

SPRING Architecture Overview

Séverin Lemaignan - PAL Robotics SoRAIM Winter School - Grenoble, Feb 2024



What does it take to build an autonomous robot?







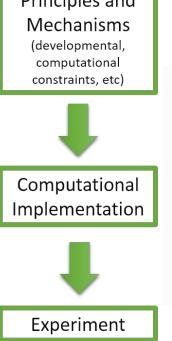


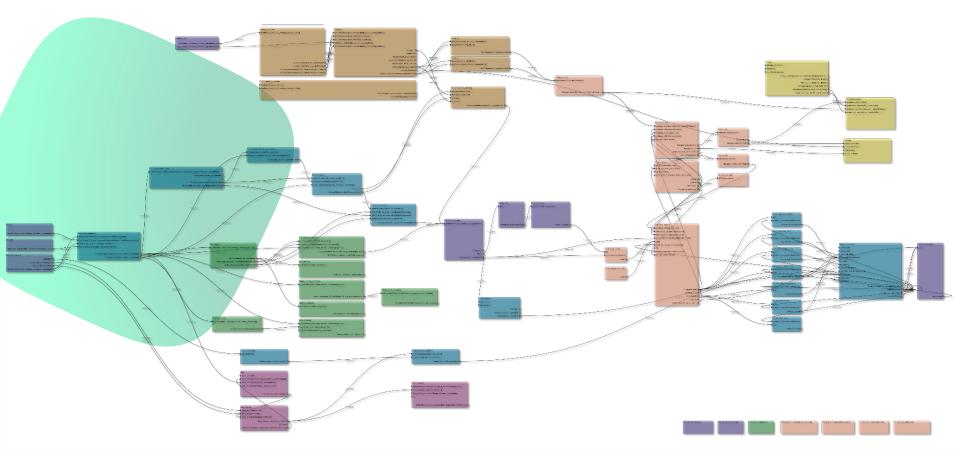
Diagram courtesy Paul Baxter



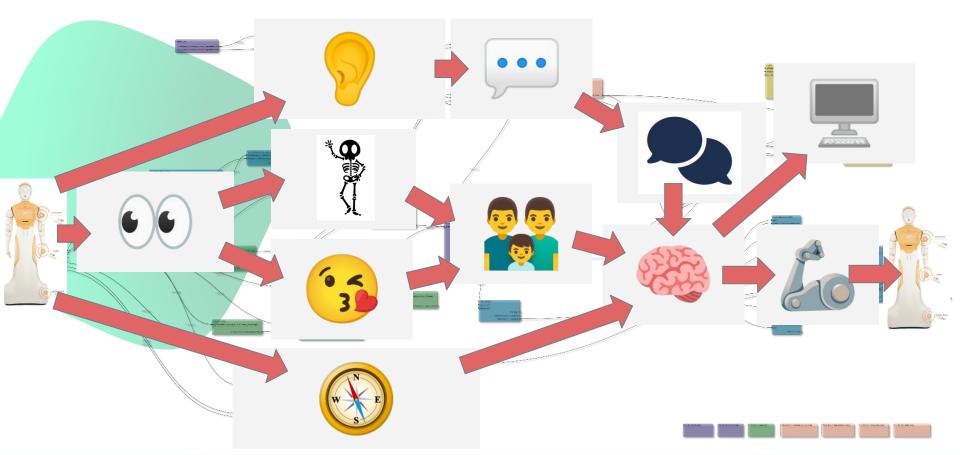
Computational Implementation



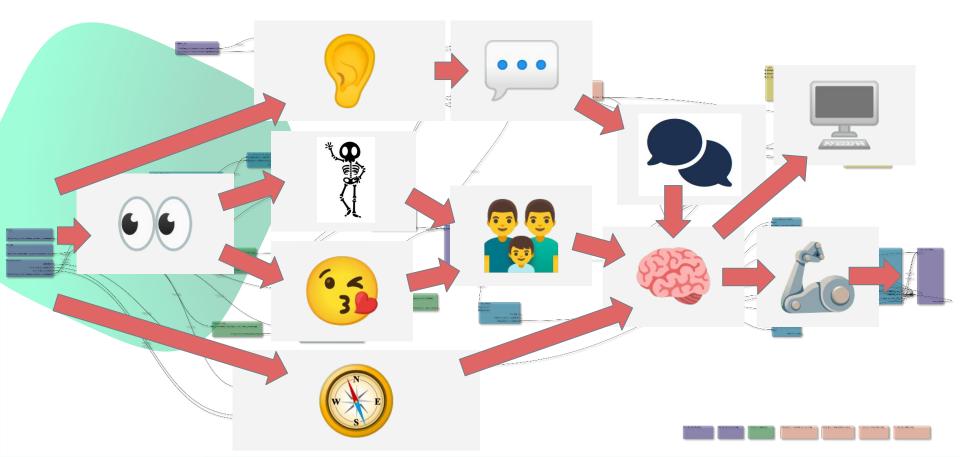




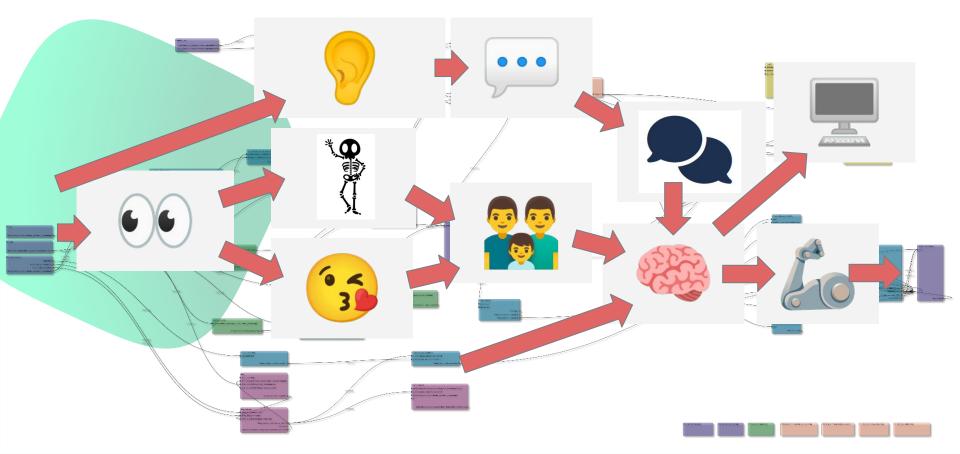












HLoc

- /front_camera/fisheye/image_raw/compressed
- /rear_camera/fisheye/image_raw/compressed
- /robot_pose [geometry_msgs/PoseWithCovarianceStamped]
- 🗢 tf: camera fr<u>ames</u>

