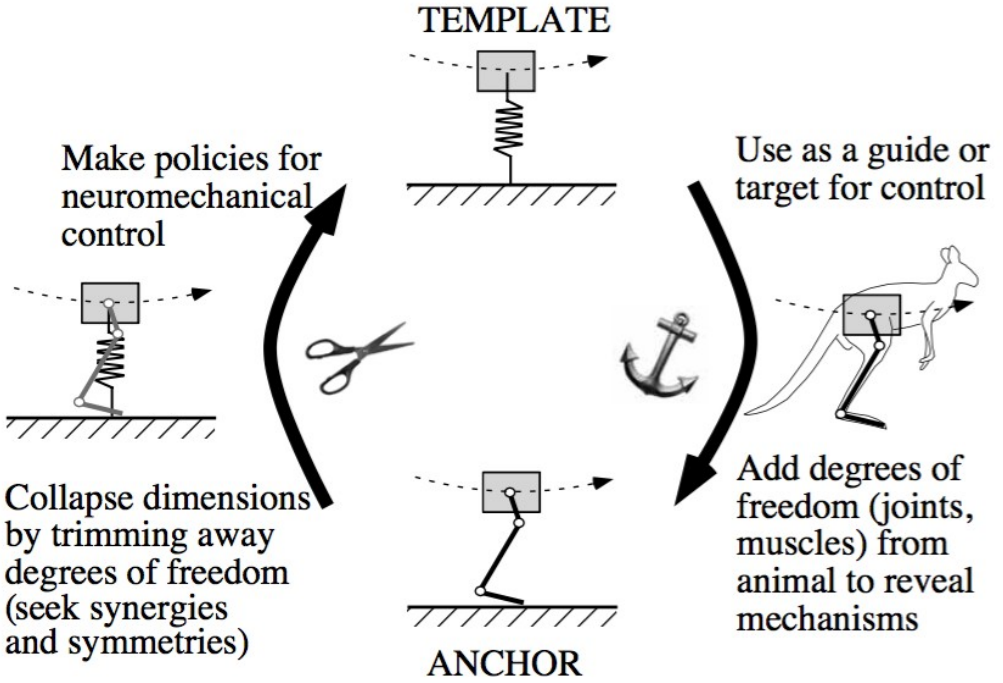
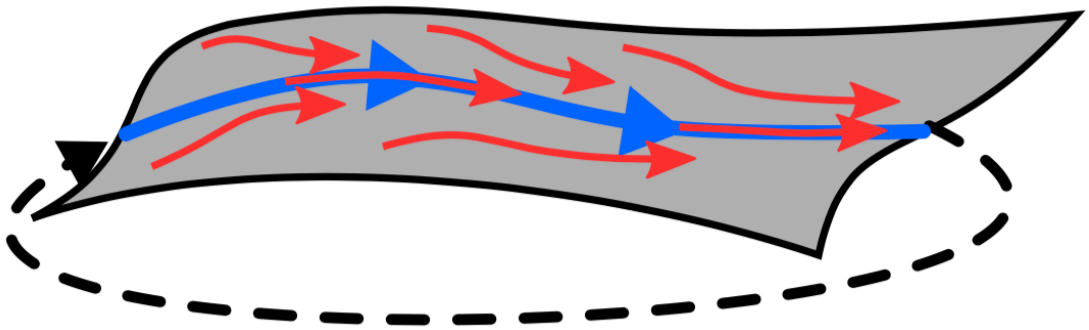
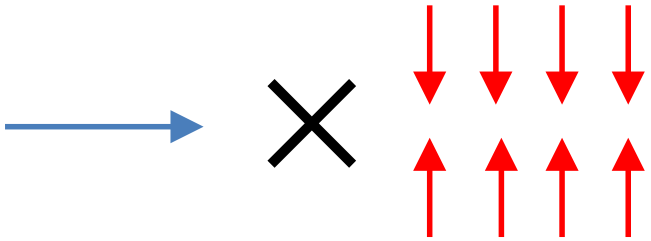
# Templates and anchors (recap from 2.1)

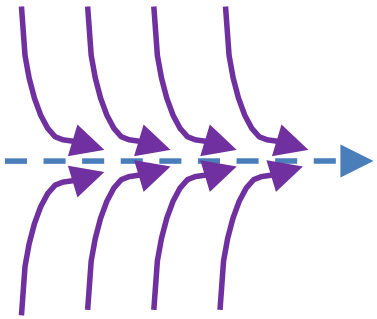
From Full and Koditschek [1999]



Anchoring is a parallel composition!

