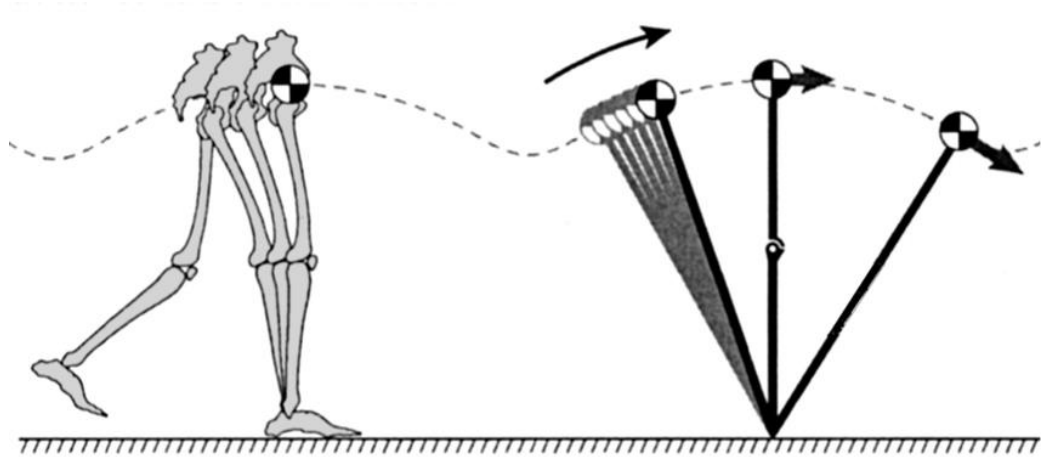
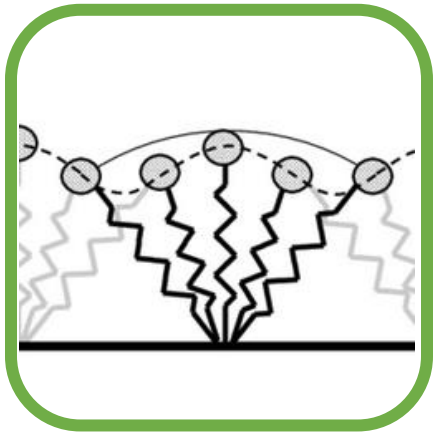
Template-based locomotion

Nicolas Mansard

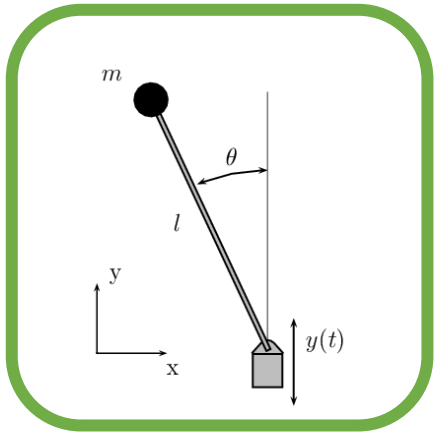
Gepetto
LAAS-CNRS & ANITI



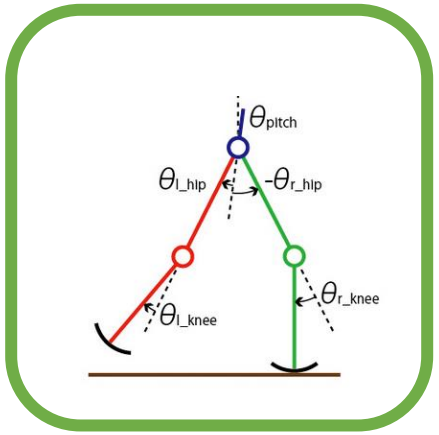
Modèles réduits



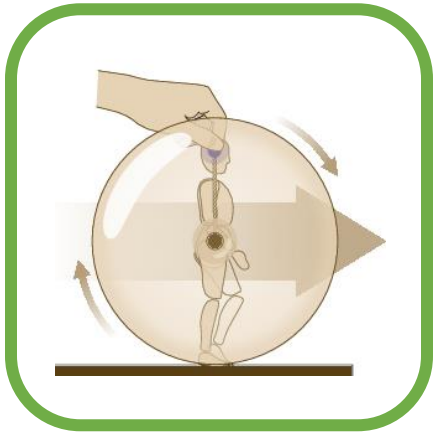
Spring Linear Inverted Pendulum (SLIP)



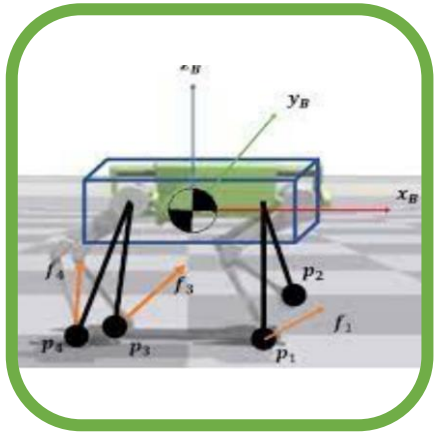
Linear Inverted Pendulum Model (LIPM)



