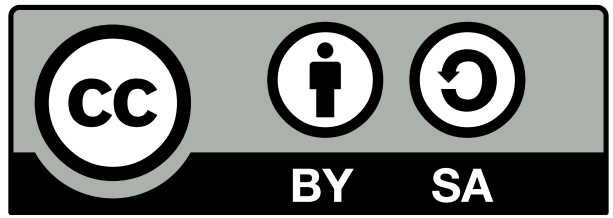


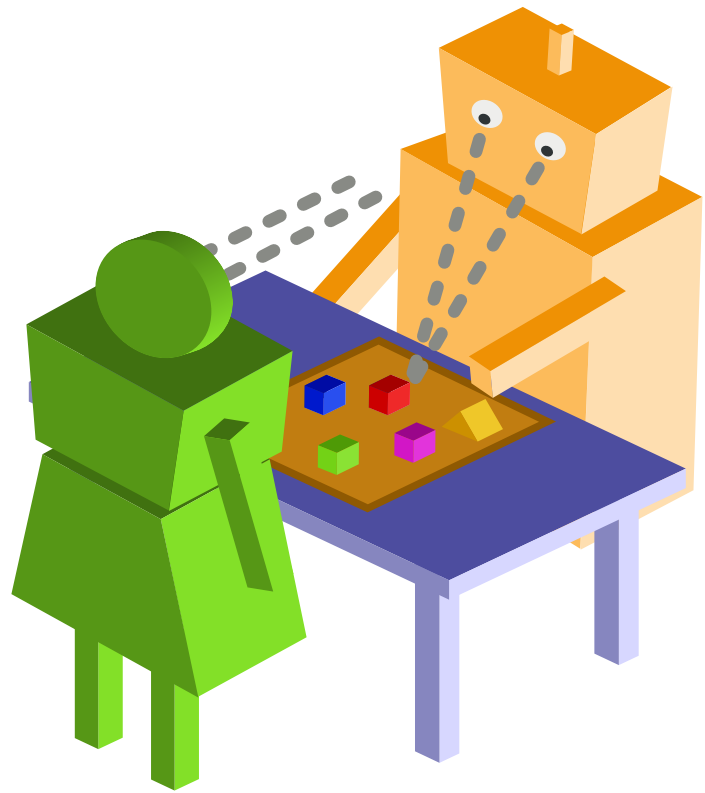
You can download the sources of this presentation here:

github.com/severin-lemaignan/presentation-ros4hri

PAL ROBOTICS

ROS for Human-Robot Interaction
Towards REP-155

ROSCon | Oct 2022



Séverin Lemaignan

PAL Robotics Senior Scientist AI & Social Interactions

situation assessment

symbolic grounding

symbolic reasoning

SYMBOLIC SOCIAL COGNITION FOR ROBOTS

ontologies

perspective taking

cognitive architectures

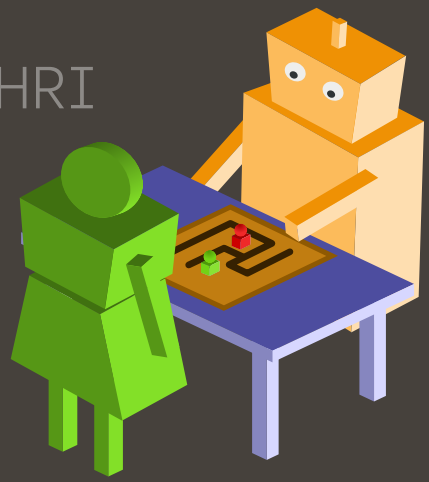
social situation assessment

joint action

ROS4HRI

natural language processing

REAL-WORLD SOCIAL AUTONOMY



DATA-DRIVEN HRI

learning of social policies

large datasets

theory of mind

group dynamics

human-in-the-loop ML

experimental robotics

robotics for learning

CHILD-ROBOT INTERACTION

trust

HUMAN FACTORS

engagement

responsible AI

anthropomorphism

social robotics

participatory design

persuasion

WHY ROS4HRI?

- dealing with humans is actually hard: they keep on disappearing/reappearing; hard to predict where/when; ‘shape’ known at run-time only, etc.
- widely different requirements depending on application: from ‘2D points’ to full online kinematic model.
- no ROS standard for HRI (nothing, nada, rien!)

[Mohamed, Lemaignan, **ROS for Human-Robot Interaction**, IROS 2021]

DESIGN REQUIREMENTS

- representations **application-agnostic**: from point-like crowd simulation, to kineastetic teaching, to social interaction

[Mohamed, Lemaignan, **ROS for Human-Robot Interaction**, IROS 2021]

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- does not enforce any specific algorithm or perception pipeline

[Mohamed, Lemaignan, **ROS for Human-Robot Interaction**, IROS 2021]

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- however, takes into account what current algorithms can or can not do (eg: kinematic model of human)

DESIGN REQUIREMENTS

- representations **application-agnostic**: from point-like crowd simulation, to kineastetic teaching, to social interaction
- does not enforce any specific algorithm or perception pipeline
- however, takes into account what current algorithms can or can not do (eg: kinematic model of human)
- integrated as much as possible with existing ROS conventions (eg: `robot_state_publisher` for human forward kinematics)

[Mohamed, Lemaignan, **ROS for Human-Robot Interaction**, IROS 2021]

SCOPE

- set of new messages (`hri_msgs`)

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- topics naming convention

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- for now, focus on *perception* only