ROS service: pose + covariance 🧲

slam_rtabmap

- torso_front_camera/infra*/*
- [call HLoc to perform global localization]
- 🔍 /torso_front_camera/imu

/robot_pose [geometry_msgs/PoseWithCovarianceStamped]

tf:/odom

/slam/occupancy_map [OccupancyGrid]

ARABVINAUS

Scene perception and understanding

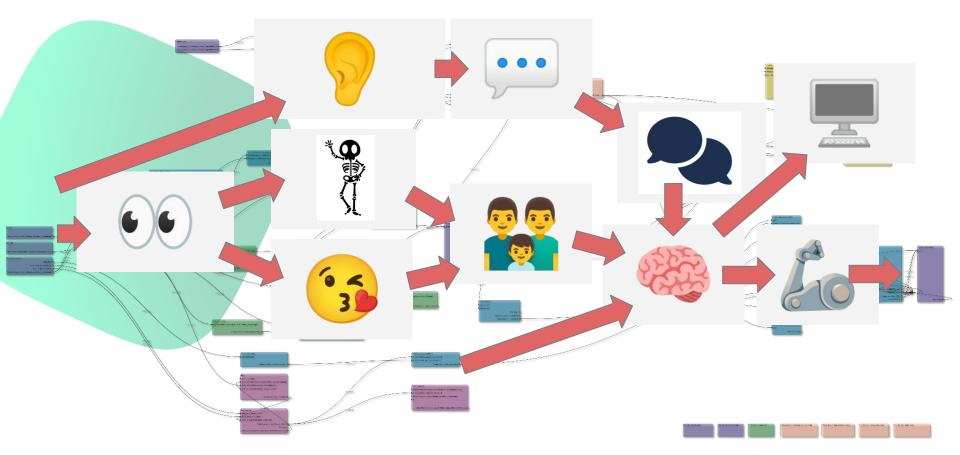
MOCK: Yolact3D

🔵 tf

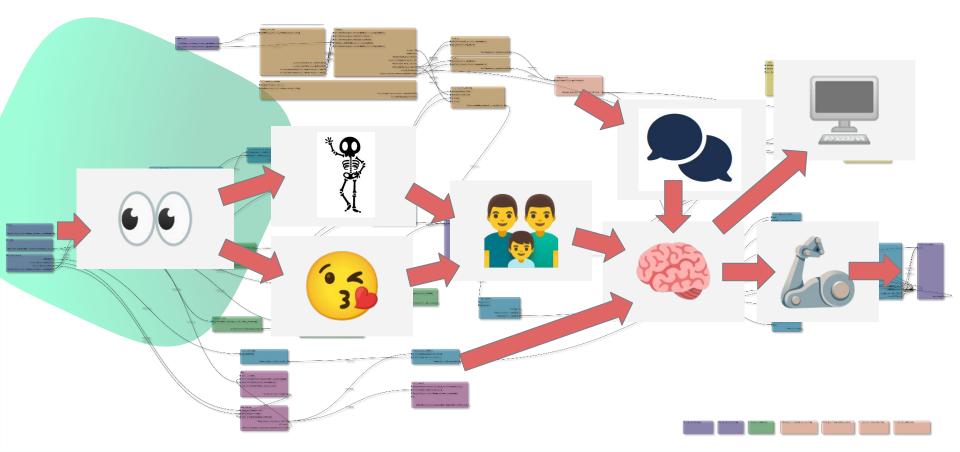
- /slam/occupancy_map [OccupancyGrid]
- /torso_front_camera/aligned_depth_to_color [sensor_msgs/Image
- /torso_front_camera/color/image_raw [sensor_msgs/Image]

/yolact3d/detected_objects_distribution [yolact3d/Yolact3DObjects]