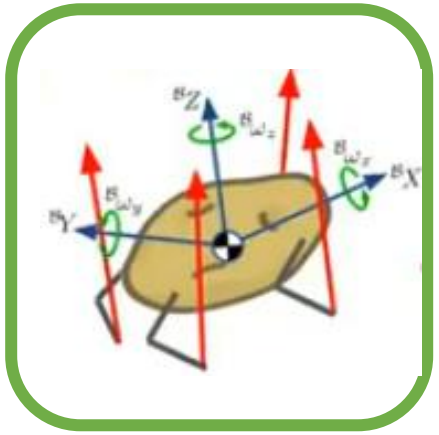
Three masses model



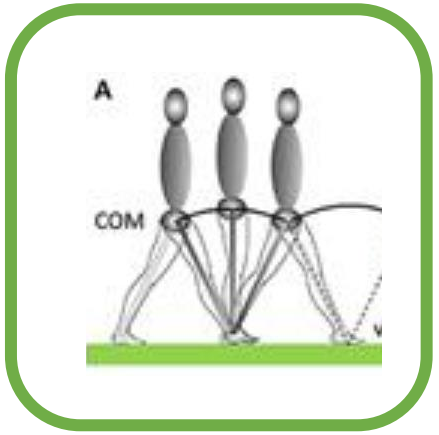
Yoyo-men



Stick legs

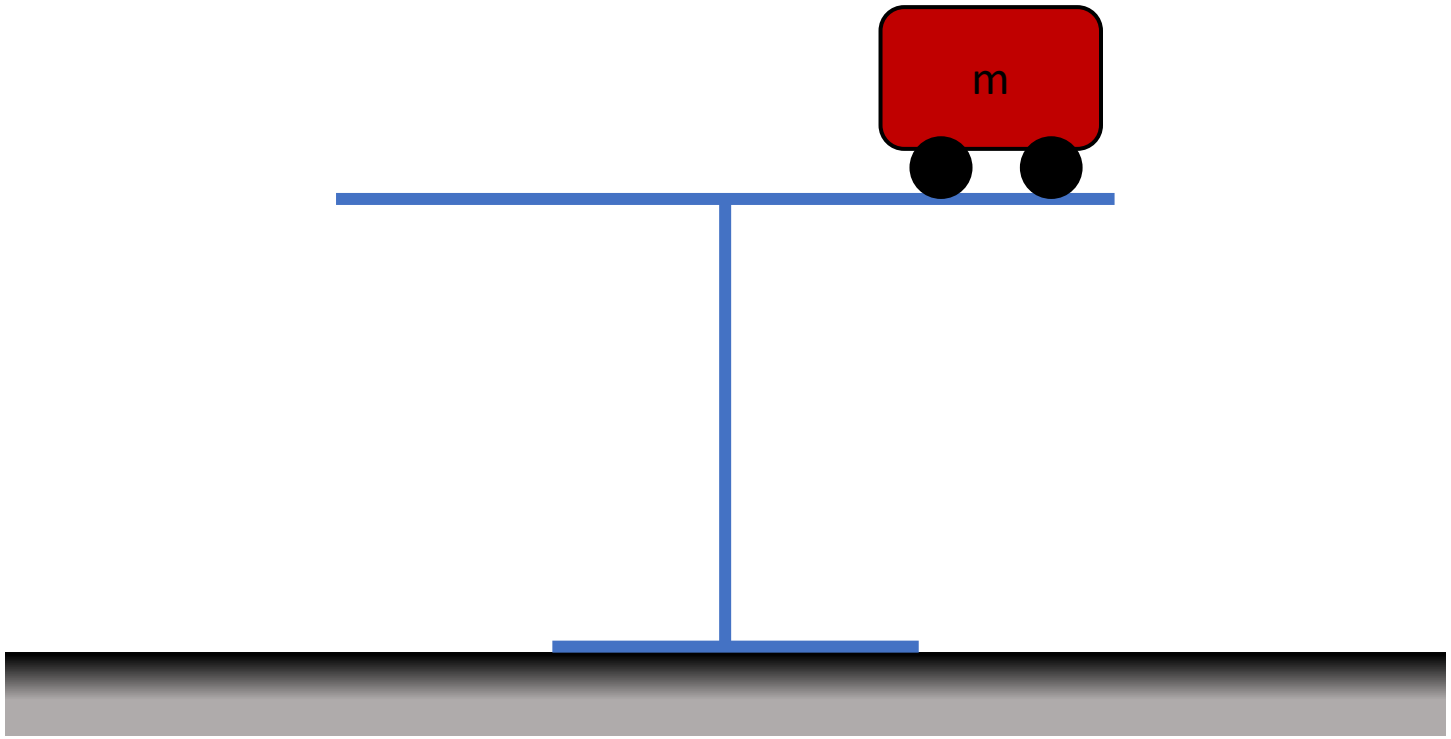


Flying potatoe



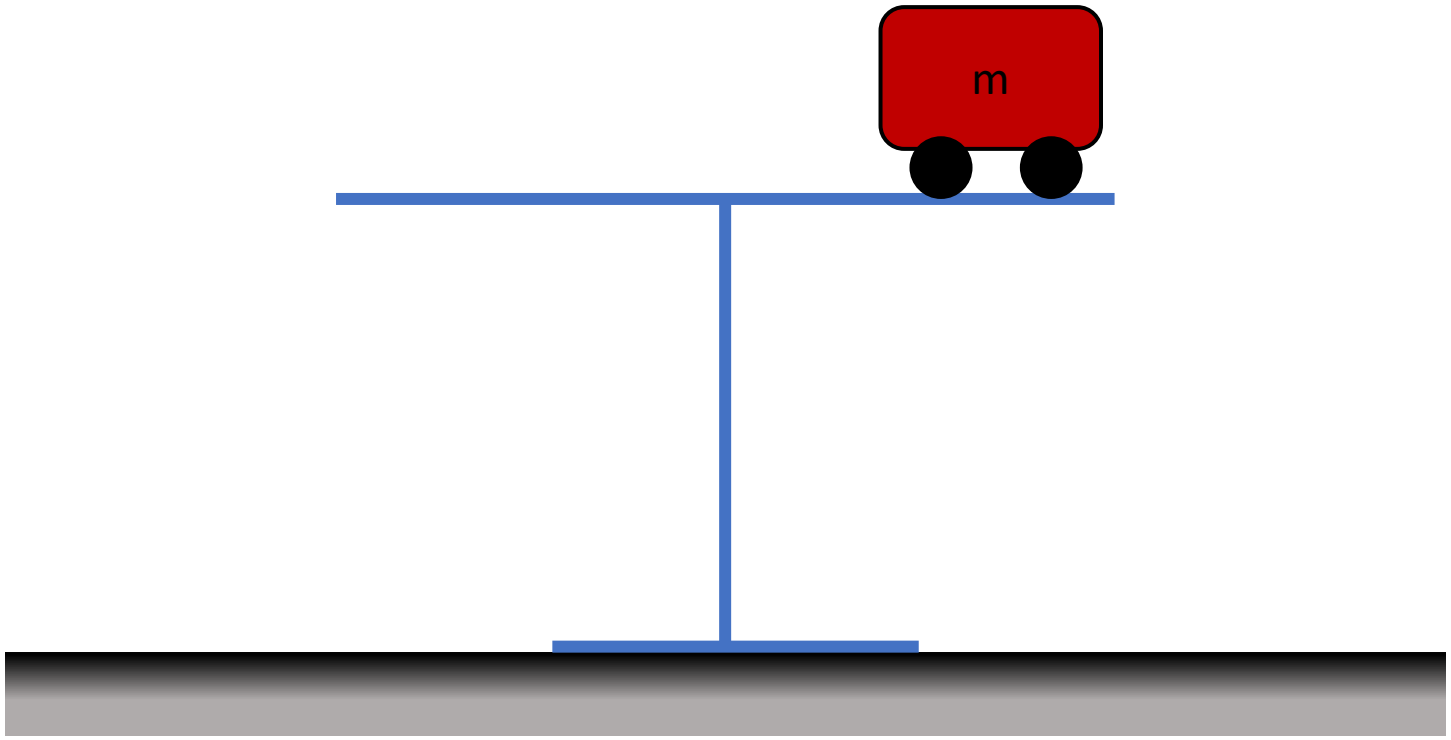
Biomechanical

Le « chariot sur la table »