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- `tf` frames naming convention
- (parametric) kinematic model of humans
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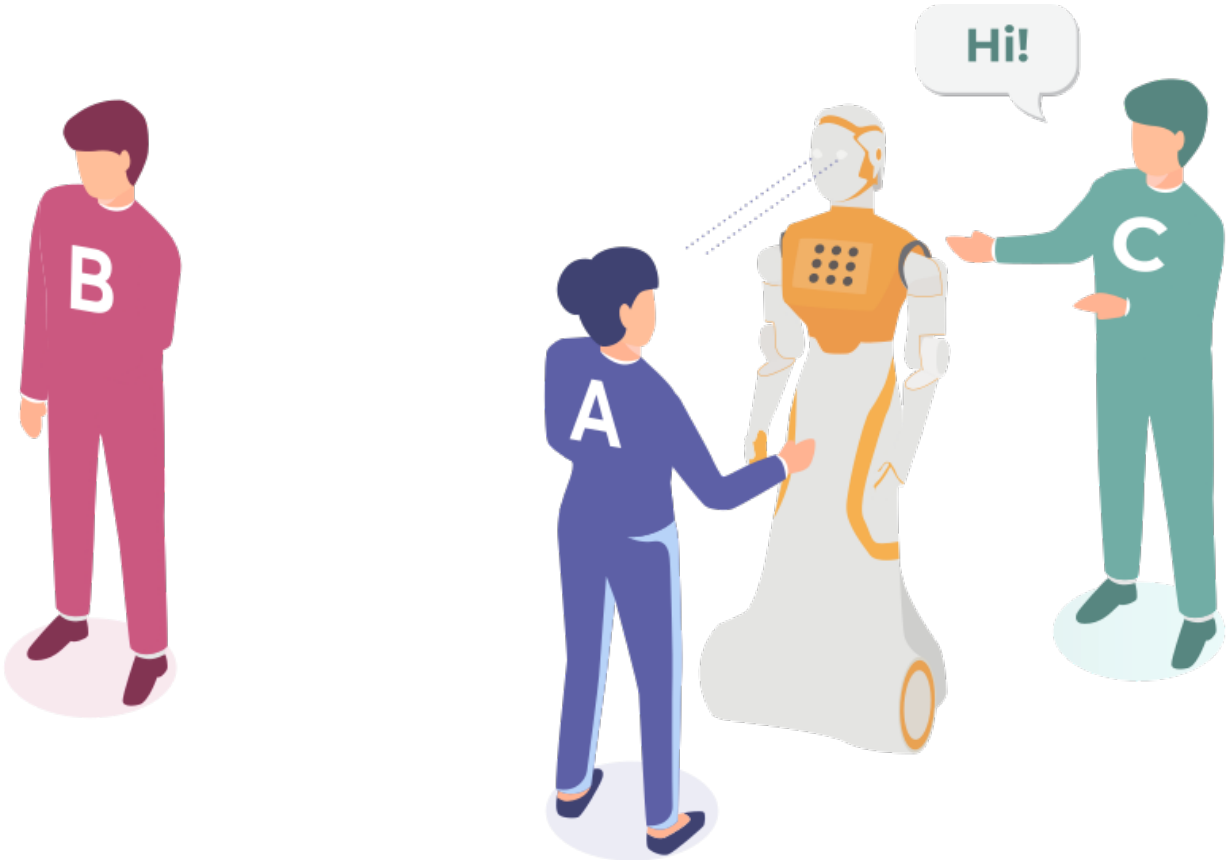
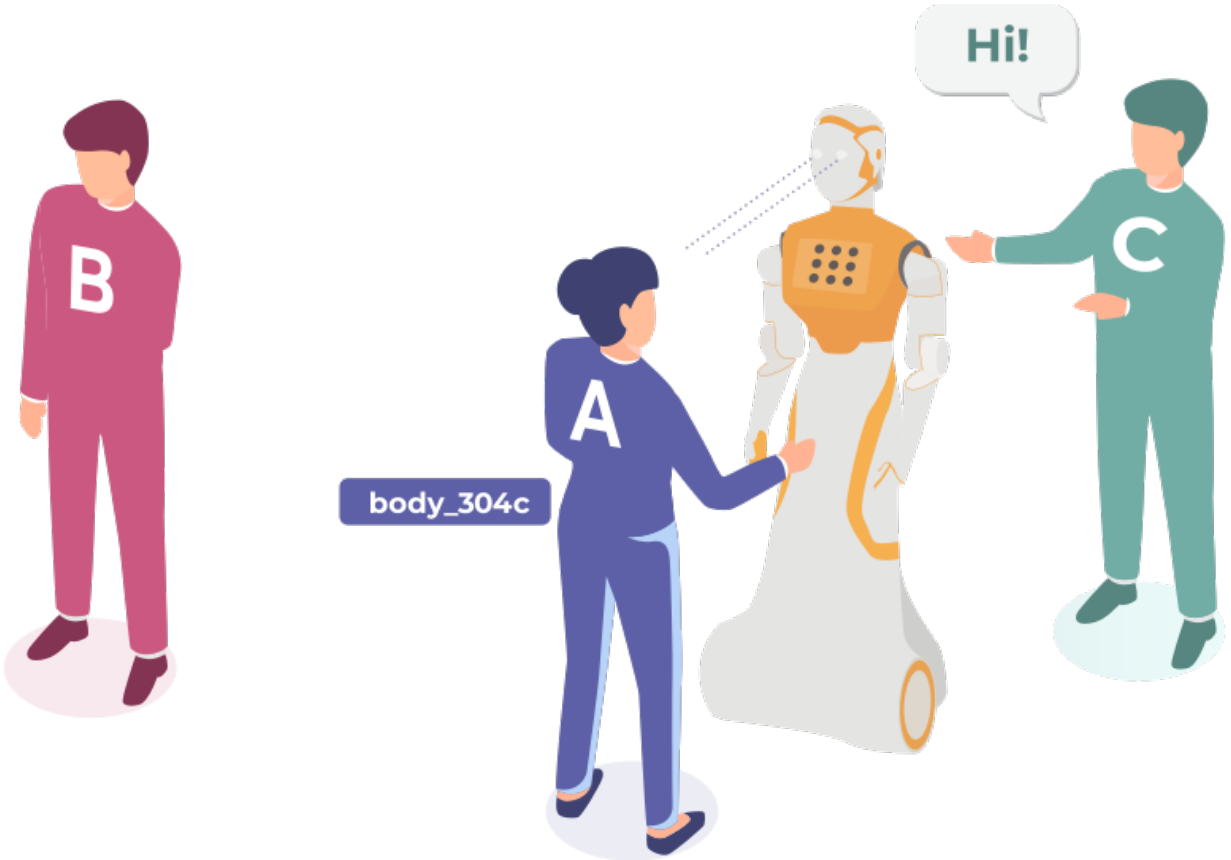
- for now, focus on *perception* only
- initially, ROS1

