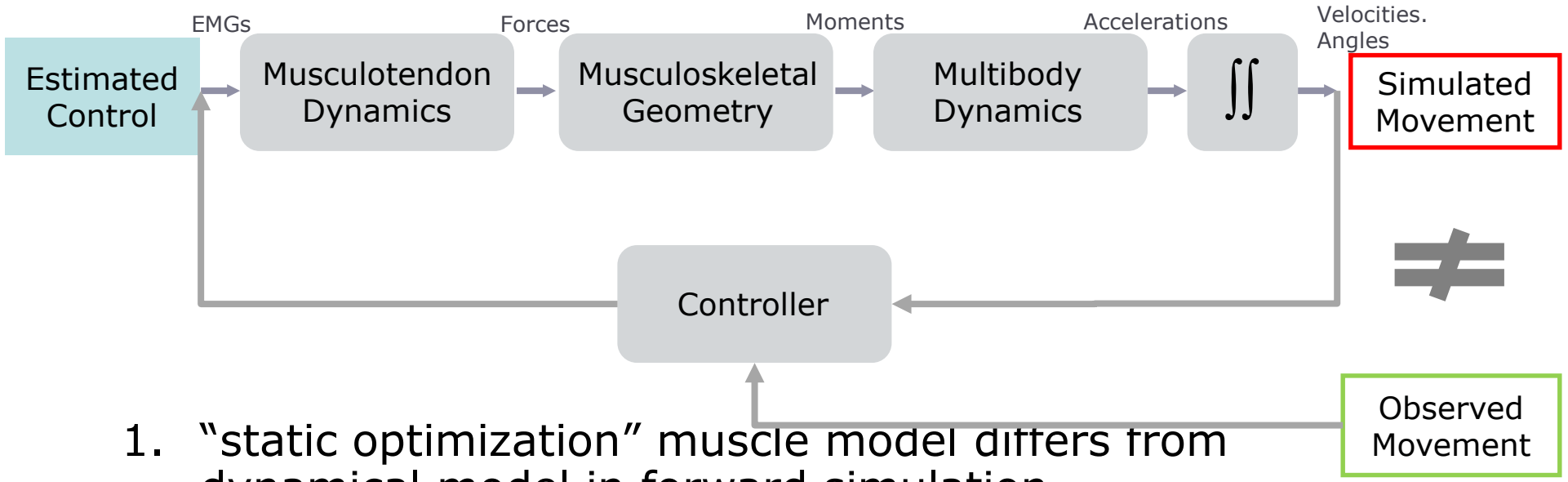
Behind Computed Muscle Control

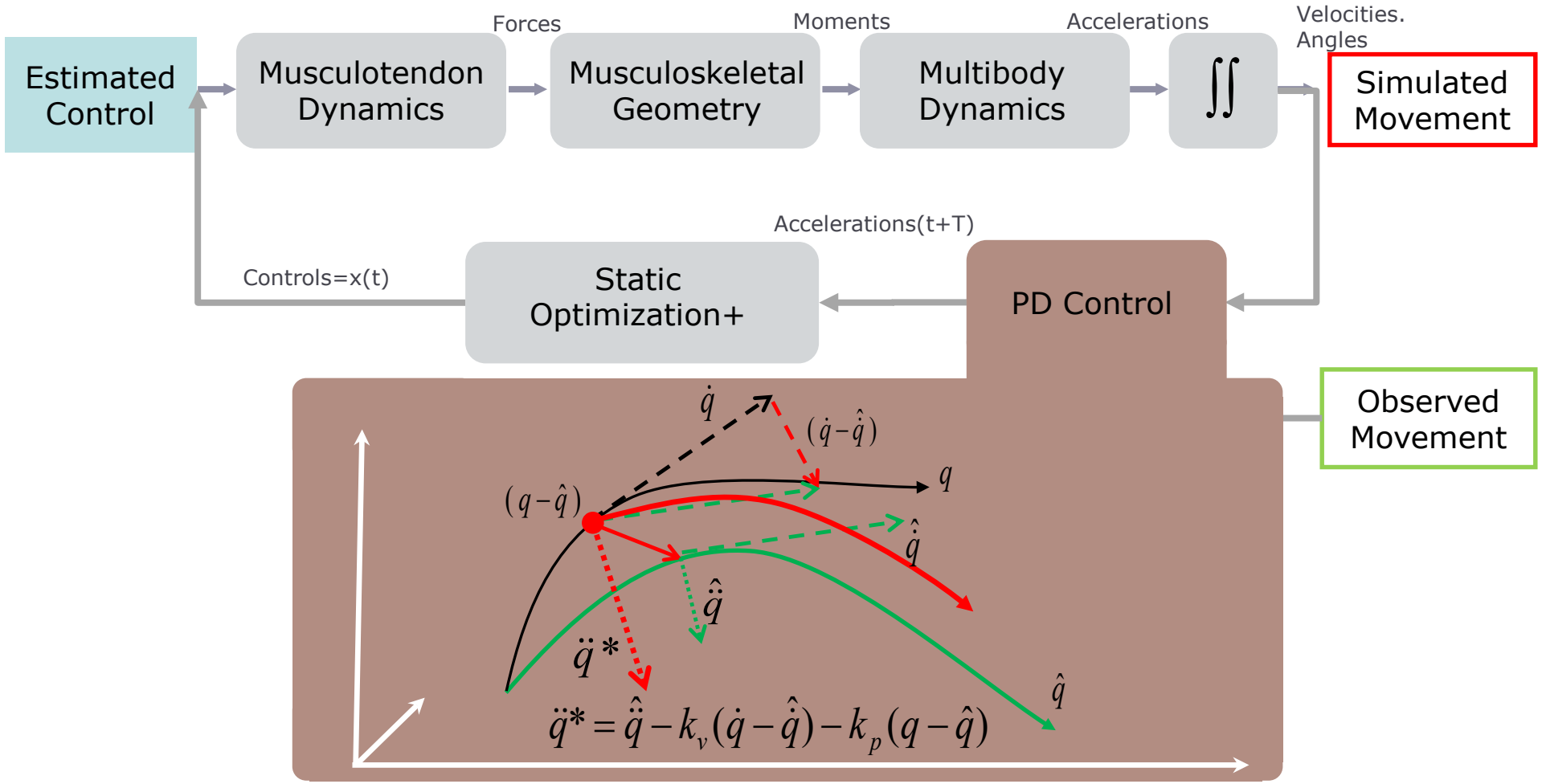
Muscle-Driven Forward Simulation



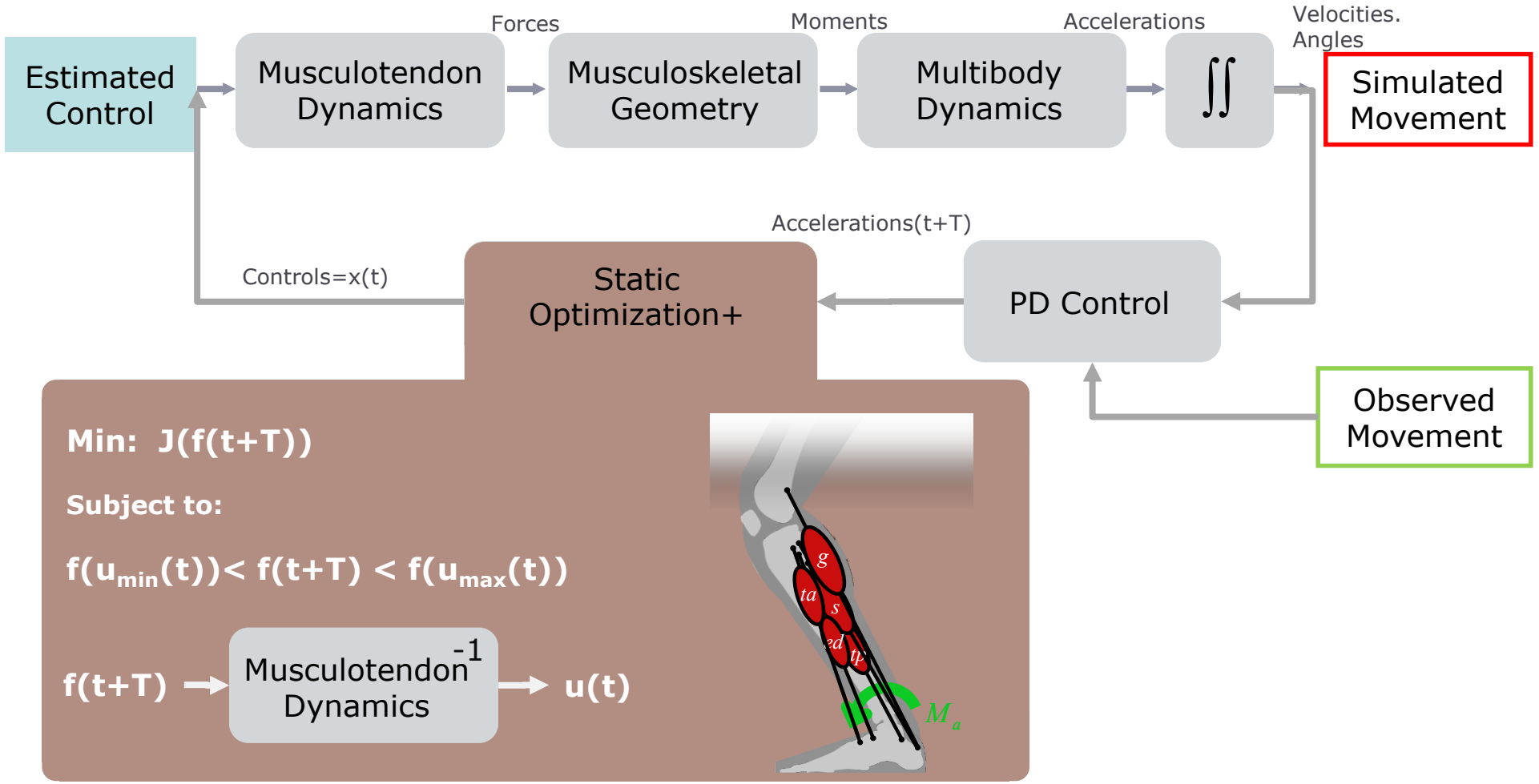
1. "static optimization" muscle model differs from dynamical model in forward simulation.
2. Acceleration data is discrete and noisy.
3. Numerical integration.

Solution: Close the loop!