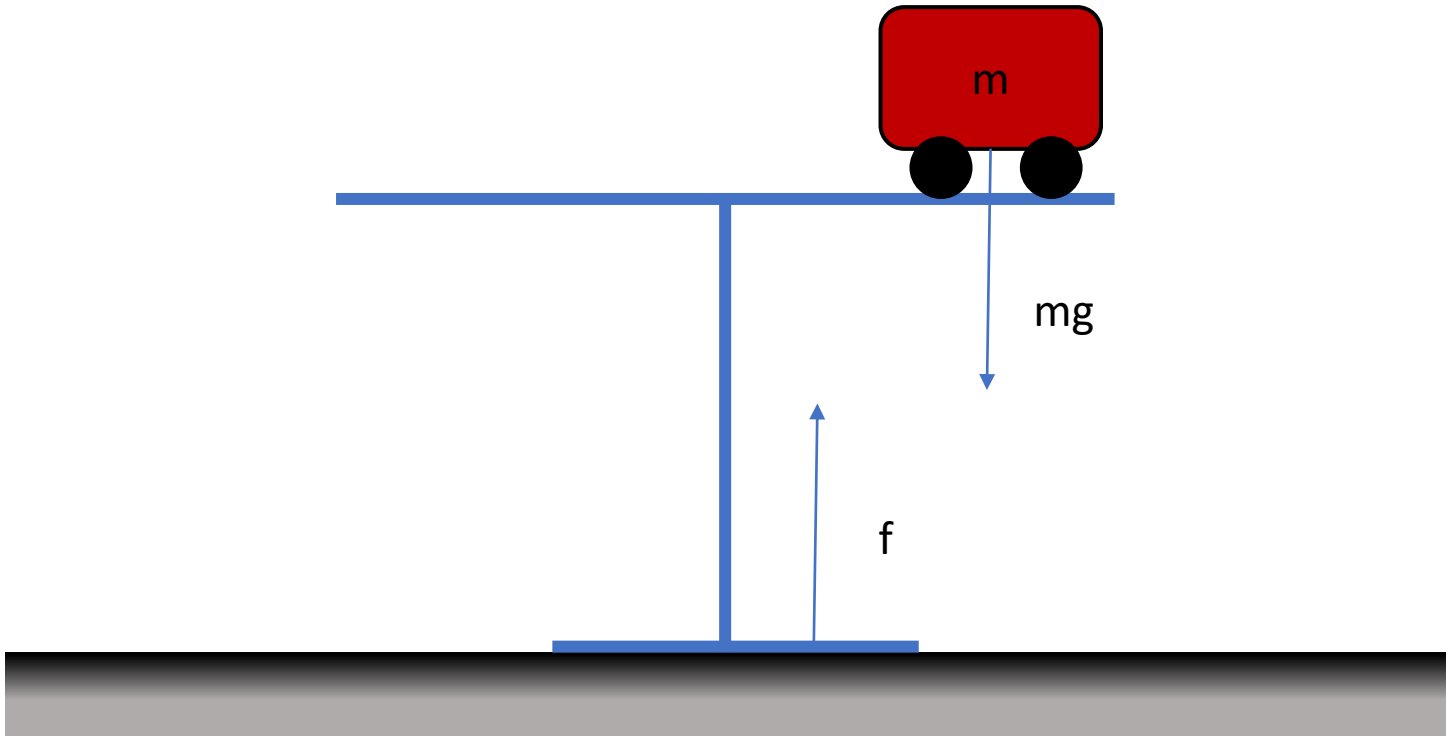
Le « chariot sur la table »

Direction verticale



Le « chariot sur la table »

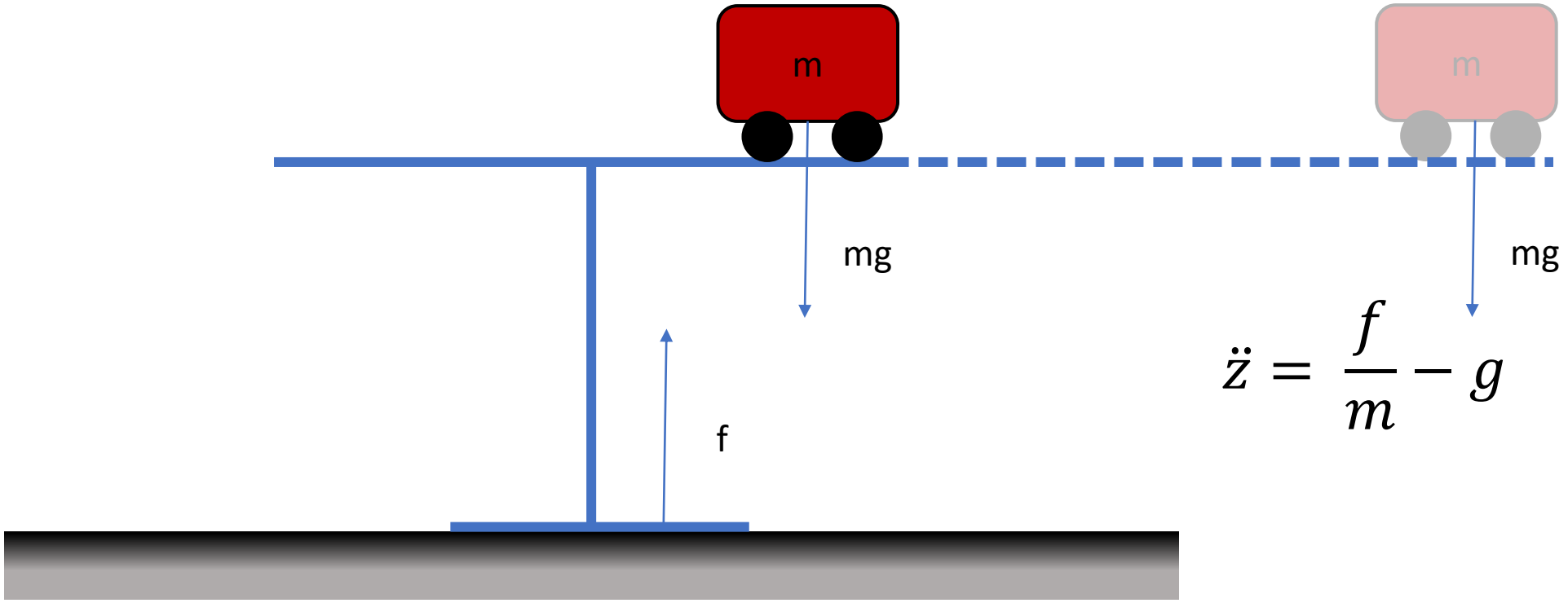
Direction verticale



$$\ddot{z} = \frac{f}{m} - g$$

Le « chariot sur la table »