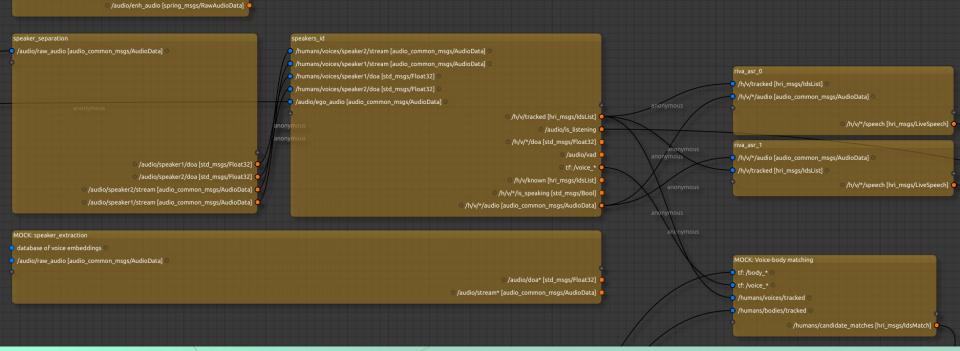






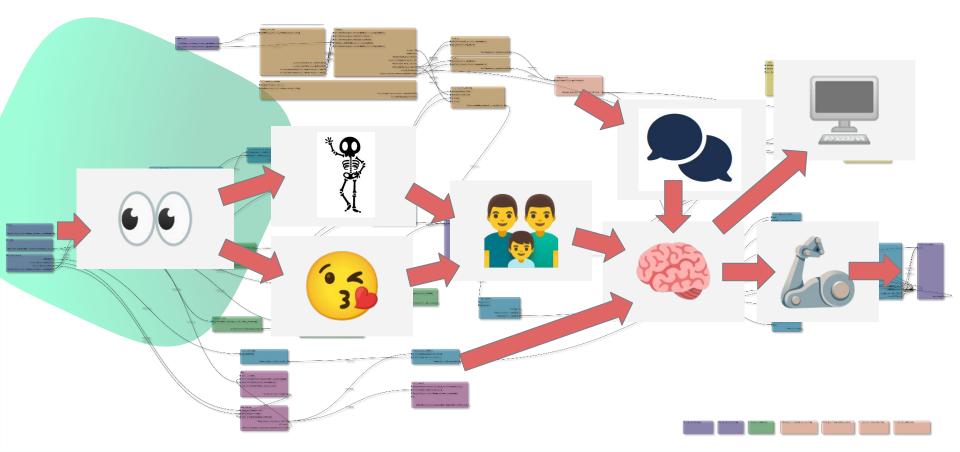
audio_processing_mode

🖕 /audio/raw_audio [spring_msgs/RawAudioData] 🐃

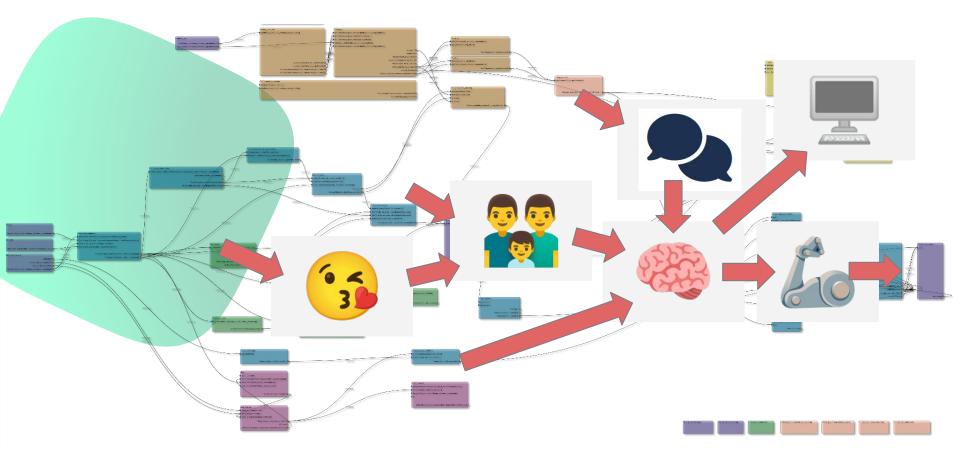


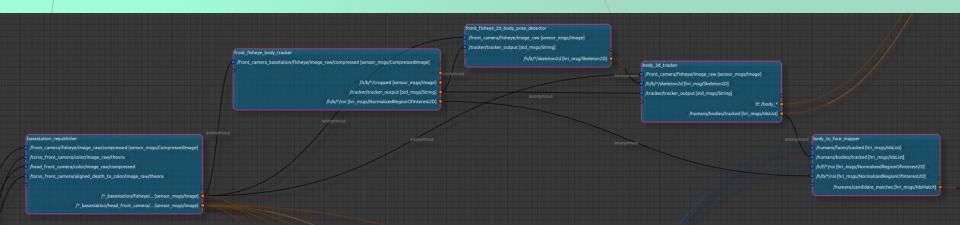
Audio processing and speech recognition





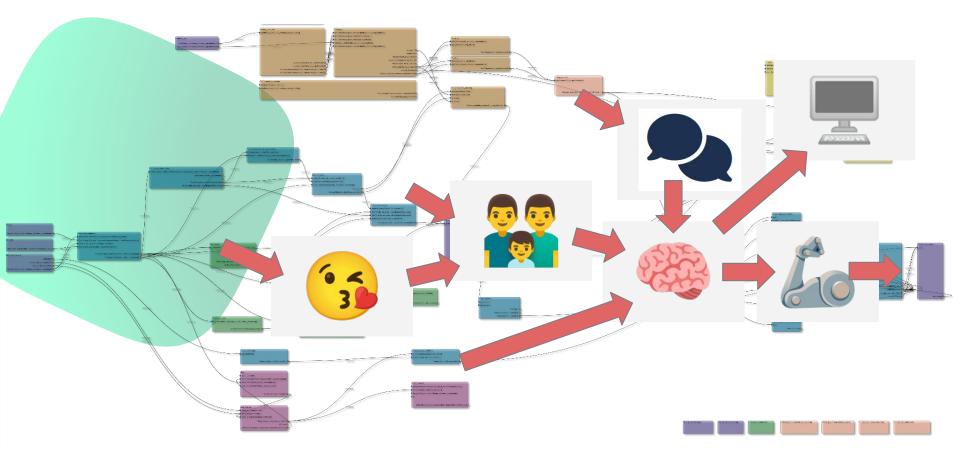




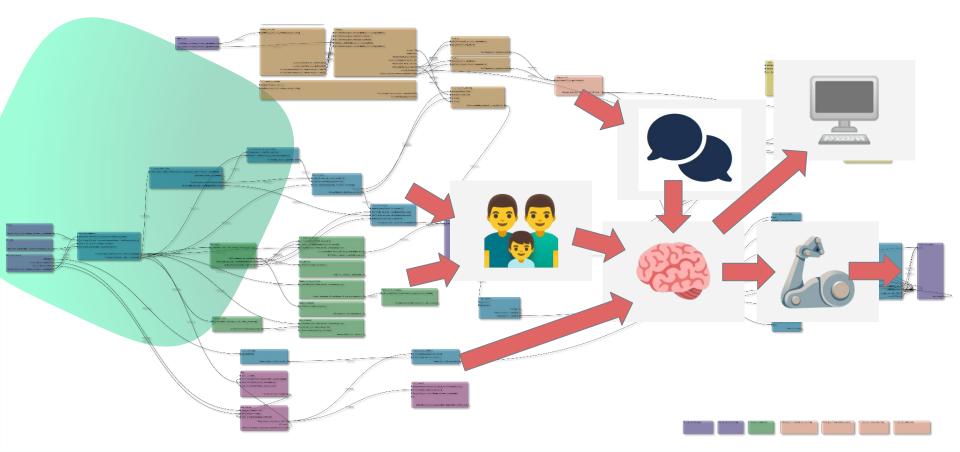


Multi-person visual tracking











h/f/*/cropped [sensor_msg/Image] O /h/f/*/roi [hri_msgs/NormalizedRegionOfInterest2D]

/*_basestation/head_front_camera/... [sensor_msgs/Image]

/depth_estimation [sensor_msgs/Image] 🥥

depth_estimation

/humans/faces/tracked [hri_msgs/ldsList] 🥥

anonymous

human_2d_pose_estimation /*_basestation/head_front_camera/... [sensor_msgs/Image]