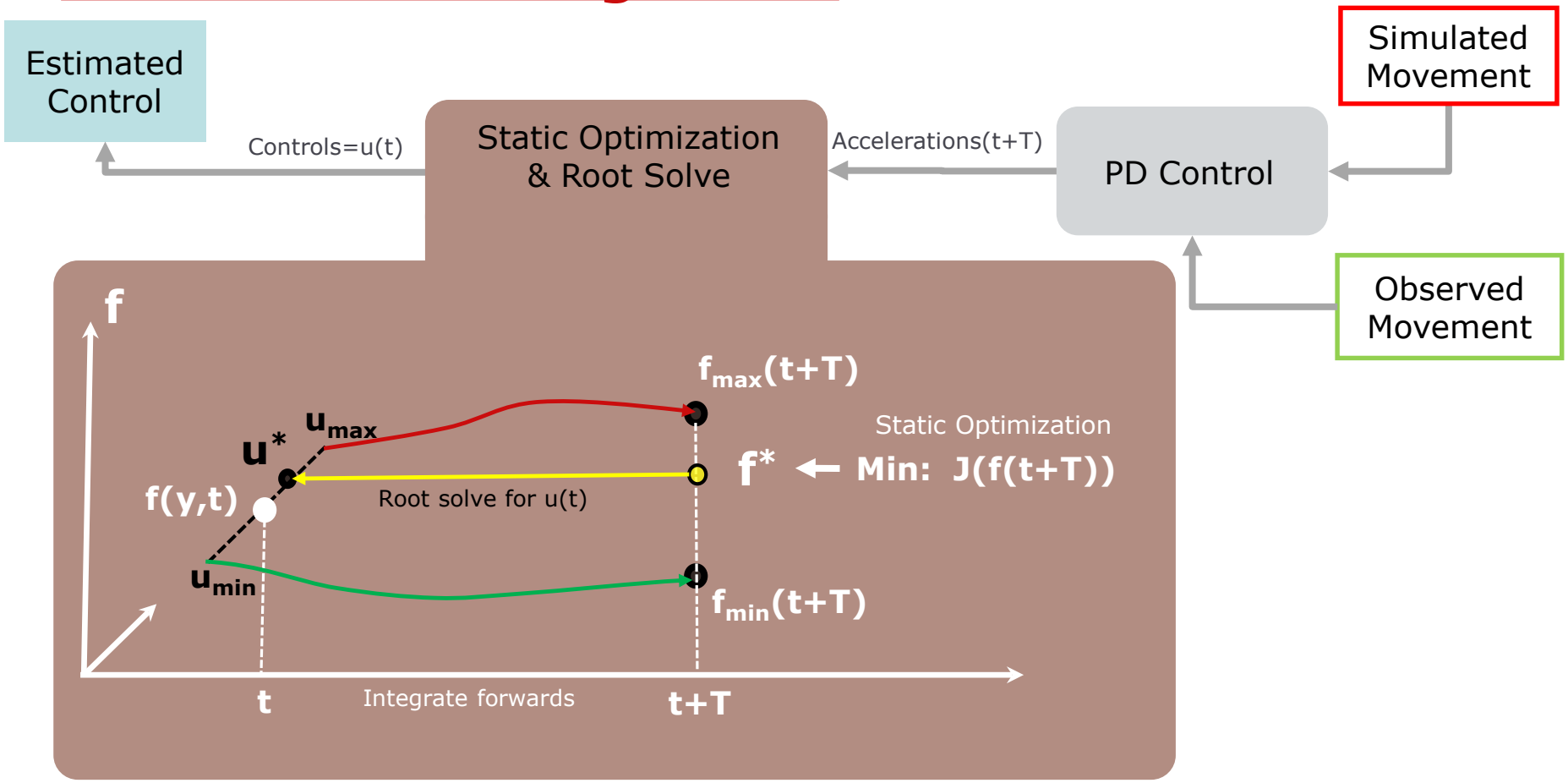
Computed Muscle Control (CMC)



