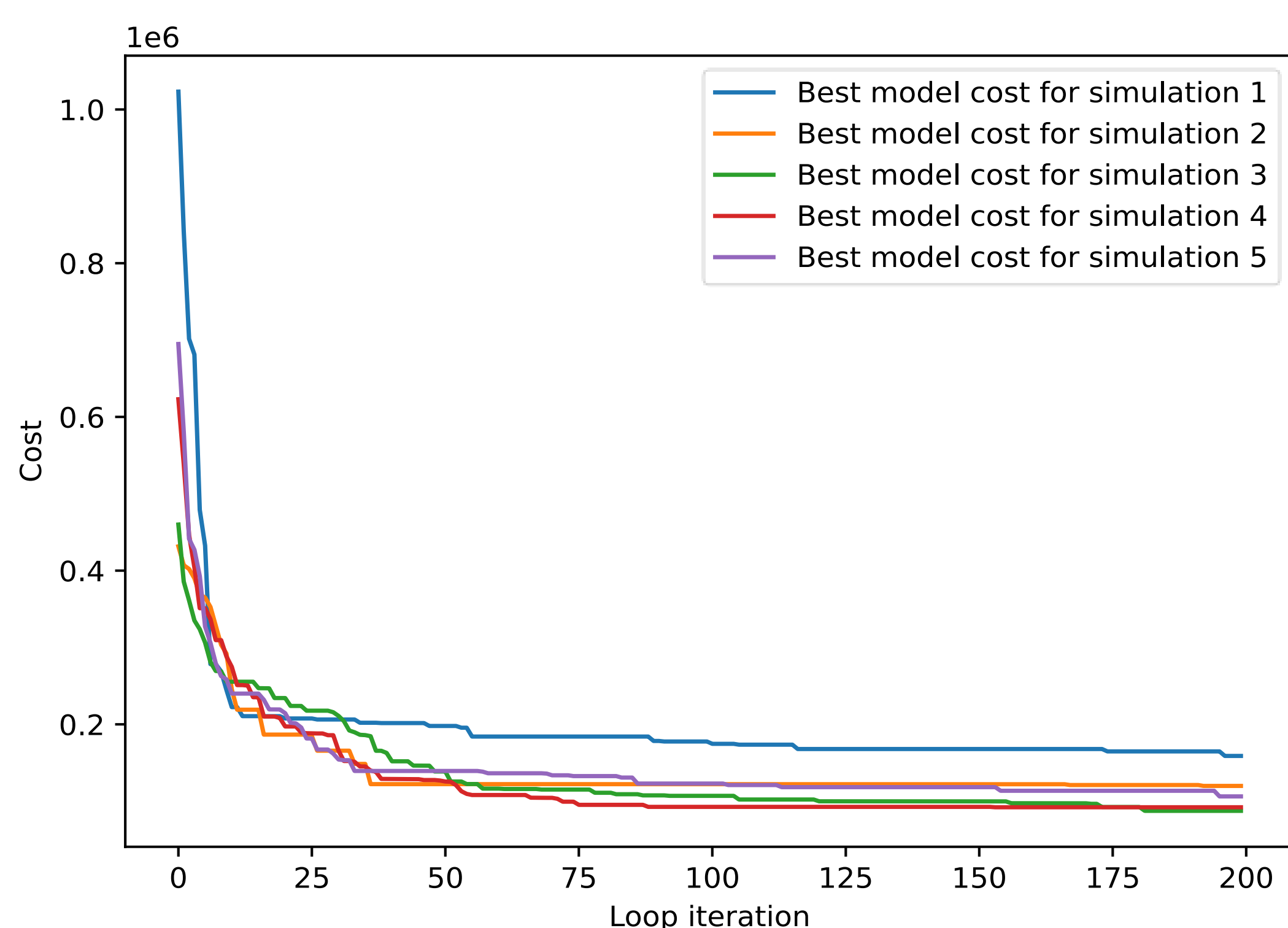


## Musculoskeletal model fitting

Can we retrieve a musculoskeletal model which would produce force polytopes measured experimentally on a subject?

### Genetic Algorithm (GA) approach

1. Create a population of random musculoskeletal models.
2. At each loop, compute a cost function for each model of the population.
3. Create a new population:
  - Keep the 3 best models such that the cost is minimized
  - Create 3 new weakly-perturbated models for each
  - Fill the rest by totally random musculoskeletal models.
4. Restart from step 2 with this new population.



This graph shows the cost evolution of each loop iteration's best model for different simulations. In each simulation, we try to find a MSK model which approximates 8 force polytopes generated by a random MSK model.

Comparison between the force polytopes created by the solution found by the GA (in red) to approximate the force polytopes of the MSK model in simulation 3 (in blue). Each force polytope corresponds to a different joint configuration.