/*_basestation/head_front_camera/... [sensor_msgs/Image]

/vision_msgs/human_2d_pose [human_2d_pose_estimation/Frame] 🥥

/humans/candidate_matches [hri_msgs/ldsMatch] [face reco] /h/f/*/softbiometrics [hri_msgs/SoftBiometrics]

emotion estimation

soft_biometrics_estimator

mask detector

/h/f/*/cropped [sensor_msg/Image]

/h/f/*/cropped [sensor_msg/Image]

/h/f/*/expression [hri_msgs/Expression]

/h/f/*/has_mask [wp4_msgs/FaceMask] 🤤

gaze_estimation

/*_basestation/head_front_camera/... [sensor_msgs/Image]

/depth_estimation [sensor_msgs/Image]

/h/f/*/roi [sensor_msgs/RegionOfInterest]

GazeFrame [2D point in rgb frame] 🧔

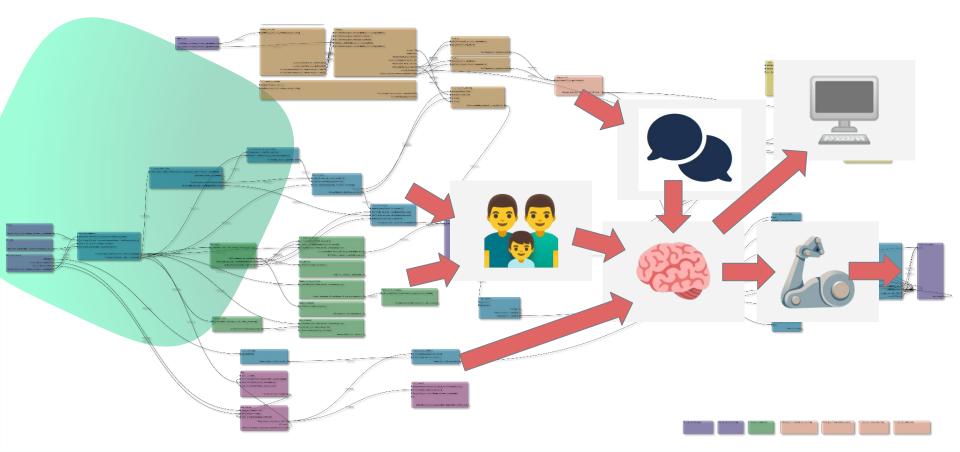
MOCK: activity_recognition

/vision_msgs/human_2d_pose [human_2d_pose_estimation/Frame]