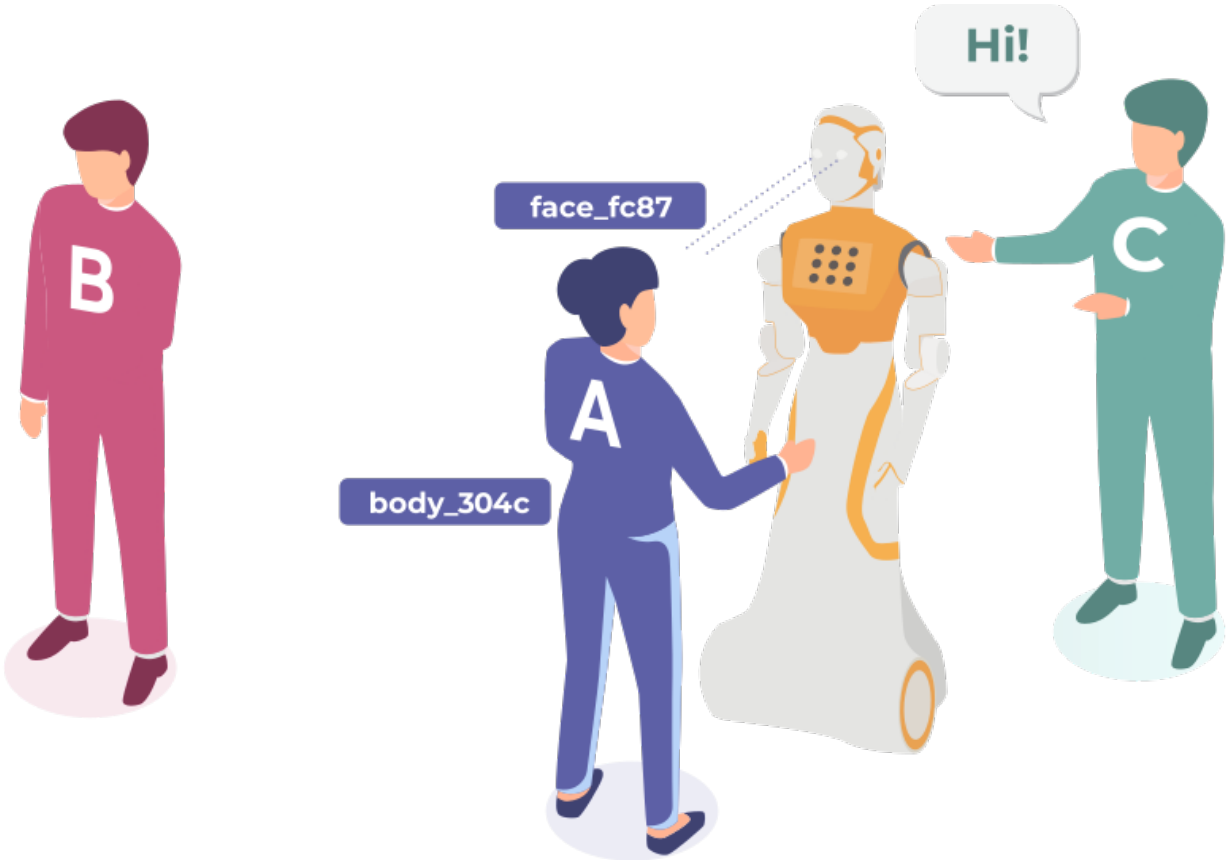
HUMAN REPRESENTATION: PERMANENT VS TRANSIENT IDS



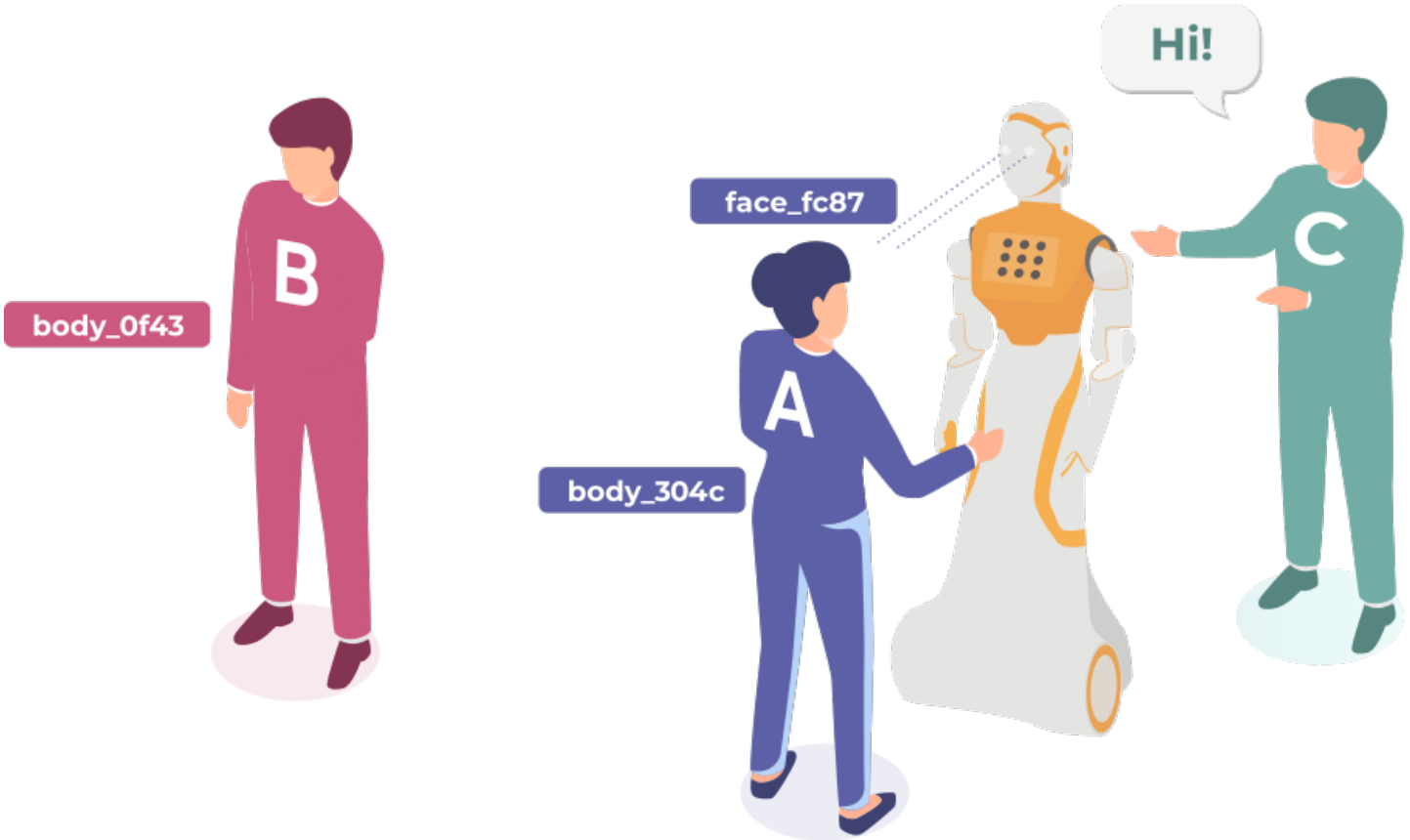
HUMAN REPRESENTATION: PERMANENT VS TRANSIENT IDS