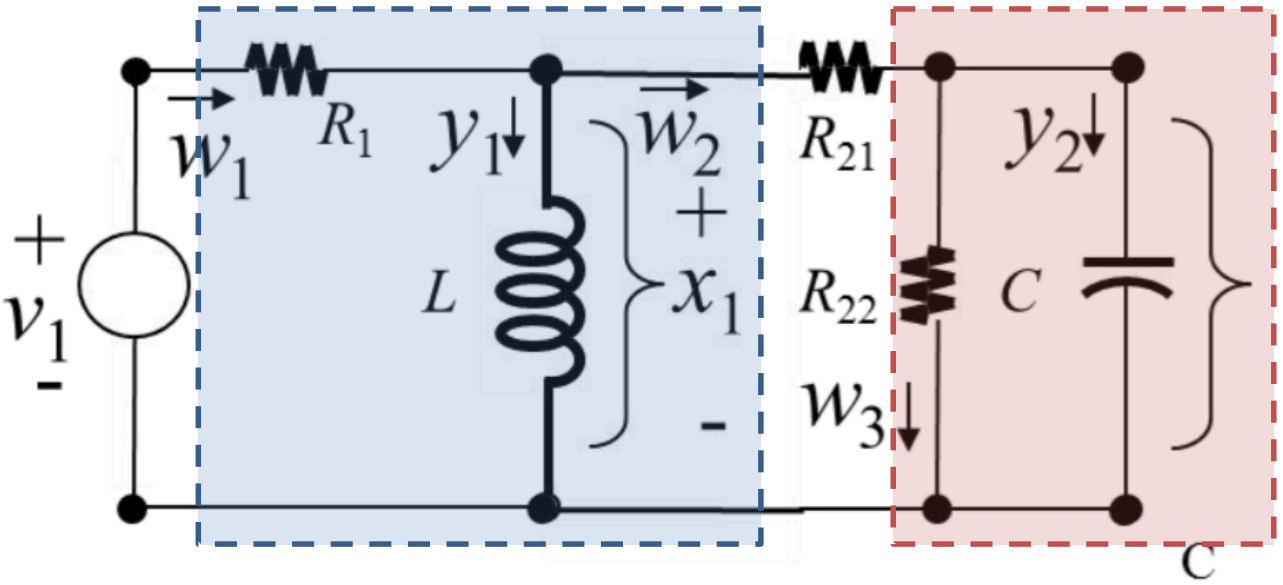


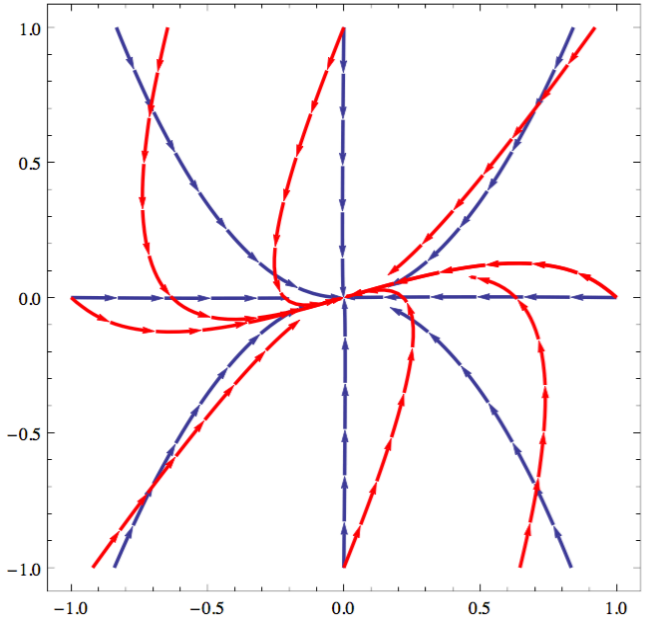


Template

Anchoring dynamics

# Decoupled vs. coupled systems

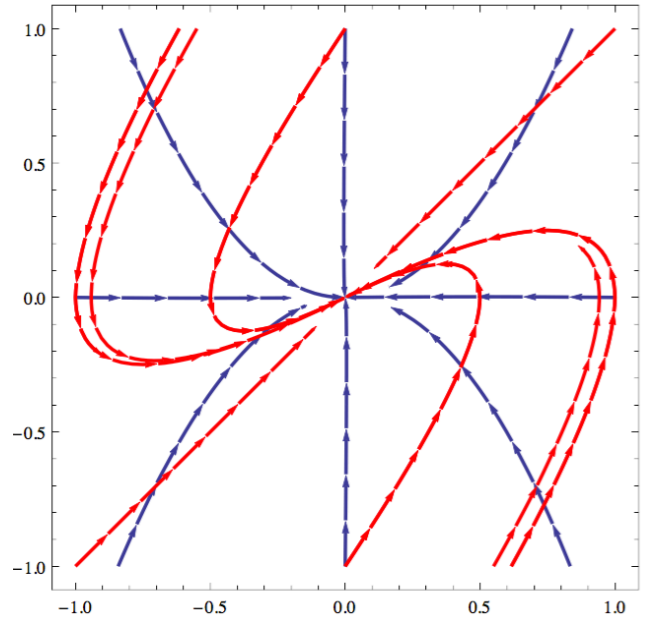



$R_{21} \to \infty$