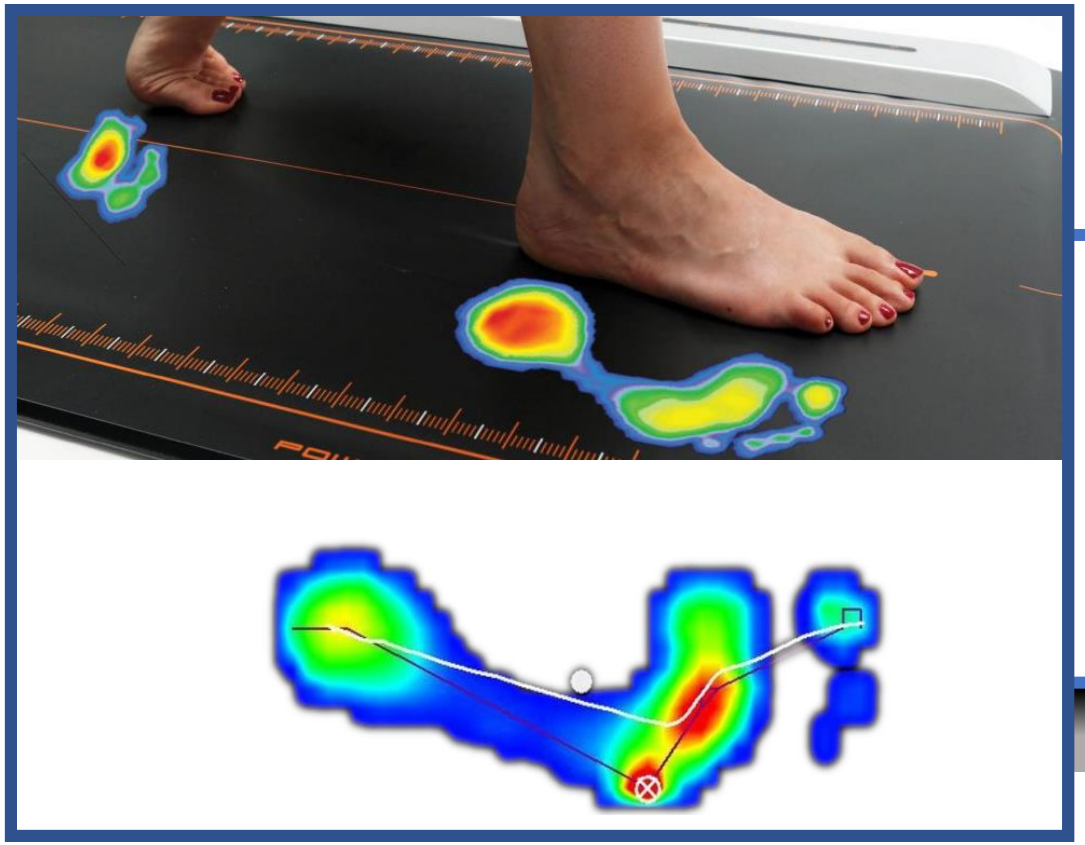
Direction verticale

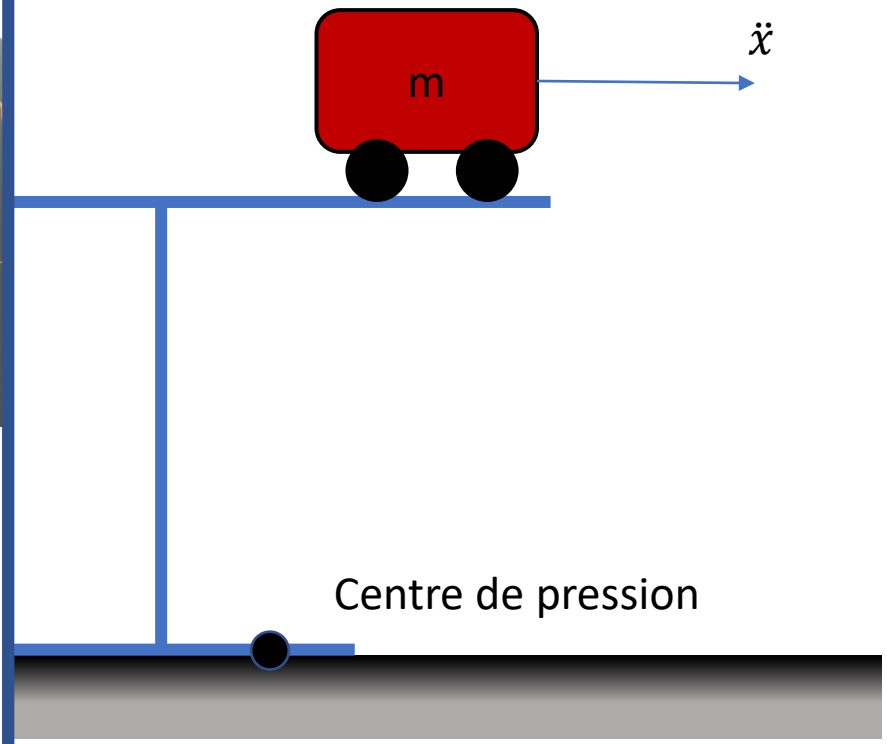


$$\ddot{z} = \frac{f}{m} - g$$

Le « chariot sur la table »

Direction horizontale





$$\ddot{x} = \omega^2 (x - p)$$

Table cart is just physics

- Newtown and Euler relation

$$m\,(\ddot{\boldsymbol{c}} + \boldsymbol{g}) = \sum_i \boldsymbol{f}_i \qquad \dot{\boldsymbol{L}} = \sum_i (\boldsymbol{p}_i - \boldsymbol{c}) \times \boldsymbol{f}_i$$