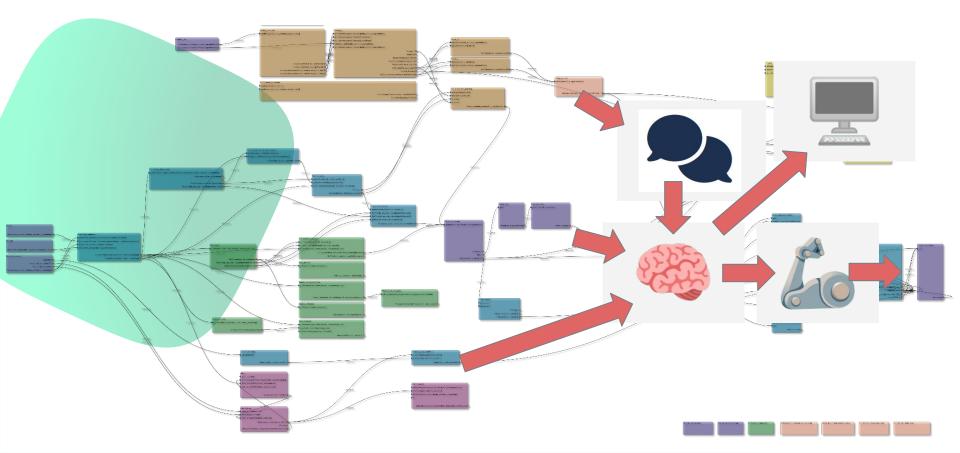
[?] output to be defined + added to hri_msgs if possible 🧲