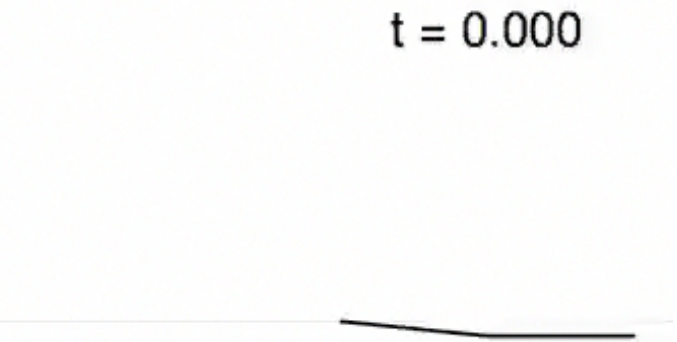
- Physical decoupling (circuit disconnected)
- Solutions decoupled (diagonal $A$)

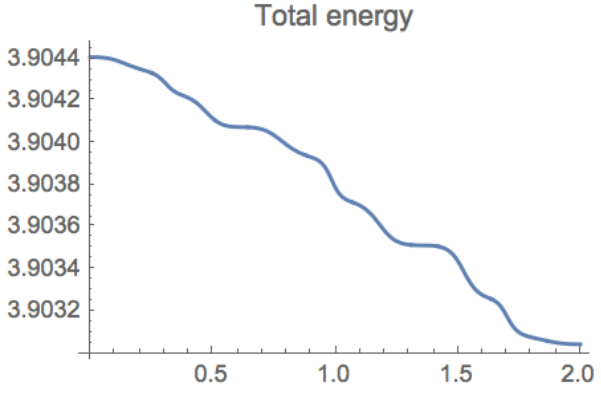
$$\dot{x} = Ax = \begin{bmatrix} A_{11} & 0 \\ 0 & A_{22} \end{bmatrix} x$$