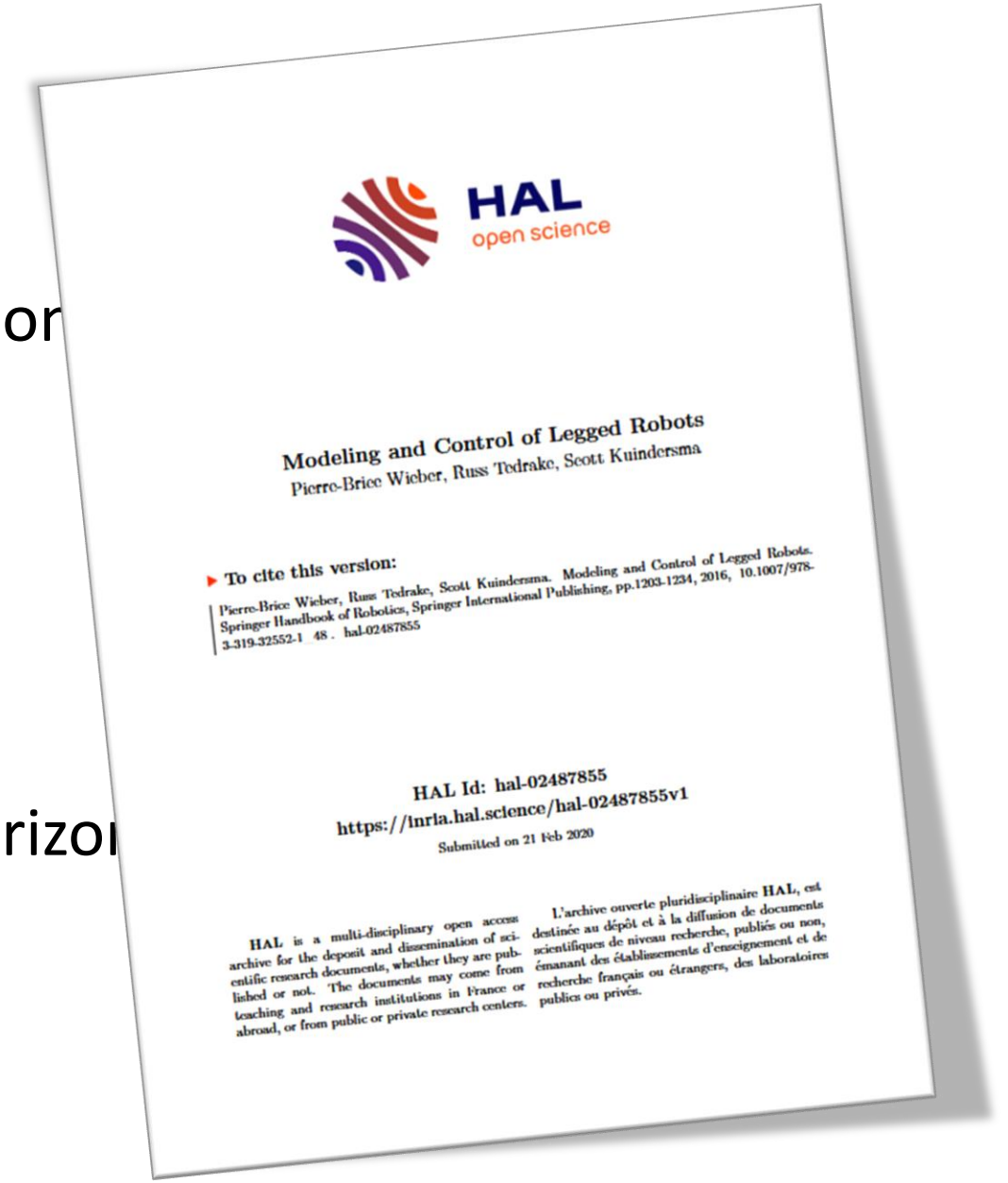
- Mix both todether

$$m\,\boldsymbol{c} \times (\ddot{\boldsymbol{c}} + \boldsymbol{g}) + \dot{\boldsymbol{L}} = \sum_i \boldsymbol{p}_i \times \boldsymbol{f}_i,$$

- Finally, since contacts and motion are horizo

$$\boldsymbol{c}^{x,y} - \frac{c^z}{\ddot{c}^z + g^z}(\ddot{\boldsymbol{c}}^{x,y} + \boldsymbol{g}^{x,y}) + \frac{1}{m(\ddot{c}^z + g^z)}\boldsymbol{S}\dot{\boldsymbol{L}}^{x,y} = \boldsymbol{z}^{x,y}$$

$$c - w^2\ddot{c} = z$$



HAL open science

Modeling and Control of Legged Robots

Pierre-Brice Wieber, Russ Tedrake, Scott Kuindersma

▶ **To cite this version:**

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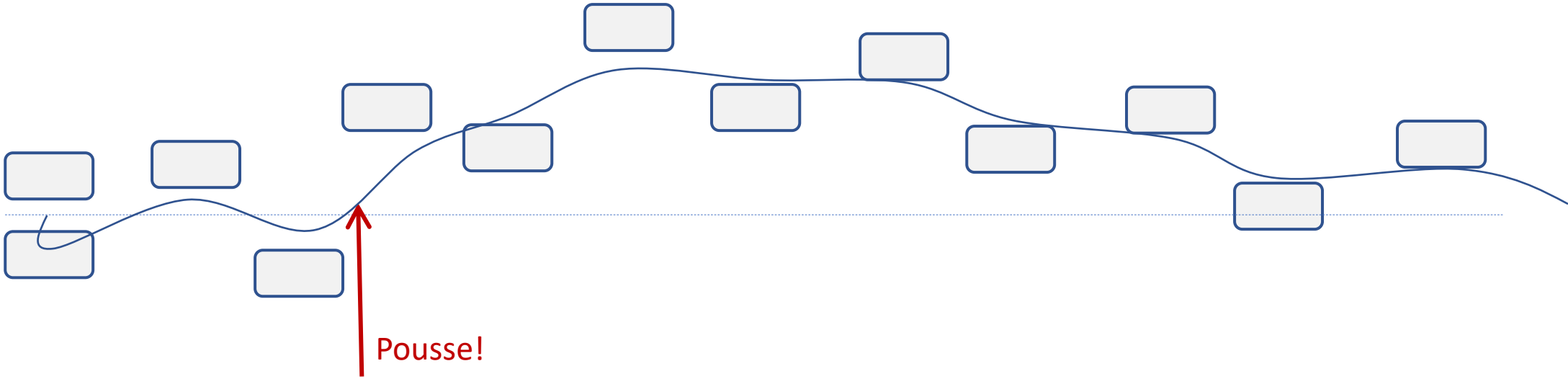
Le « chariot sur la table »