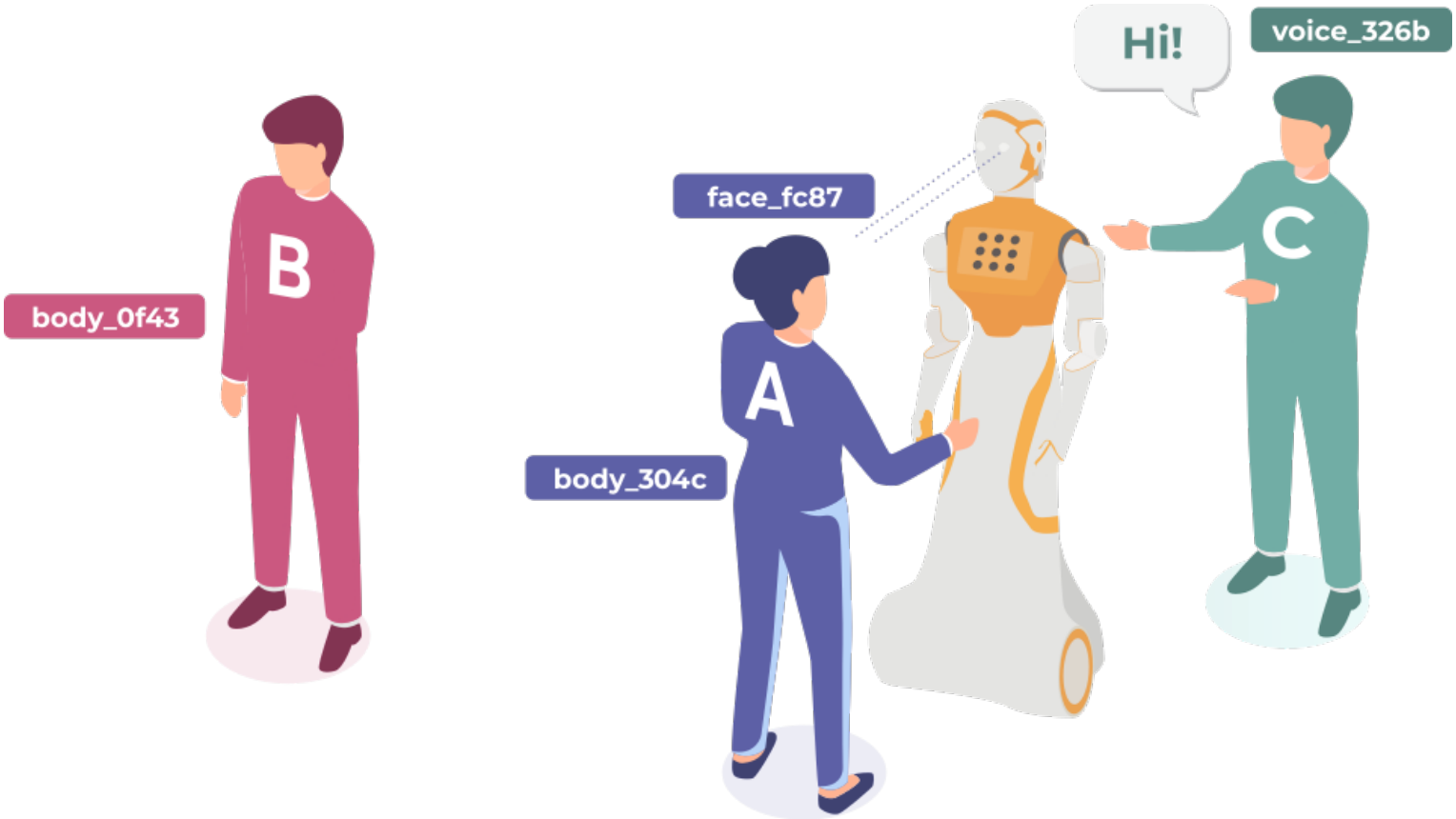
HUMAN REPRESENTATION: PERMANENT VS TRANSIENT IDS