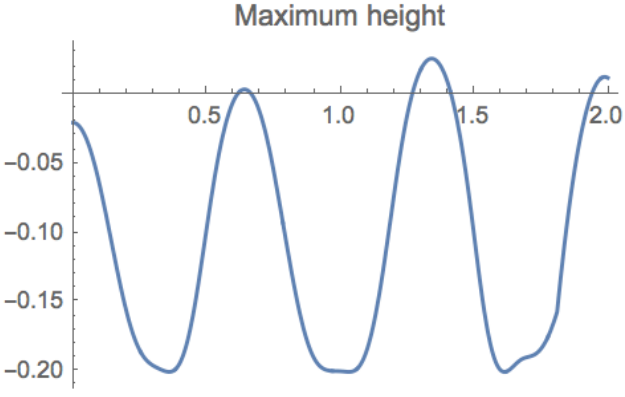


# Cross-talk in mechanical systems

- Double pendulum
- Controller is gravity + natural damping
- "Template:" decaying oscillator

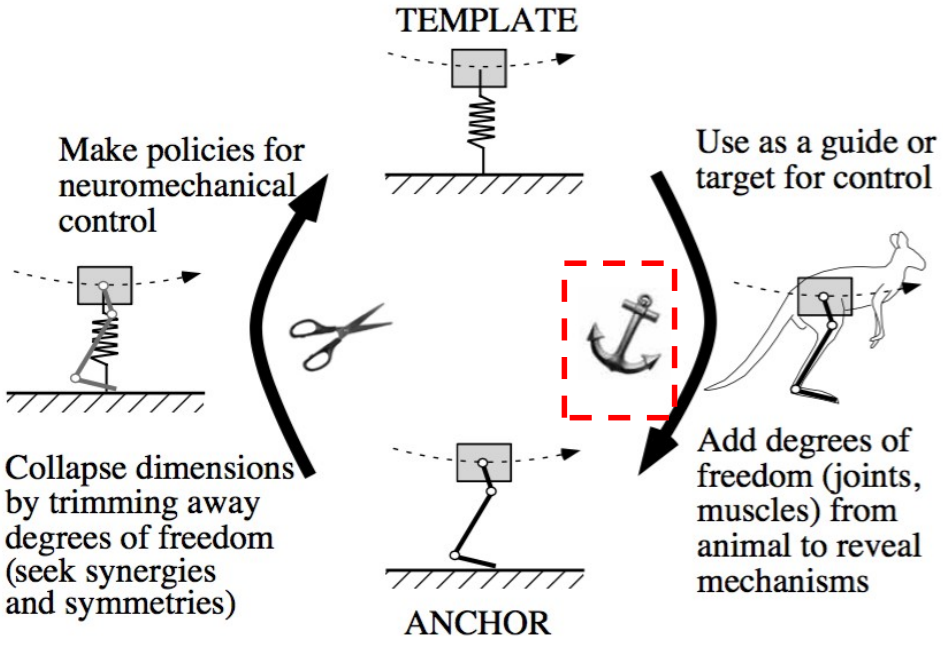


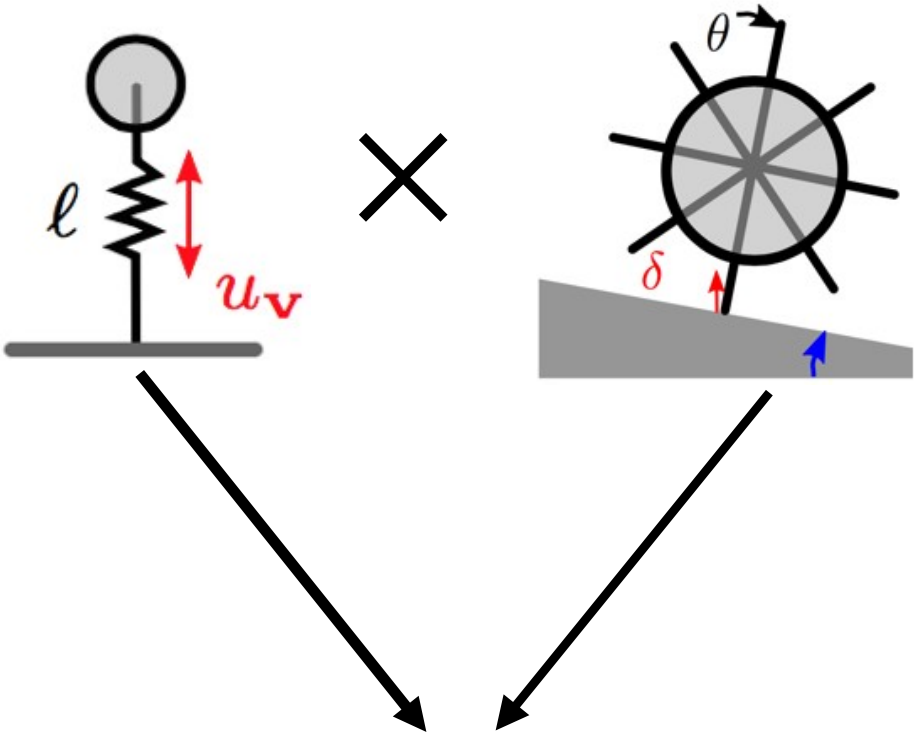



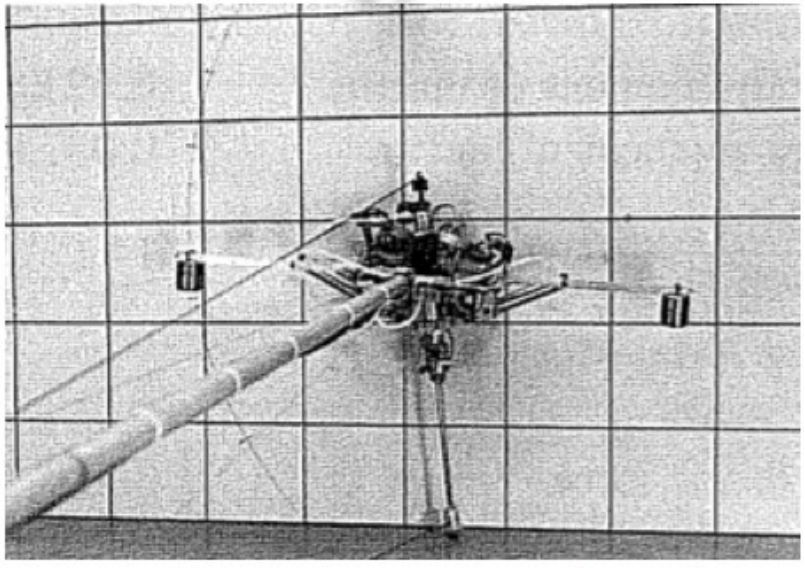
# Synthetic view of anchoring

From Full and Koditschek [1999]



