

# Humoto software for walking motion generation

Jan Michalczyk

jan.michalczyk@inria.fr

Bipop Team

Montpellier  
October 2017

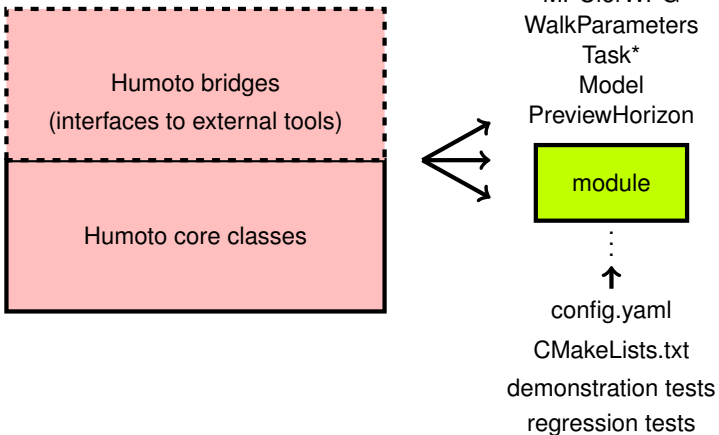


- 1 Humoto
  - Humoto library
- 2 Humoto with LIRMM control framework
  - Integration of Humoto with LIRMM control framework
- 3 Perspectives

# Humoto

## Humoto

- Open-source <https://github.com/bip-team/humoto>
- Software framework for manipulation of linear least-squares problems with constraints
- Special interest in MPC problems for robotics applications in real-time
- Specific functionalities related to robotics (FSM for walking, trajectories, logging etc.)
- Interfaces to external tools (solvers, yaml-cpp, rbdl etc.)
- Modular architecture (enable/disable parts)
- Regression tests and Continuous Integration
- Support for foreign toolchains (Aldebaran's qibuild)



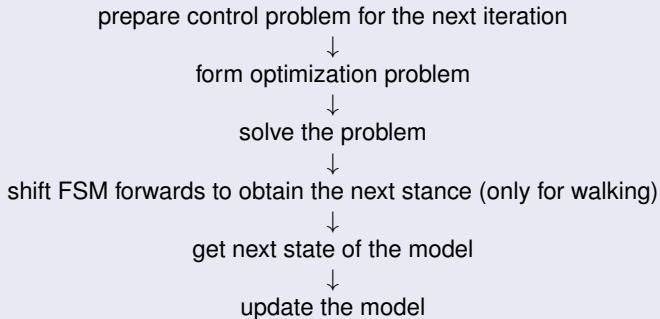
## Control objectives as tasks

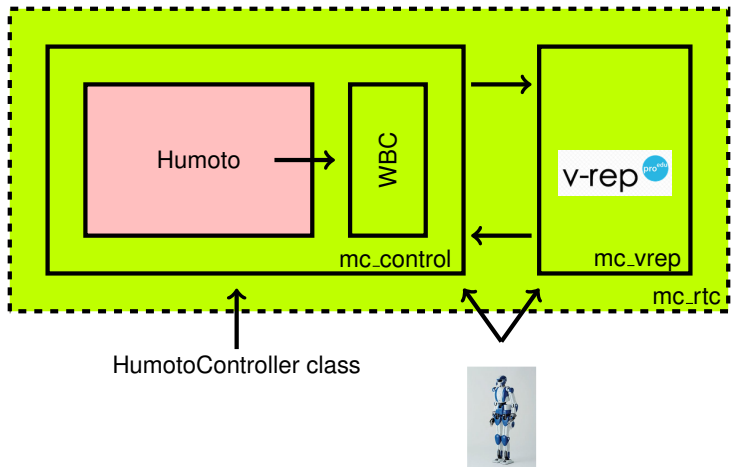
- Optimization problems are posed as hierarchical least squares problems
- They consist of tasks in the following form:

$$\underline{b} \leq \mathbf{A}x \leq \bar{b}$$

- Equalities are represented by setting equal lower and upper bounds  $\underline{b} = \bar{b}$
- During a single control iteration we form all necessary objectives and organize them into a hierarchy. Individual class is created for each objective with the corresponding  $\underline{b}$ ,  $\mathbf{A}$ ,  $\bar{b}$  matrices
- Two levels of hierarchy possible when using qpOASES
- Arbitrary number of hierarchy levels possible when using LexLsi

## Humoto control loop







# Integration with LIRMM control framework



# Perspectives

- Implement humoto module containing all relevant functionalities
  - Obstacle avoidance
  - Feet rotations
  - Time-variation of footsteps
  - Vertical CoM motion
- Obstacle avoidance already partly implemented
- Adding state feedback in simulations with LIRMM framework
- Implementations of MPC schemes on hrp4

# Thanks