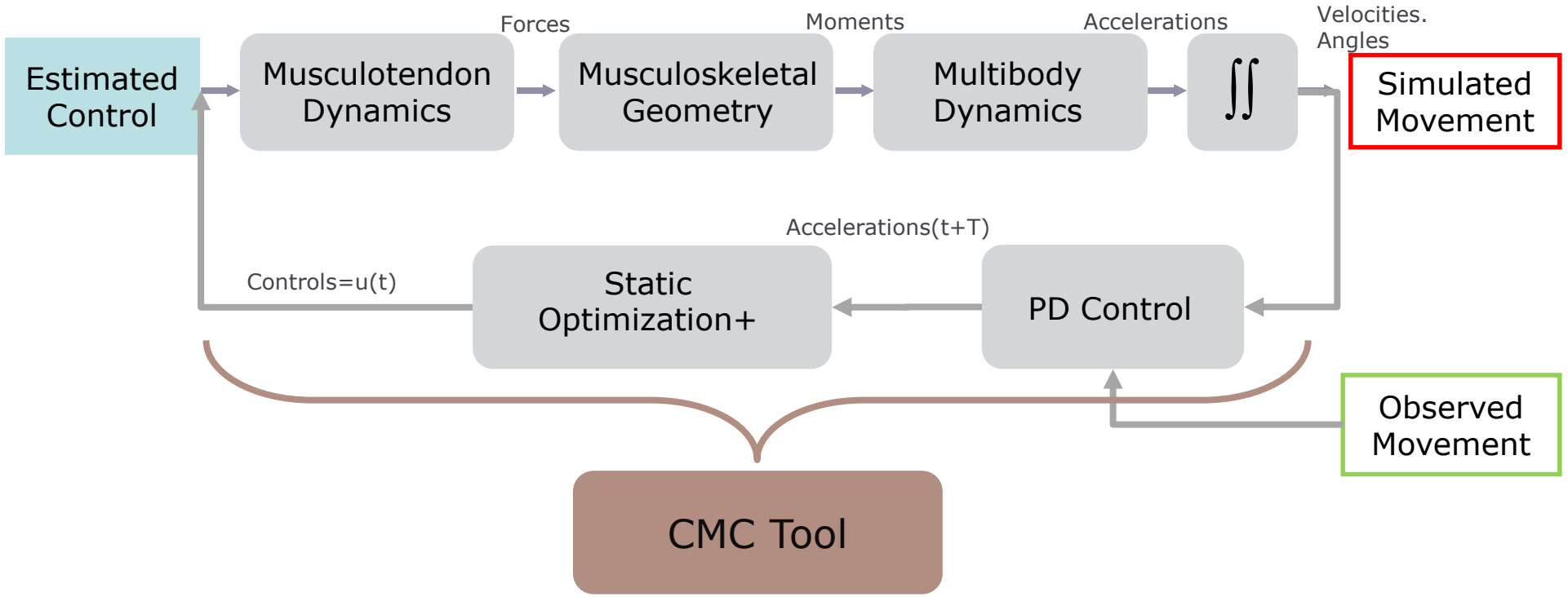
Computed Muscle Control (CMC)