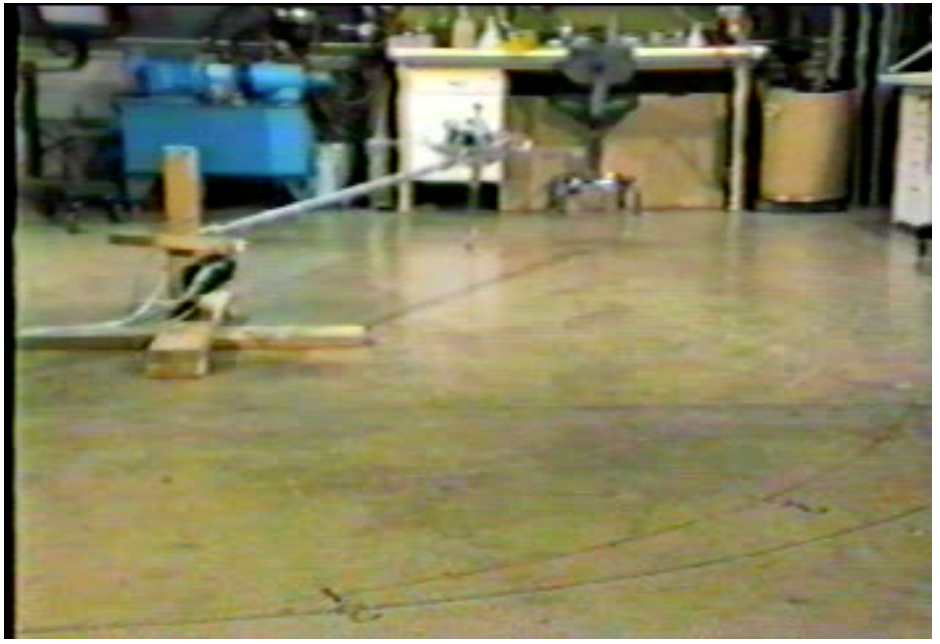




- Map *controllers* T → A
- Anchor multiple templates in parallel
- Decoupled controllers
- Conditions for correctness



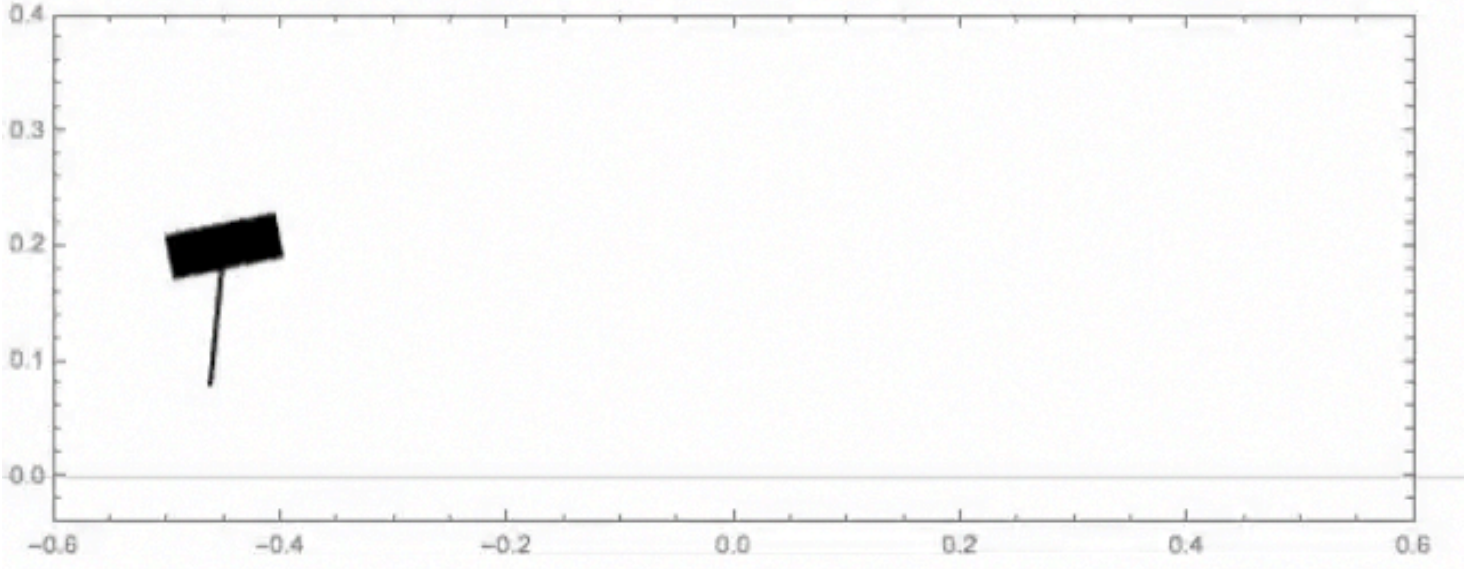
# Empirical parallel compositions – Raibert hopper

From Raibert [1986]

Body:leg inertia

- 14:1 (Raibert)
- 7:1 (10 g)
- 1:1 (70 g)



# Summary

- On a high DOF robot, there is no alternative to thinking about either parallel composition, or preflexes
- Coupling forces try to screw us up
- Parallel composition = "anchoring multiple templates simultaneously with decoupled controls"
- Verification is important, but also difficult