dfki ai Robotics Innovation Center

GRASP STABILITY ESTIMATION

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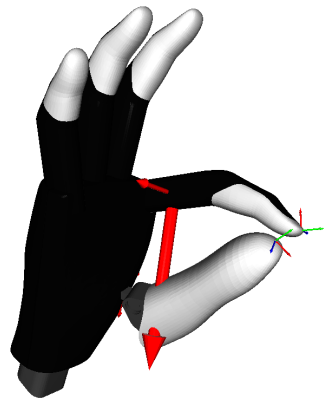
Grasp Stability Estimation

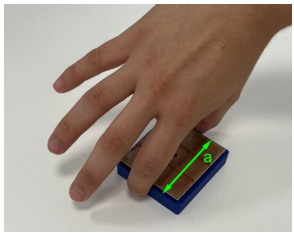
Dataset Recording

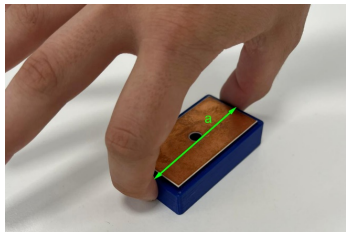
Available Features

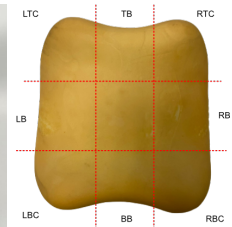
Type	Variable	Description
Joint angle	`finger_angle_index`	flexion of index finger
	`finger_angle_mrl`	flexion of middle finger
	`finger_angle_thumb`	flexion of thumb
Force	`finger_tangential_mrl`	Tangential, middle finger
	`finger_normal_index`	Normal, index finger
	`finger_tangential_index`	Tangential, index finger
	`finger_tangential_thumb`	Tangential, thumb
	`finger_normal_thumb`	Normal, thumb
	`finger_normal_mrl`	Normal, middle finger
Label	label: `no_contact`, `failure`, `success`, `success_and_stable`	Quality of grasp

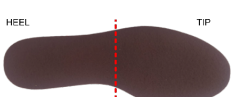


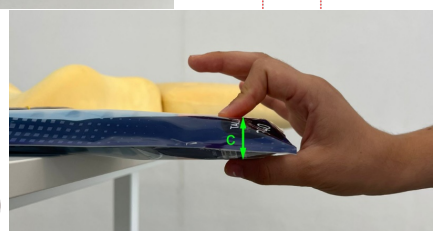
Objects











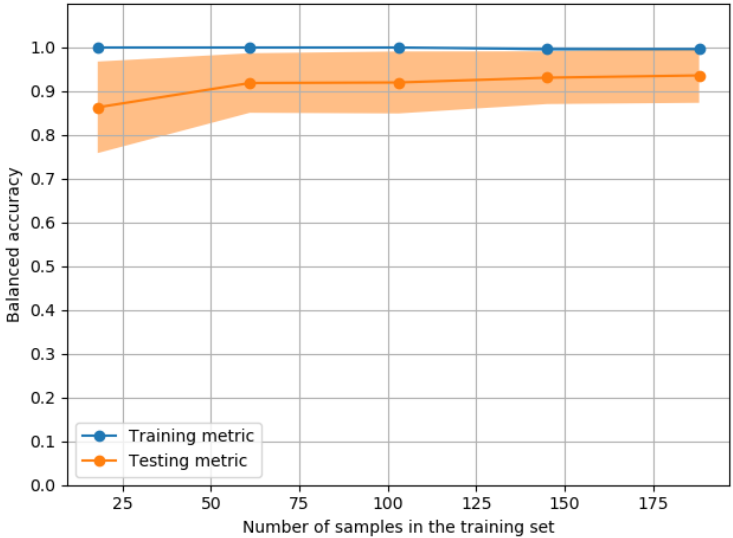
Why is it difficult?

- All data is available as a time series (measurements during the grasp)
- One measurement is not sufficient to determine stability exactly; a better approach would be to use tactile sensors (expensive!)
- Transfer between hands might not be possible for small objects, because the calibration (joint angle measurement) is not precise

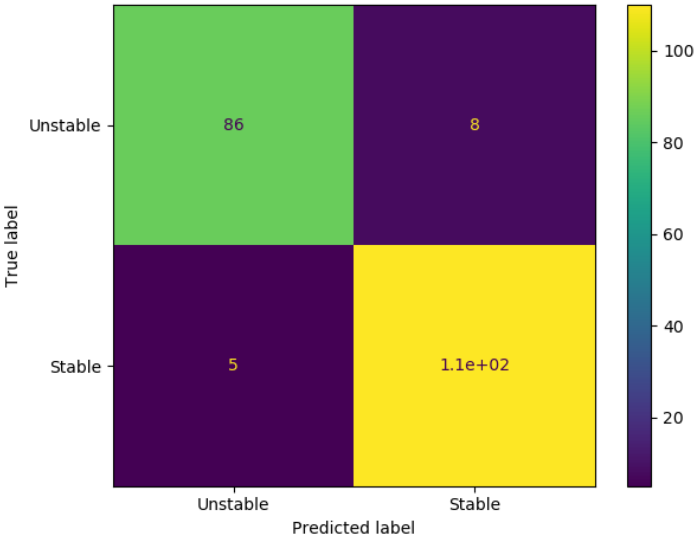
Machine Learning Pipeline

- Feature engineering: compute distance between finger tips from joint angles
- ML pipeline: manual feature selection + standard scaler + random forest
- Metric: balanced accuracy
- Validation: stratified 10-fold CV
- Various tests were performed with transfer between objects and hands (with different calibrations)
- We still needed fine-tuning for each object, hand, and grasp
- We will try that in the next tutorial

Learning Curve



Confusion Matrix



Framework

What should we do when the grasp is not stable?

- The grasp stability estimation module is embedded in the APRIL framework
- Main layers: high-level planning, behavior trees, low-level control ($\leftarrow$ we are here)
- Behavior tree is able to trigger a fallback solution (regrasp)
- If that does not work, we have to go back and plan another grasp attempt

Thank You!
Please feel free to ask questions in the forums.