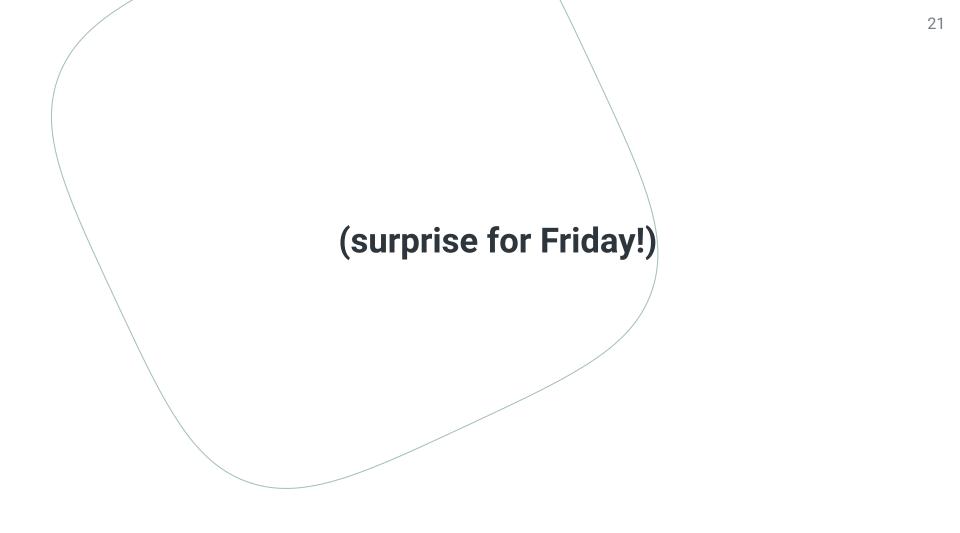
Face & Behaviour recognition



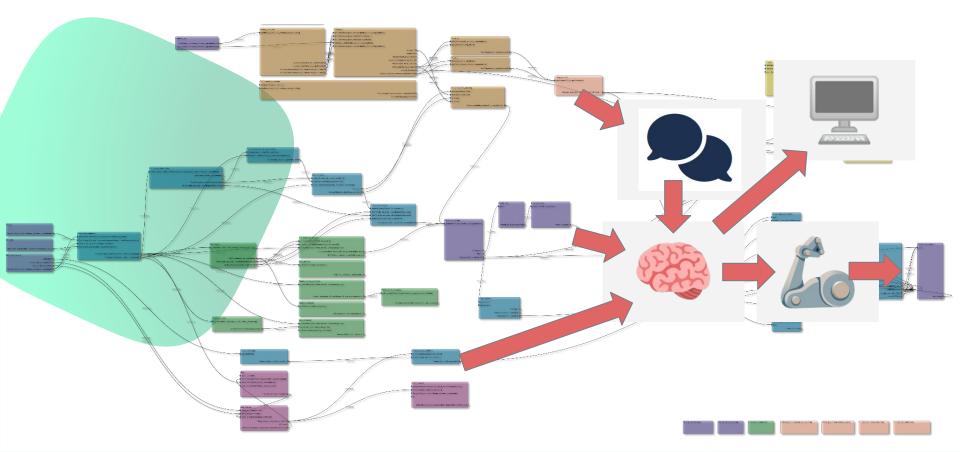




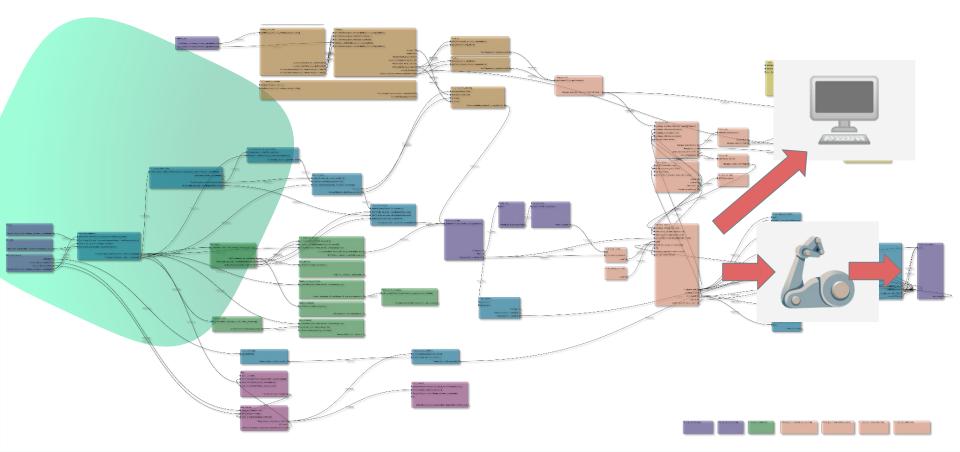




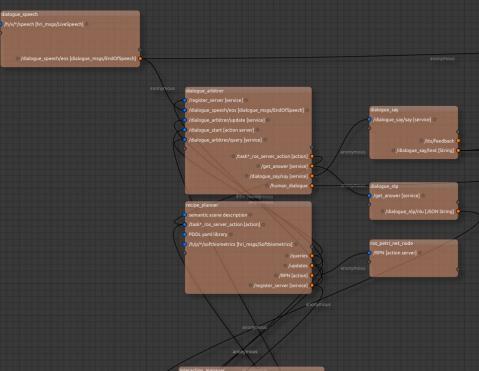








Multi-party spoken conversation



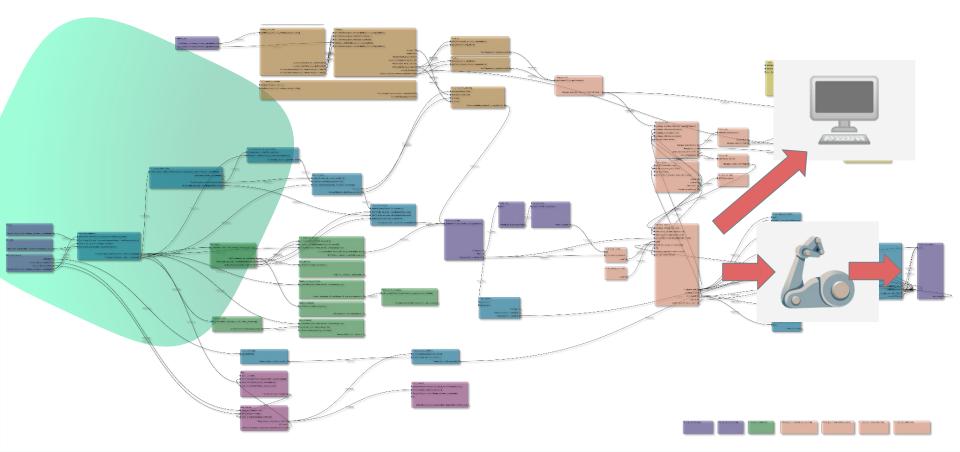
cial_state_analyzer

al_strategy_supervis

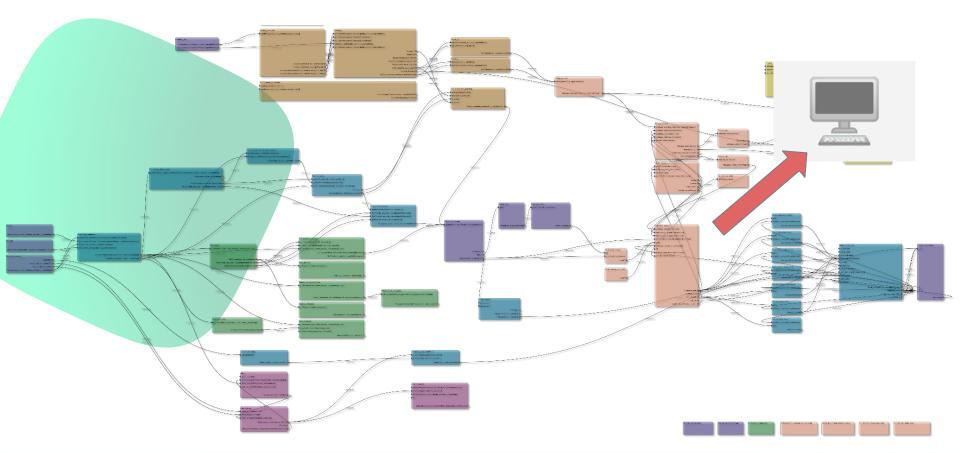
logue speech

h/p/*/softbiometrics [hri msgs/Softbiometrics] ialogue nlp/nlu [JSON String] oller_status [ControllerStatus]