HUMAN REPRESENTATION: PERMANENT VS TRANSIENT IDS



HUMAN REPRESENTATION: PERMANENT VS TRANSIENT IDS



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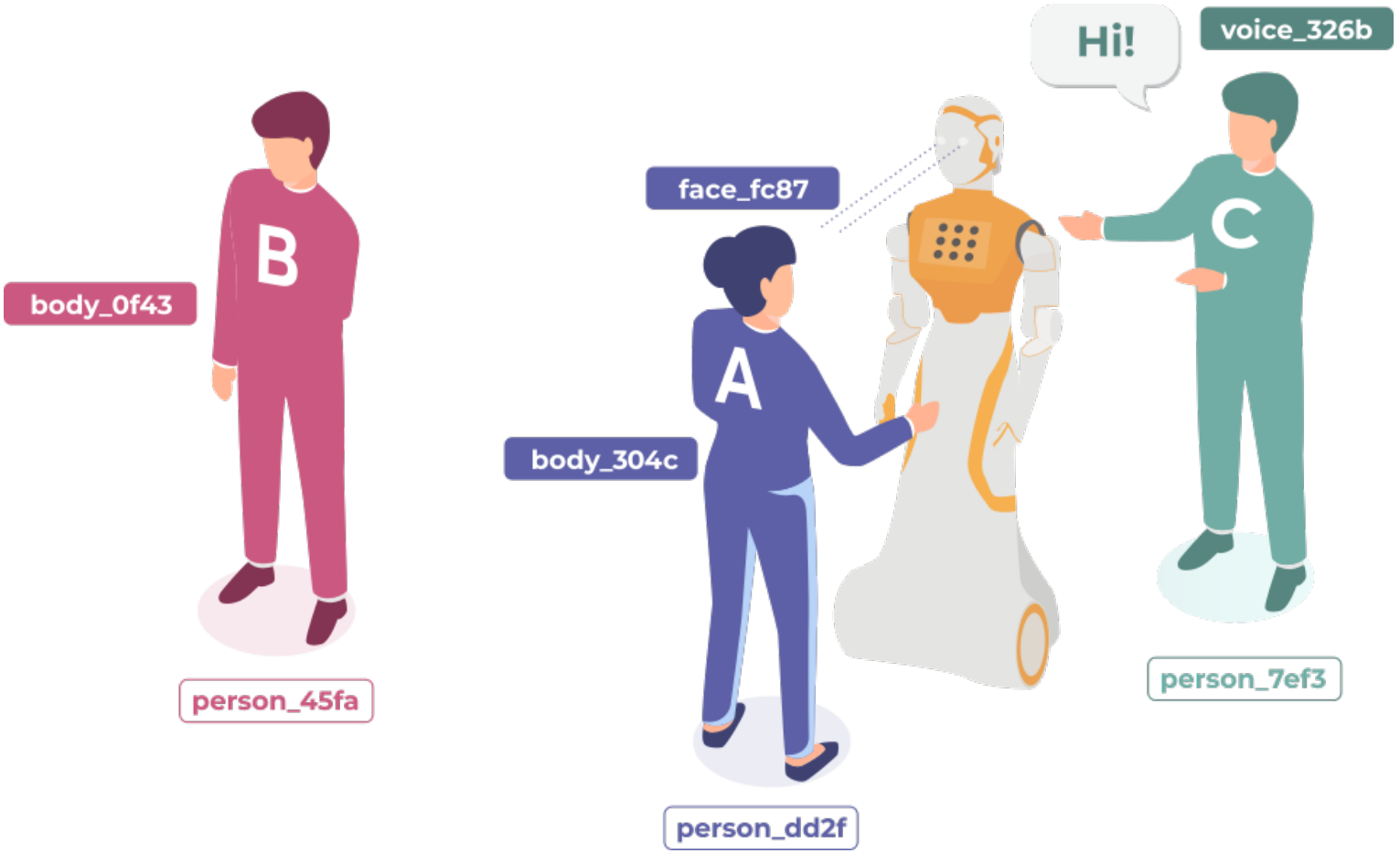


TOPICS STRUCTURE: FACES

Under **`/humans/faces/<faceID>/`** (eg `/humans/faces/bf3d`):

Name	Message type	Description
`/roi`	`hri_msgs/NormalizedRegi...`	Region of the face in the source image
`/cropped`	`sensor_msgs/Image`	Cropped face
`/frontalized`	`sensor_msgs/Image`	Frontalised face
`/landmarks`	`hri_msgs/FacialLandmarks`	The 2D facial landmarks extracted from the face
`/facs`	`hri_msgs/FacialActionUnits`	The presence and intensity of facial action units found in the face
`/expression`	`hri_msgs/Expression`	The expression recognised from the face
`/softbiometrics`	`hri_msgs/SoftBiometrics`	Soft biometrics like age and gender of the face

TOPICS STRUCTURE: BODIES

Under **`/humans/bodies/<bodyID>/`** (eg `/humans/bodies/5e4d`):

Name	Message type	Description
`/roi`	`hri_msgs/NormalizedRegi...`	Region of the whole body in the source image
`/cropped`	`sensor_msgs/Image`	Cropped image of the body
`/joint_states`	`sensor_msgs/JointState`	The joint state of the human body
`/skeleton2d`	`hri_msgs/Skeleton2D`	The 2D points of the detected skeleton
`/posture`	`hri_msgs/BodyPosture`	Recognised body posture (sitting, standing)
`/gesture`	`hri_msgs/Gesture`	Recognised symbolic gesture

3D pose? `tf` frames from joint state + human URDF! I'll come to it in a minute.

TOPICS STRUCTURE: VOICES

Under **/humans/voices/<voiceID>/**
(eg /humans/voices/dde2):

Name	Message type	Description
/audio	audio_common_msgs/AudioData	Separated audio stream for this voice
/features	hri_msgs/AudioFeatures	INTERSPEECH'09 Emotion challenge low-level audio features
/is_speaking	std_msgs/Bool	Whether or not speech is recognised from this voice
/speech	hri_msgs/LiveSpeech	The live stream of speech recognized via an ASR engine

TOPICS STRUCTURE: PERSONS

Under **/humans/persons/<personID>/**
(eg /humans/persons/45ff):

Name	Message type	Description
/face_id	std_msgs/String (latched)	Face matched to that person (if any)
/body_id	std_msgs/String (latched)	Body matched to that person (if any)
/voice_id	std_msgs/String (latched)	Voice matched to that person (if any)
/alias	std_msgs/String (latched)	ID of other person, if alias
/anonymous	std_msgs/Bool (latched)	if true, anonymous person (not permanent ID)
/engagement_status	hri_msgs/EngagementLevel	engagement status of the person *with the robot*
/location_confidence	std_msgs/Float32	Location confidence; 1 means 'person currently seen', 0 means 'person location unknown'
/name	std_msgs/String	Name, if known
/native_language	std_msgs/String	IETF language codes like **EN_gb**, if known

TOPICS STRUCTURE: GROUPS

Under **`/humans/groups/<groupID>/`**
(eg `/humans/groups/56ef2`):

Name	Message type	Description
`/members`	`hri_msgs/IdLists`	Person ID of the members of the group

Attention: not yet in the REP-155!