Observation empirique

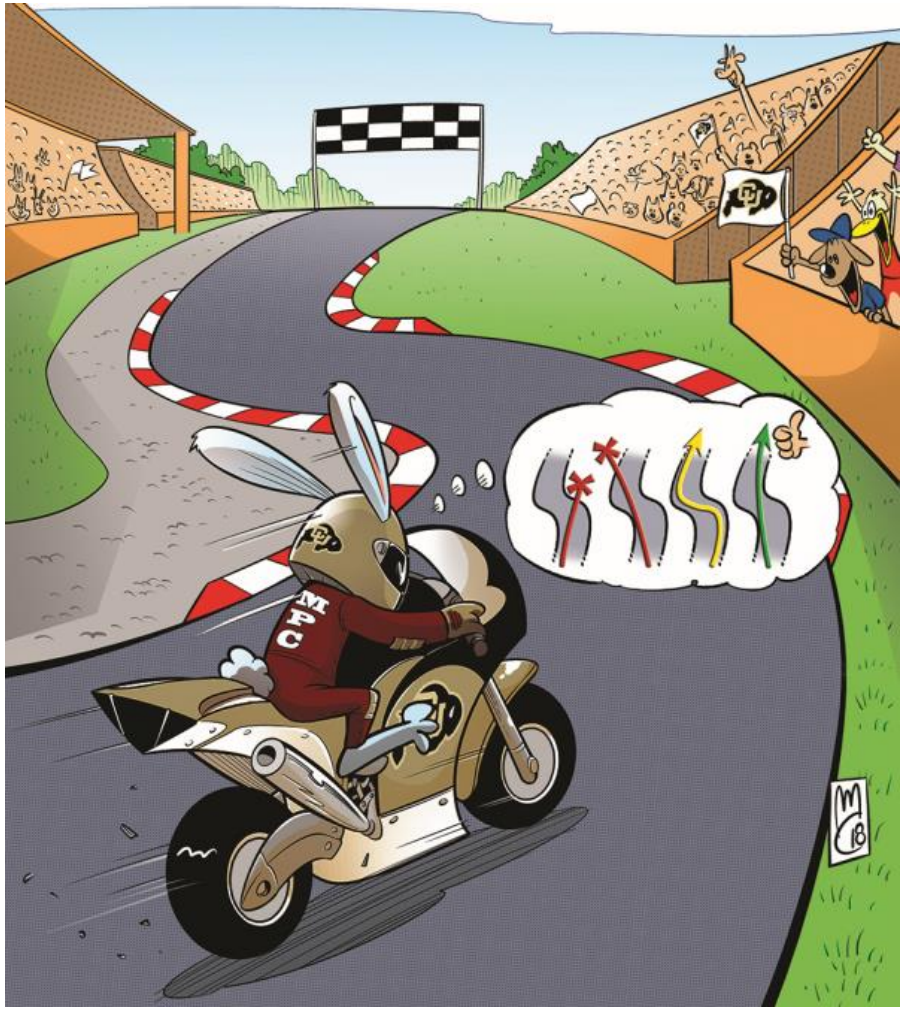
Modèle génératif



Un contrôleur doit être capable de décider:

- Quelles forces (centre de pression) appliquer
- Où placer les prochains pieds

Contrôle prédictif



Original artwork by Michele Carminati,
commissioned by Marco M. Nicotra (U. Colorado Boulder)

$$\min_{\substack{X=(Q,\dot{Q}),\\ U=\tau}} \int_0^T \sum_l l(x_t, u_t)\, dt$$

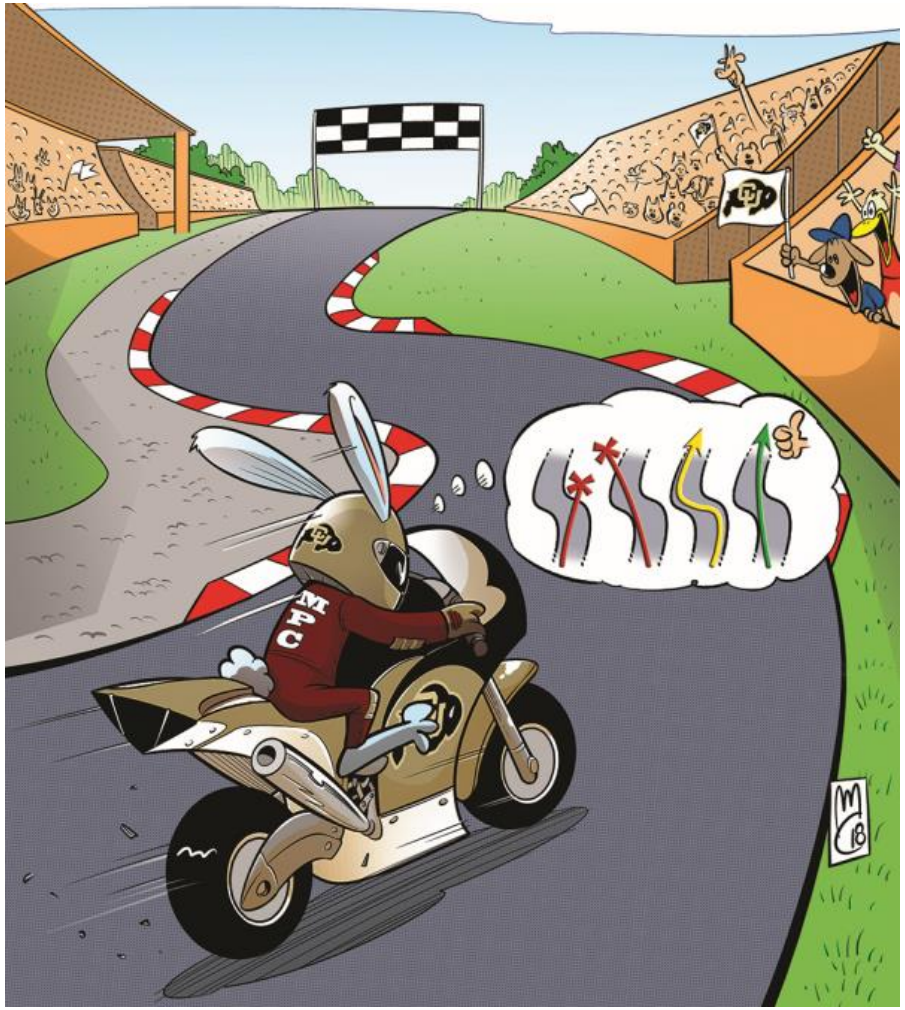
so that $\forall t,\ \dot{x}(t) = f(x(t), u(t))$