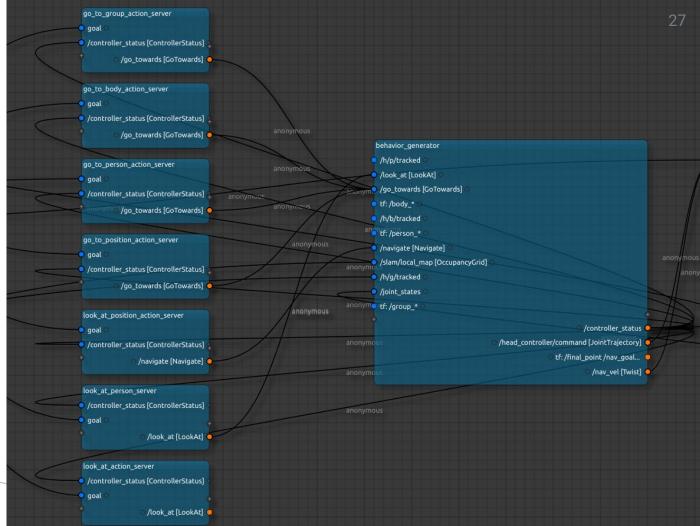




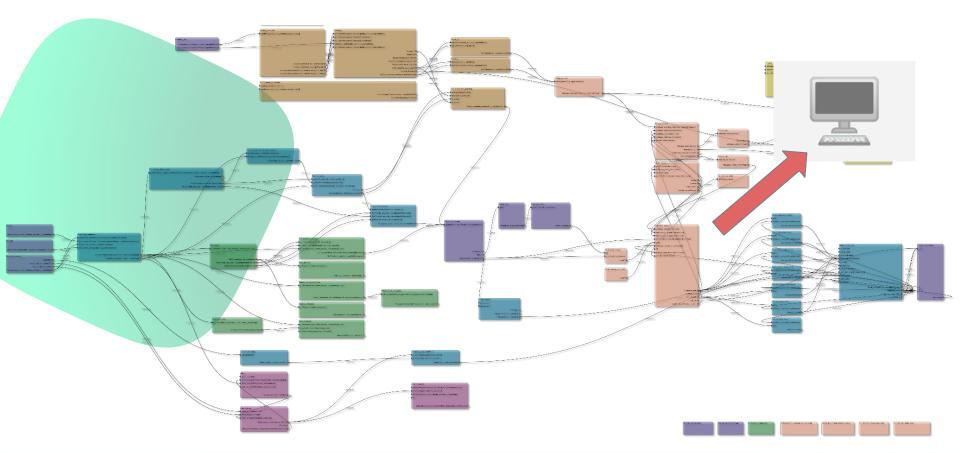




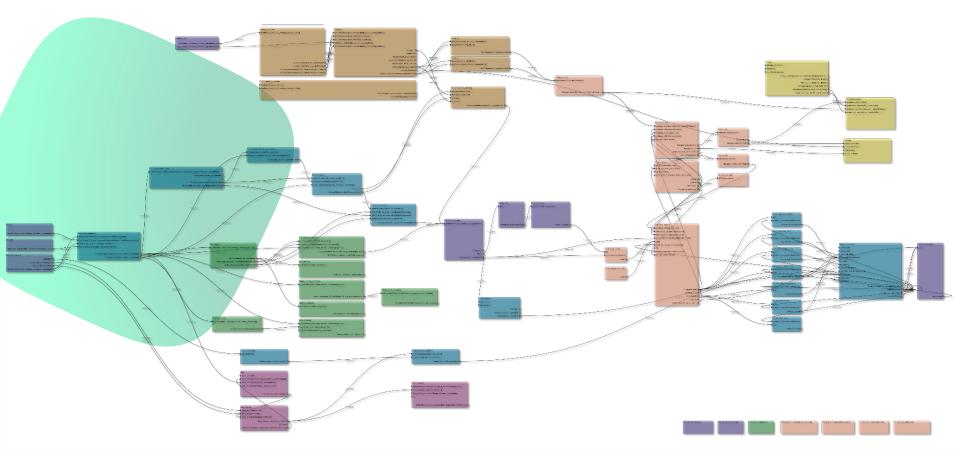
Robot's behaviours











exp_gui

🗘 /dialogue_start/status 🔍

🔿 /diagnostics 🔍

🖕 /slam/localization_pose 💿

/dialogue_start/goal [dialogue_msgs/StartDialogueActionGoal]

/dialogue_arbiter/reset [Empty]

/experiment_exporter/error_feedback [String]

/experiment_exporter/file_update [String]

/interaction_manager/start [Empty] (

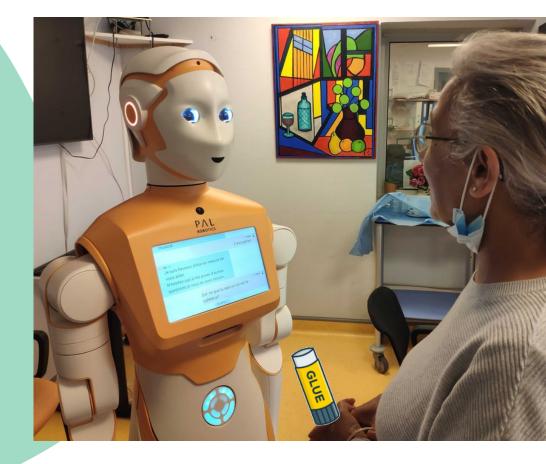
/web/go_to [pal_web_msgs/WebGoTo]

anonymous anonymous experiment_exporter 🗢 /dialogue_say/text [String] 🔍 /experiment_exporter/file_update [String] 🔷 /dialogue_speech/eos [dialogue_msgs/EndOfSpeech] 🖷 /experiment_exporter/error_feedback [String] robot gui 🗢 /dialogue_say/text 🔍 🖕 /tts/feedback 🗉 🖕 /human_dialogue 🕫 🔿 /audio/is_listening 🔍

Tablet UI



And the glue?