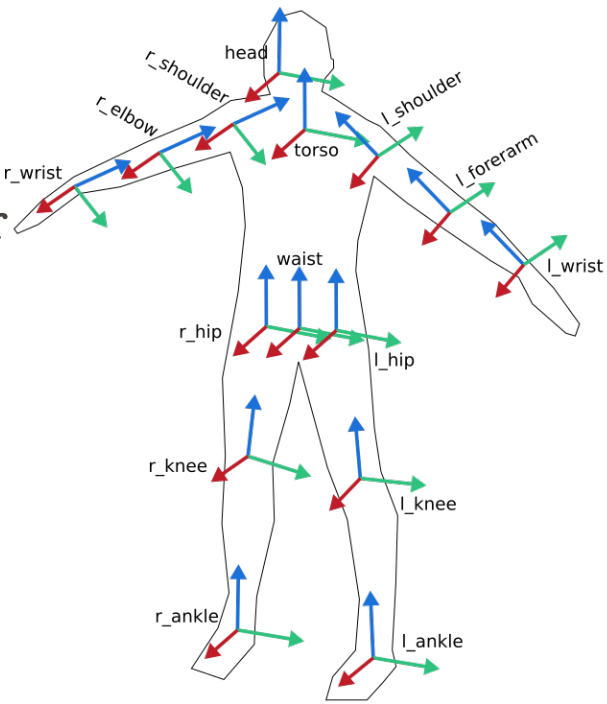
TOPICS STRUCTURE: INTERACTIONS

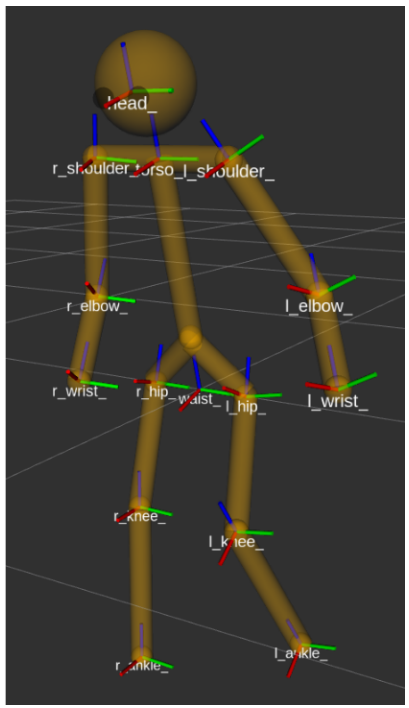
Under **`/humans/interactions/`**:

Name	Message type	Description
`/gaze`	`hri_msgs/Gaze`	estimated gazing behaviours

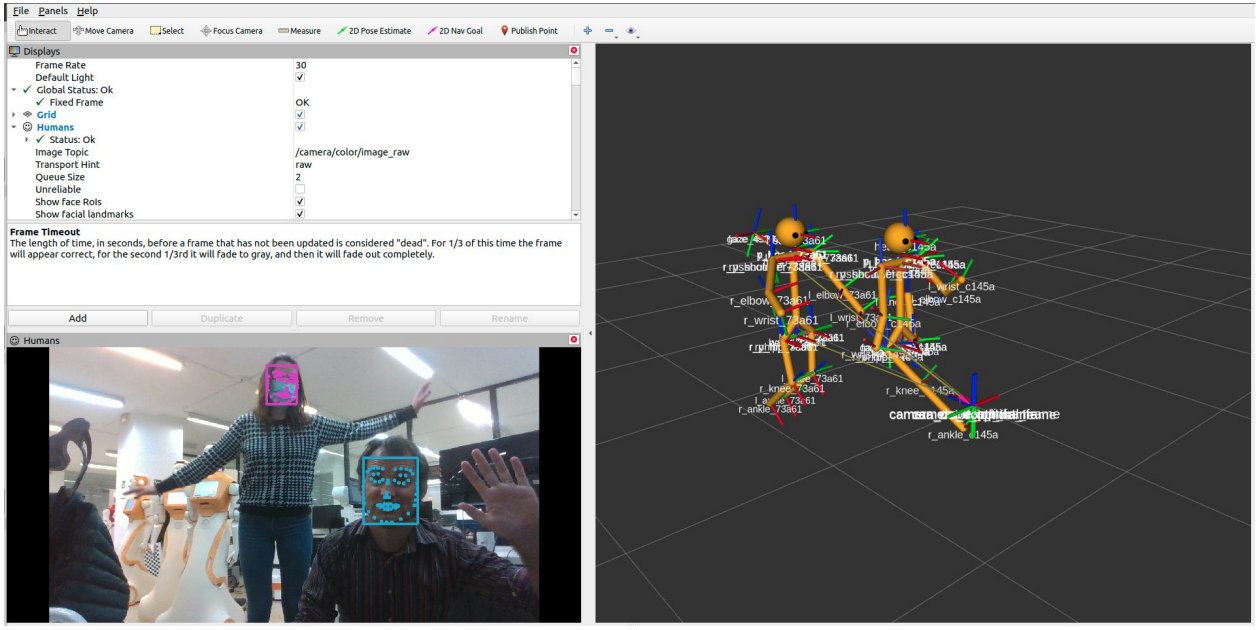
HUMAN PHYSICAL REPRESENTATION

- standard ROS pipeline: joint state (eg OpenPose, mediapipe) -> `robot_state_publisher` + URDF
- URDF generated on the fly, based on person's height (xacro params)
- Follows REP-120 as much as possible.