$u_0 = \pi(x_0)$

$\{x\},\{u\}$

$\approx +\infty$

Contrôle prédictif



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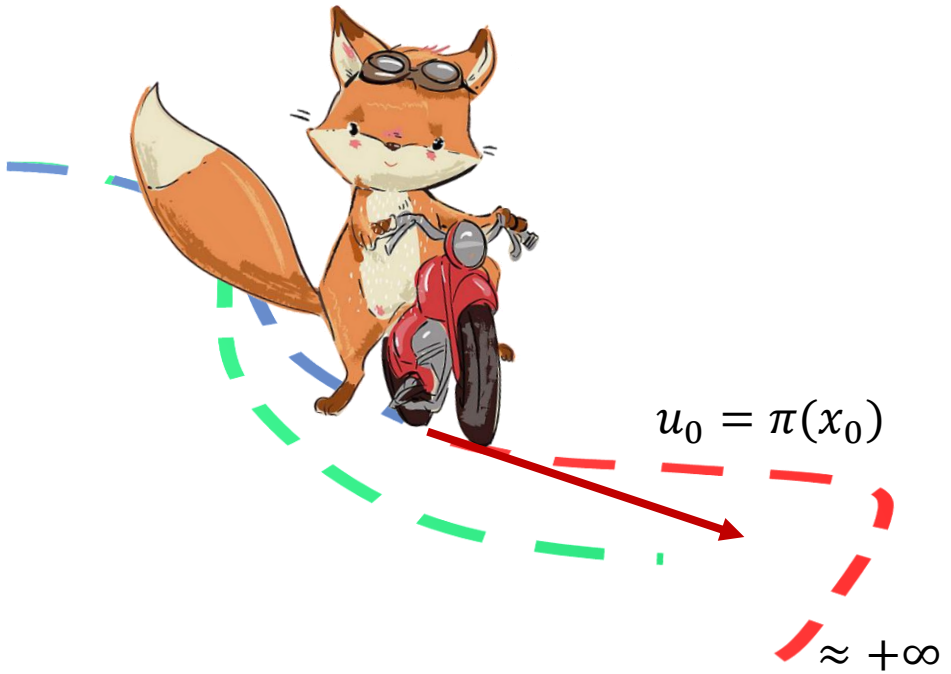
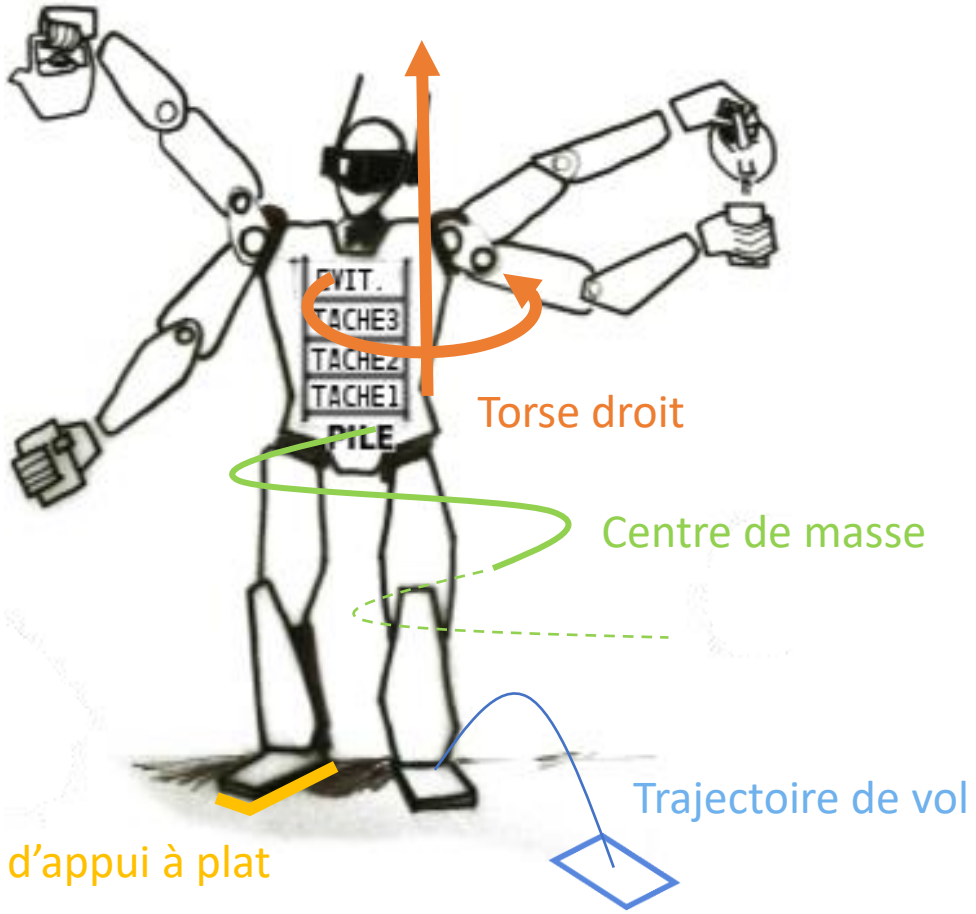
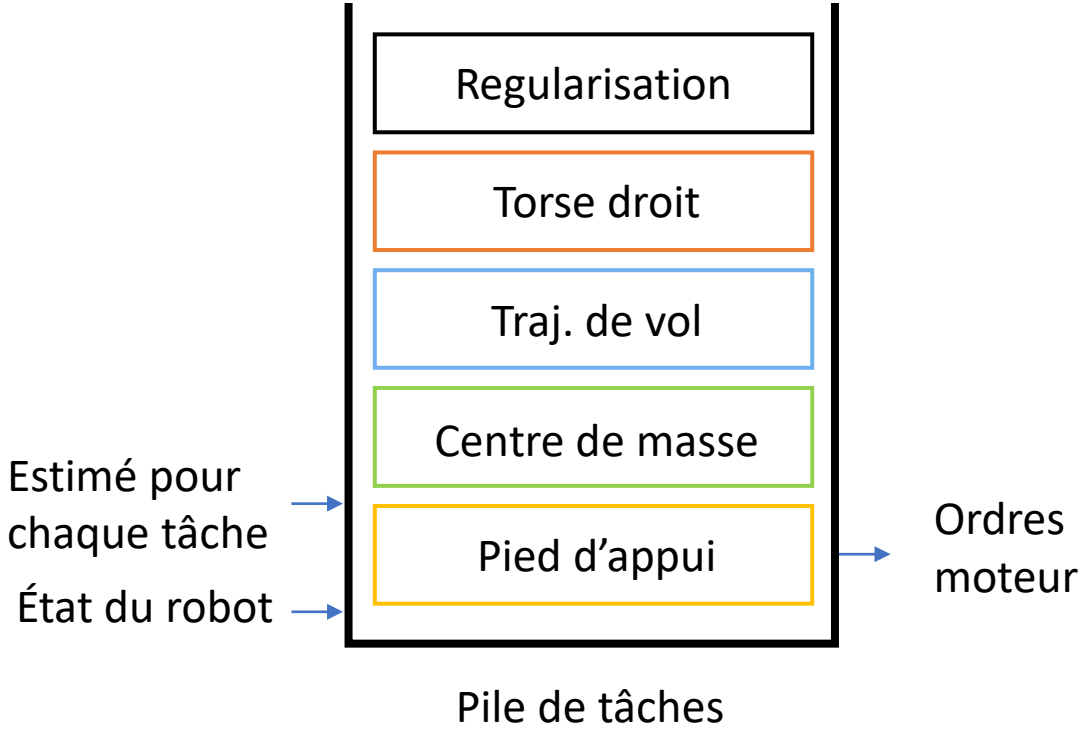
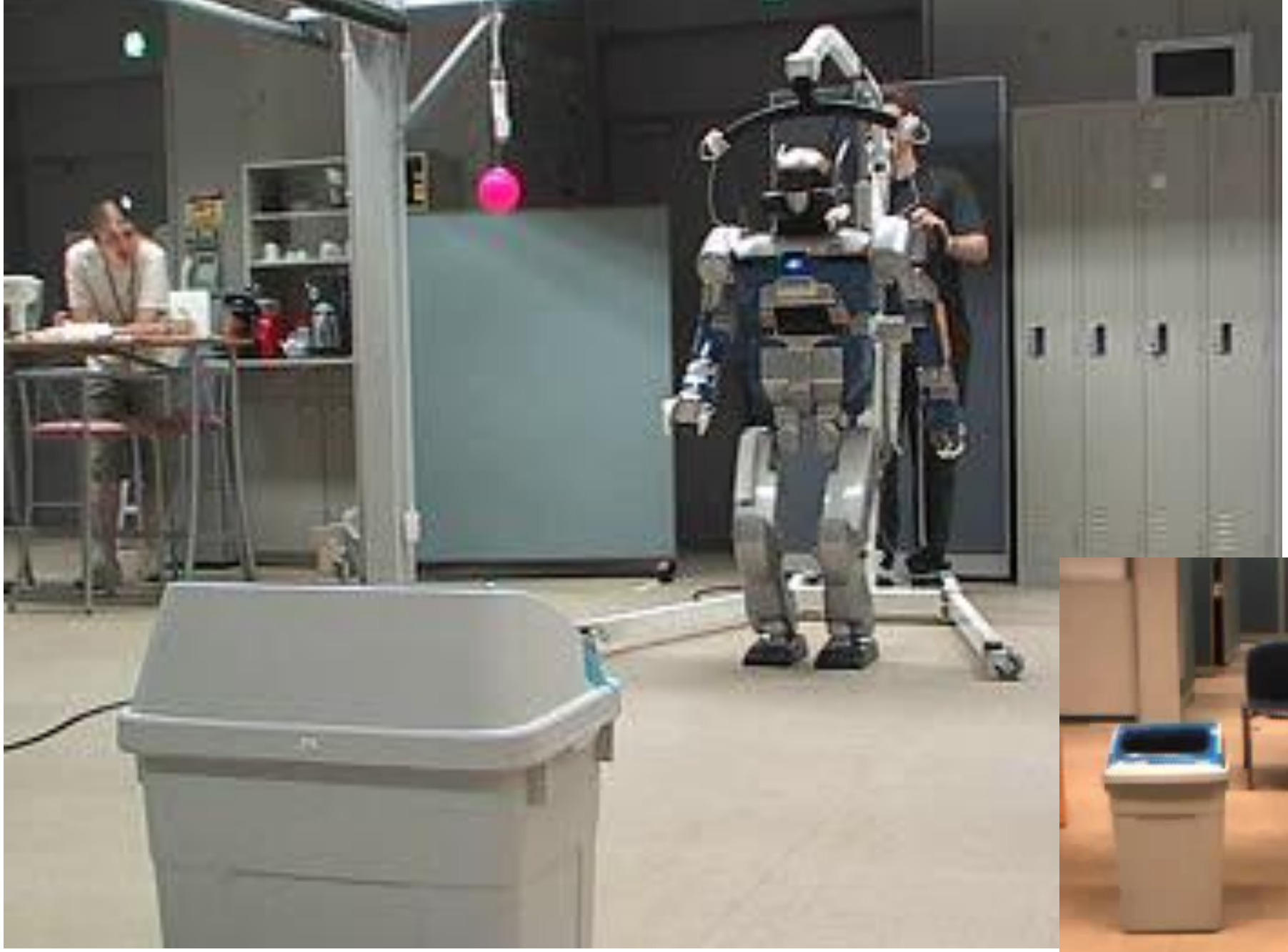