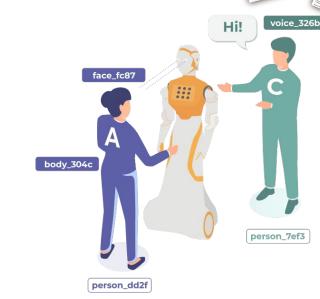
EROS4HRI

- **REP-155:** <u>https://www.ros.org/reps/rep-015</u> <u>5.html</u>
- Plenty of open-source components (and you can contribute your own!) http://wiki.ros.org/hri

R

person_45fa

body_0f43



ACCIÓ Ceneralitat de Catalunya Government of Catalonia Tecniospring INDUSTRY

TALBOT

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J.



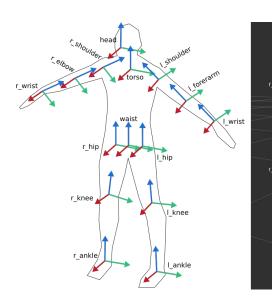
EROS4HRI

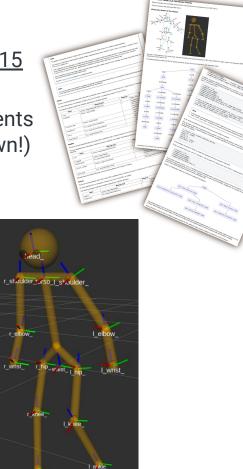
ACCIÓ Generalitat de Catalunya Government of Catalonia

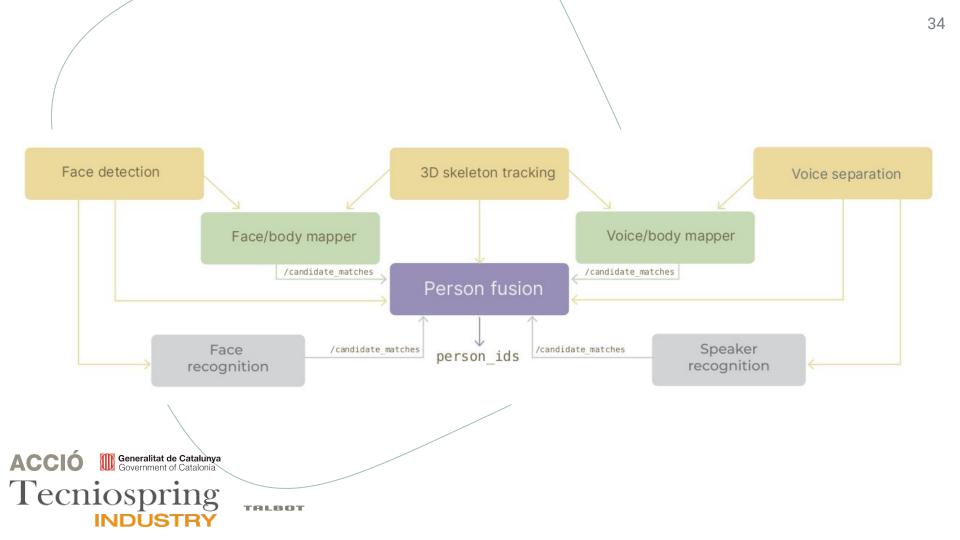
Tecniospring

TALBOT

- REP-155: https://www.ros.org/reps/rep-015 5.html
- Plenty of open-source components (and you can contribute your own!) <u>http://wiki.ros.org/hri</u>





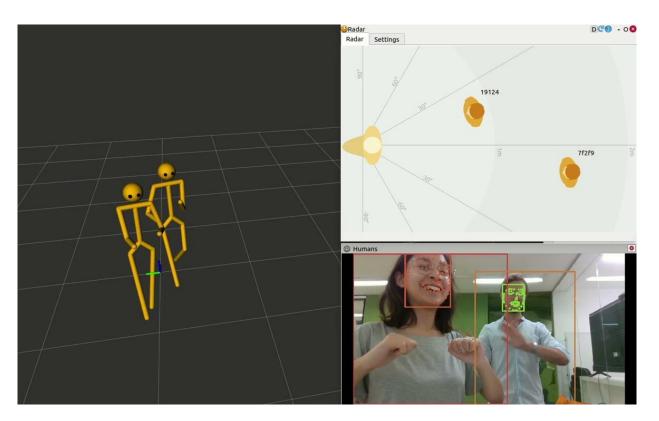




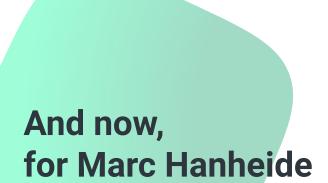
EROS4HRI



TALBOT









- Professor of Intelligent Robotics & Interactive Systems at Lincoln University
- One of the few to actually do long-term, real-world deployments of social robots
- He is (relatively) funny/easy going: you can go and talk to him as if he was not *actually* a famous professor. Do!