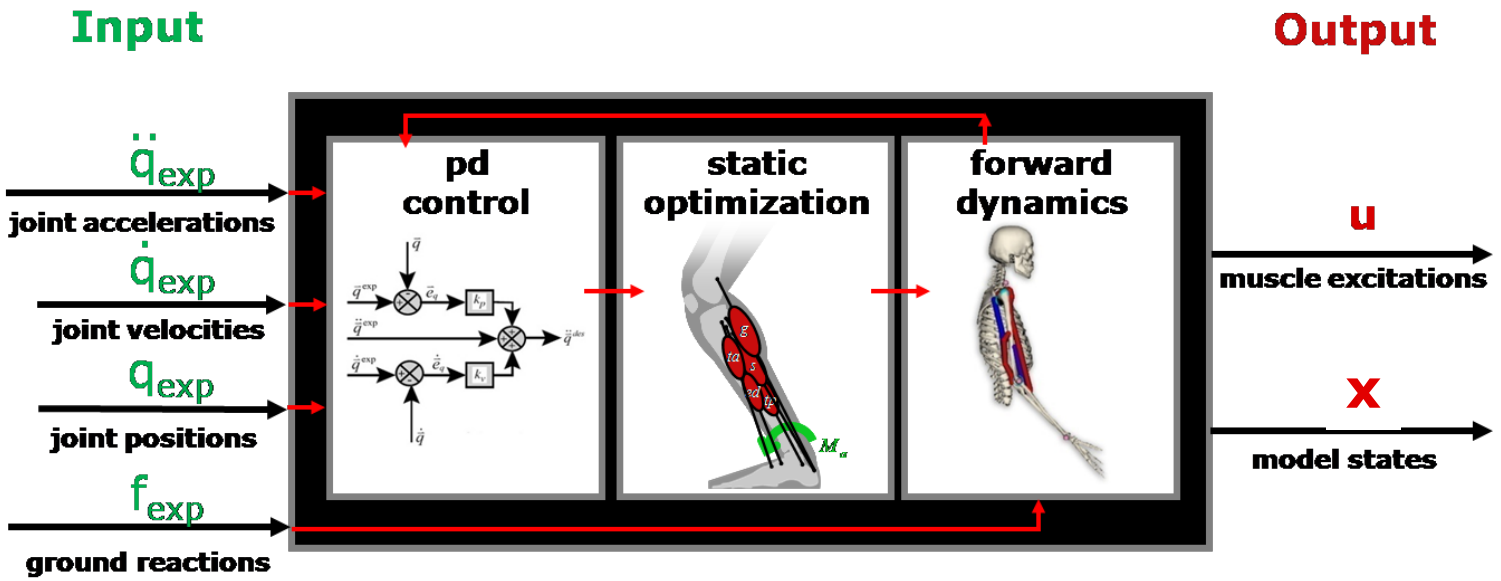
Inside the CMC Algorithm



Computed Muscle Control Tool:



Computed Muscle Control



TIPS & TRICKS
You can use results from IK or RRA. For best results, track RRA output not IK.
Increase max excitation of reserves if CMC is failing.
Compare to EMG and constrain excitations where there is a mismatch.
Command Line: cmc –S cmc_setup_file.xml

Our Experience with Computed Muscle Control

Use CMC to generate inputs for a forward simulation that tracks experimental data.