Contrôle « opérationel »

… ou « par tâches »





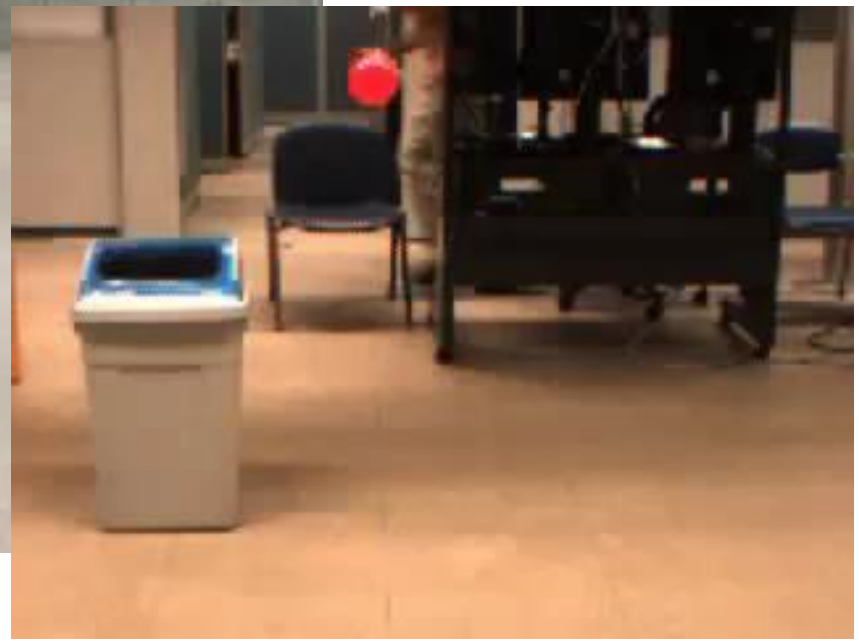



BlackBerry


Windows Vista

2006


PIRATES des CARAÏBES
LA FONTAINE
DE JOUVENCE



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