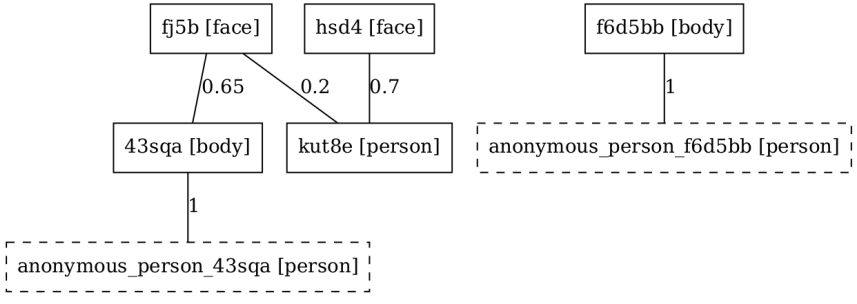




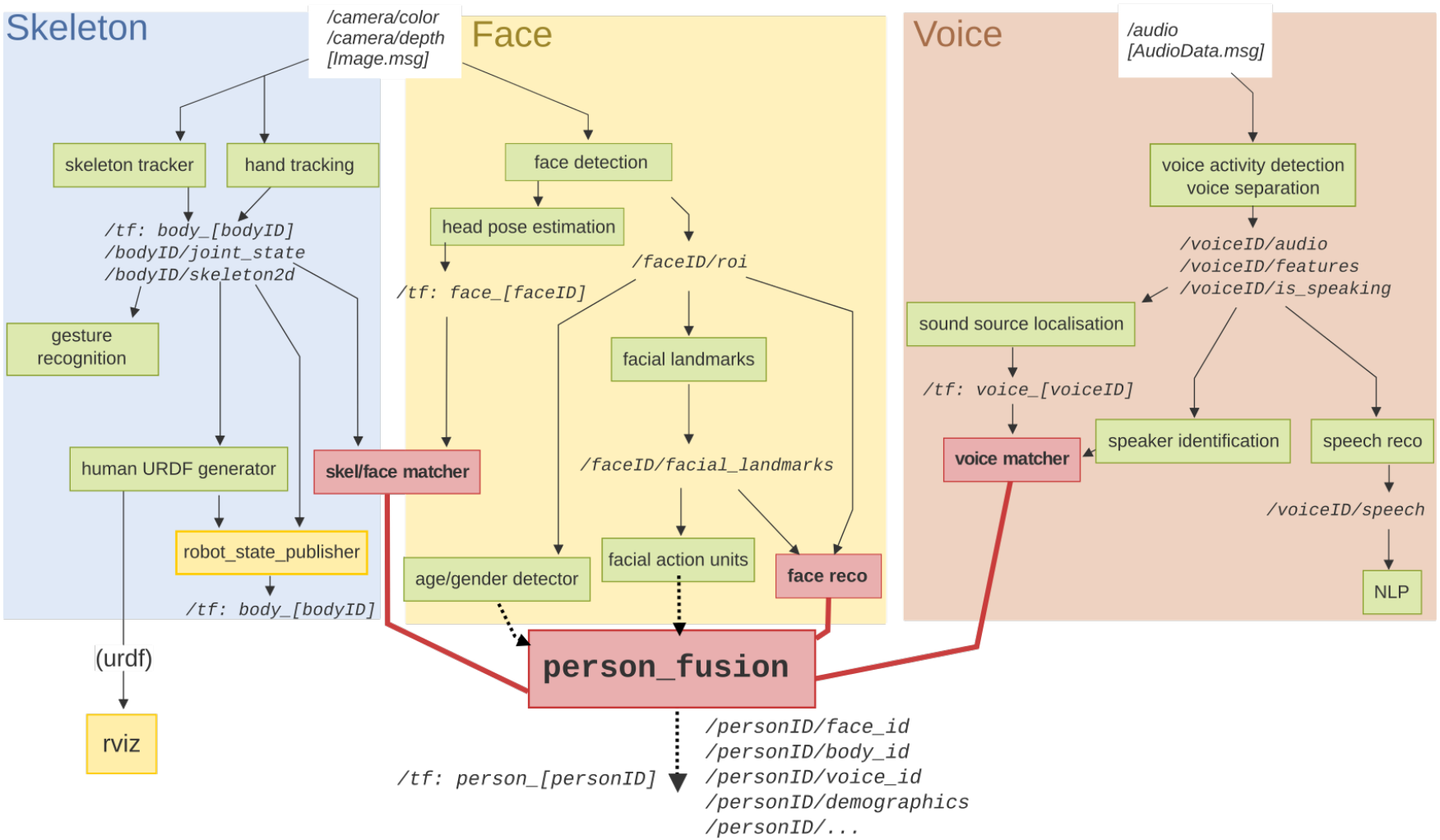
TOOLING

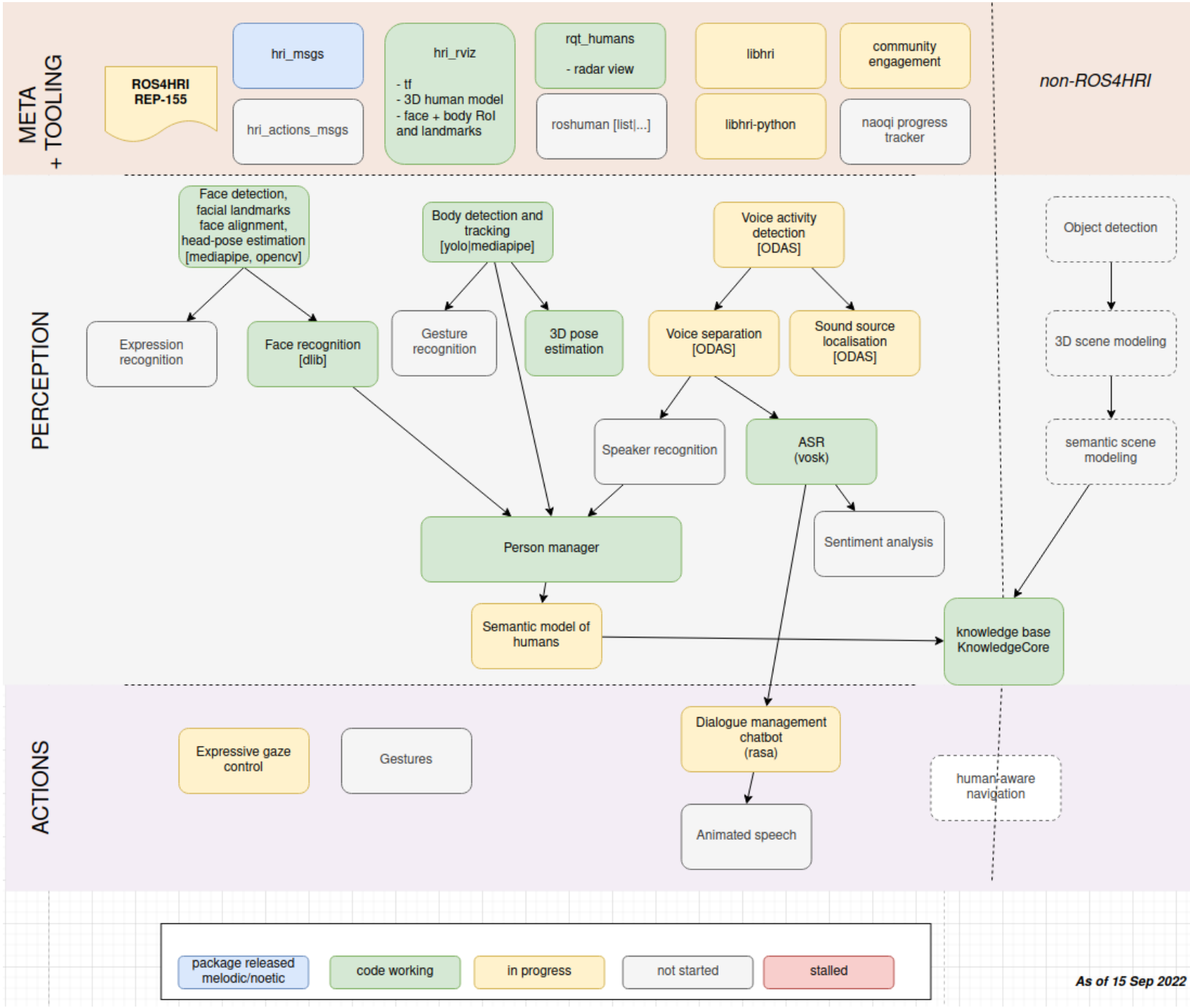

File Panels Help
Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Nav Goal
Publish Point
Displays
Frame Rate 30
Default Light
Global Status: Ok
Fixed Frame OK
Grid
Humans
Status: Ok
Image Topic /camera/color/image_raw
Transport Hint raw
Queue Size 2
Unreliable
Show face RoIs
Show facial landmarks
Frame Timeout
The length of time, in seconds, before a frame that has not been updated is considered "dead". For 1/3 of this time the frame will appear correct, for the second 1/3rd it will fade to gray, and then it will fade out completely.
Add
Duplicate
Remove
Rename
Humans

