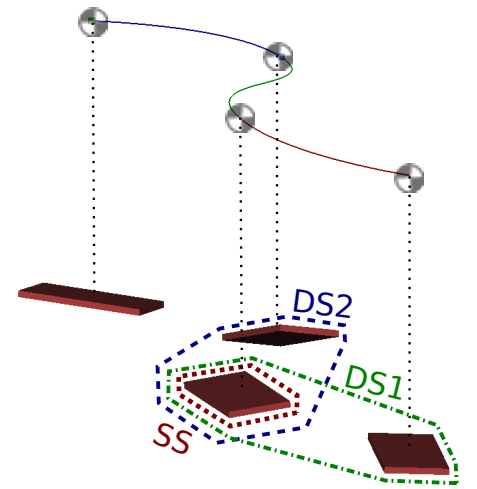
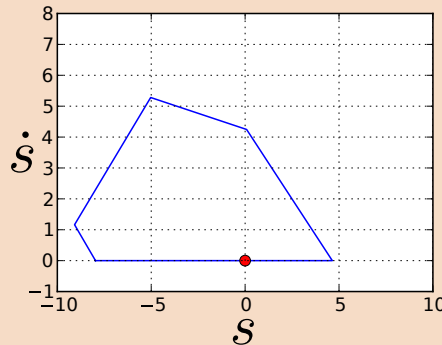


# 2 — MPC by Time-optimal Retiming

Caron & Pham — Humanoids 2017

## Contact stability

Polyhedral projection  
of the Contact Wrench Cone  
into an **Phase-space TOPP-polygon**



## Predictive

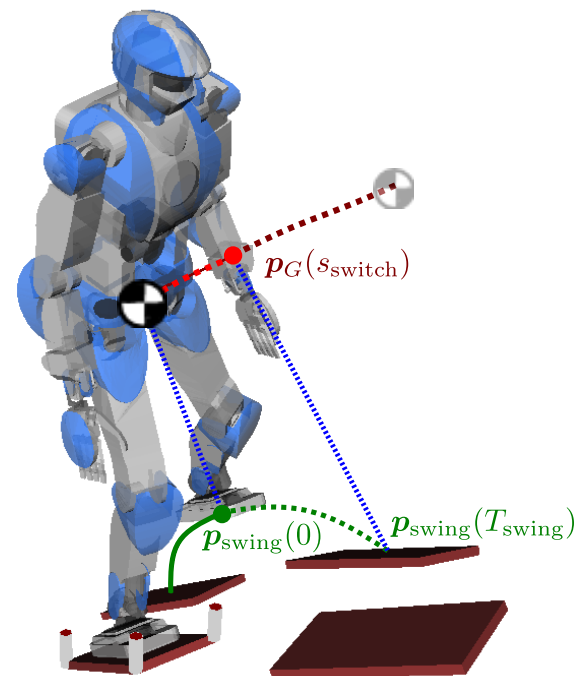
Path interpolation for COM :  $\mathbf{p}_G(s)$

Path interpolation for swing foot trajectory :  $\mathbf{p}_{\text{swing}}(s)$

**Contact stability constraints** are linear:  $\ddot{s}\mathbf{a}(s) + \dot{s}^2\mathbf{b}(s) + \mathbf{c}(s) \leq \mathbf{0}$

## Automatic step timing

- Retime swing foot trajectory by TOPP:
  - Contact switch constraint  $t_{\text{switch}} \geq T_{\text{swing}}$
  - Retime COM trajectory by TOPP
- Overall optimization: hierarchical TOPP problem



## Limitations

(1) Feasibility depends upon path interpolation (2) Bang-bang controls



<https://github.com/stephane-caron/topp-mpc/>