CMC does not globally optimize cost function.

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Solution is sensitive to initial time simulation.

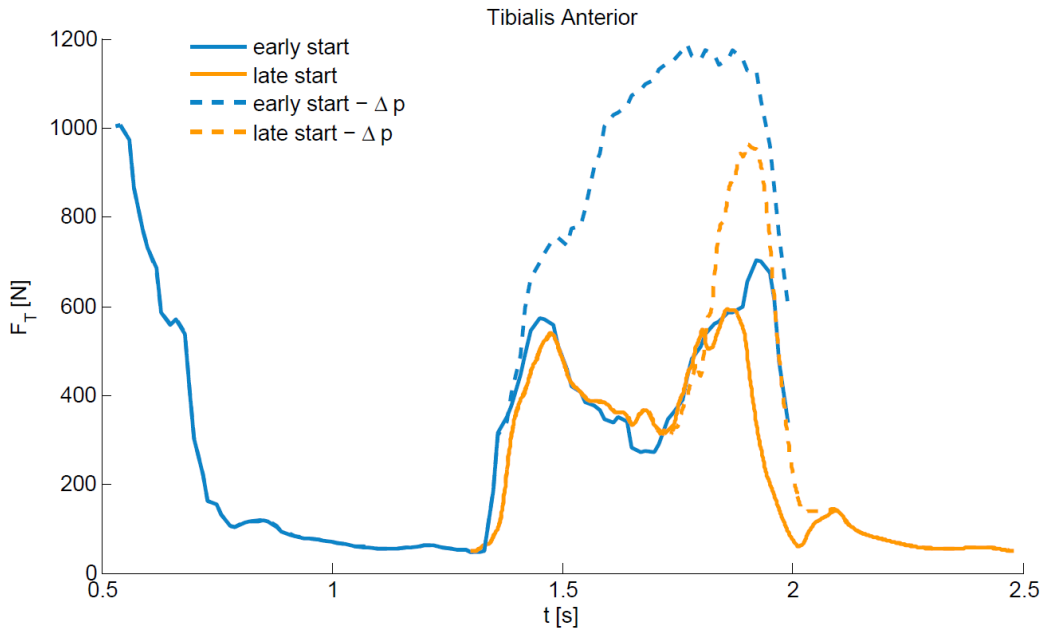

Figure from Wesseling (2014), J Biomech 47: 596–601

Demo

OPENSIM_INSTALL\Resources.zip\Models\Gait2392_Simbody

Evaluating your results:

- See table.
- Compare simulated activations to experimental EMG data (either recorded from your subject or from the literature)

Thresholds:	GOOD	OKAY	BAD
MAX Residual Force (N)	0-10 N	10-25N	> 25 N
RMS Residual Force (N)	0-10 N	10-25 N	> 25 N
MAX Residual Moment (Nm)	0-50 Nm	50-75 Nm	>75 Nm
RMS Residual Moment (Nm)	0-30 Nm	30-50 Nm	>50 Nm
MAX pErr (trans, cm)	0-1 cm	1-2 cm	>2 cm
RMS pErr (trans, cm)	0-1 cm	1-2 cm	>2 cm
MAX pErr (rot, deg)	0-2 deg	2-5 deg	> 5 deg
RMS pErr (rot, deg)	0-2 deg	2-5 deg	> 5 deg
MAX Reserve (Nm)	0-25 Nm	25-50 Nm	> 50 Nm
RMS Reserve (Nm)	0-10 Nm	10-25 Nm	> 25 Nm