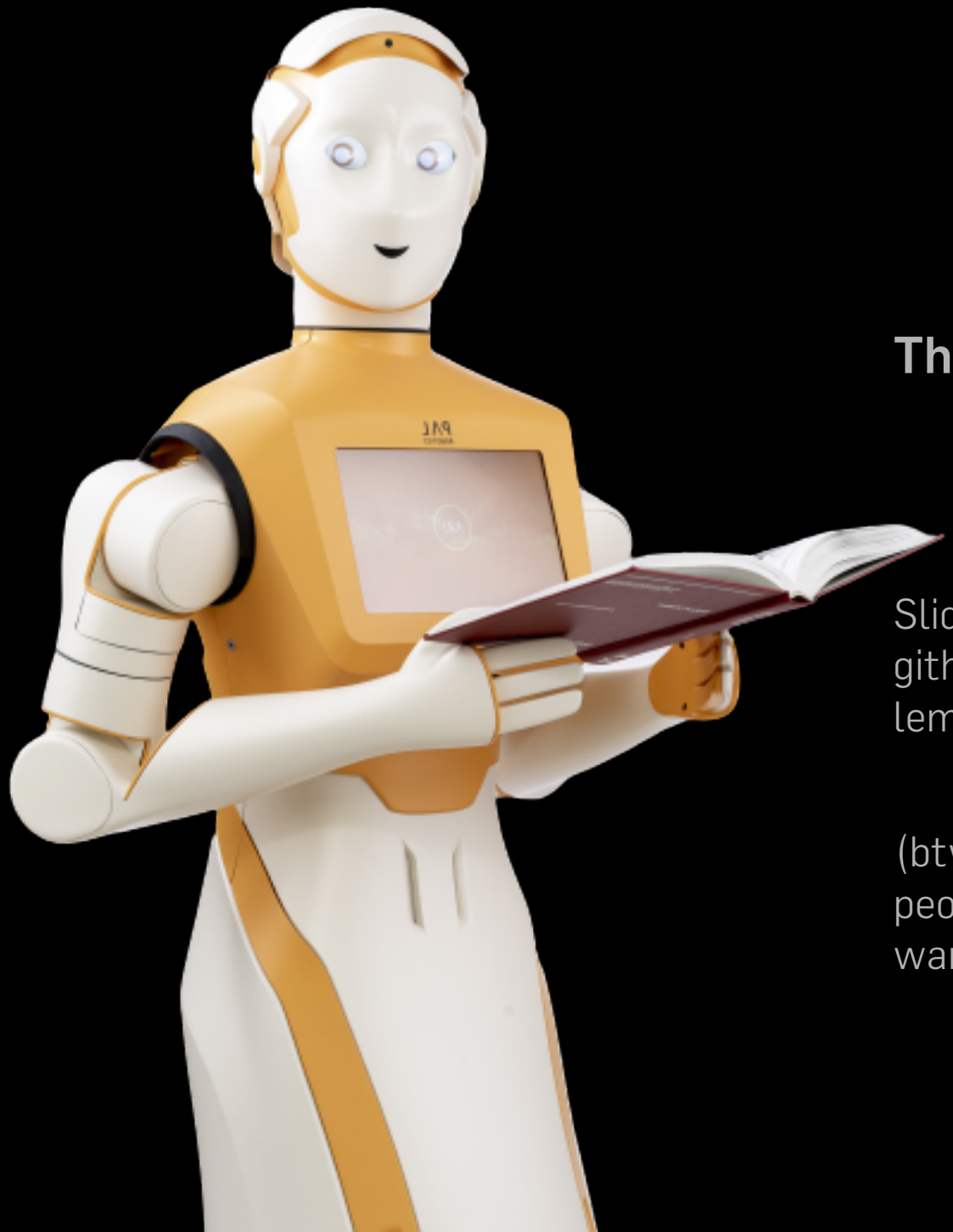

fa627
107ac
b09ad
f57bd
90°
60°
30°
-30°
-60°
-90°
2m


fj5b [face]
hsd4 [face]
f6d5bb [body]
0.65
0.2
0.7
1
43sqa [body]
kut8e [person]
anonymous_person_f6d5bb [person]
1
anonymous_person_43sqa [person]

ONE POSSIBLE PIPELINE (BUT OTHER ARE POSSIBLE!)




META + TOOLING
ROS4HRI REP-155
hri_msgs
hri_actions_msgs
hri_rviz
- tf
- 3D human model
- face + body RoI and landmarks
rqt_humans
- radar view
roshuman [list|...]
libhri
libhri-python
community engagement
naoqi progress tracker
non-ROS4HRI
PERCEPTION
Face detection, facial landmarks face alignment, head-pose estimation [mediapipe, opencv]
Expression recognition
Face recognition [dlib]
Body detection and tracking [yolo|mediapipe]
Gesture recognition
3D pose estimation
Voice activity detection [ODAS]
Voice separation [ODAS]
Sound source localisation [ODAS]
Speaker recognition
ASR (vosk)
Sentiment analysis
Person manager
Semantic model of humans
Object detection
3D scene modeling
semantic scene modeling
knowledge base KnowledgeCore
ACTIONS
Expressive gaze control
Gestures
Dialogue management chatbot (rasa)
Animated speech
human-aware navigation
package released melodic/noetic
code working
in progress
not started
stalled
As of 15 Sep 2022



Thank you!

Slides:
github.com/severin-lemaignan/presentation-ros4hri

(btw, we are always looking for great people to join us: drop me line if you want to know more!)

PAL ROBOTICS