CORSMAL
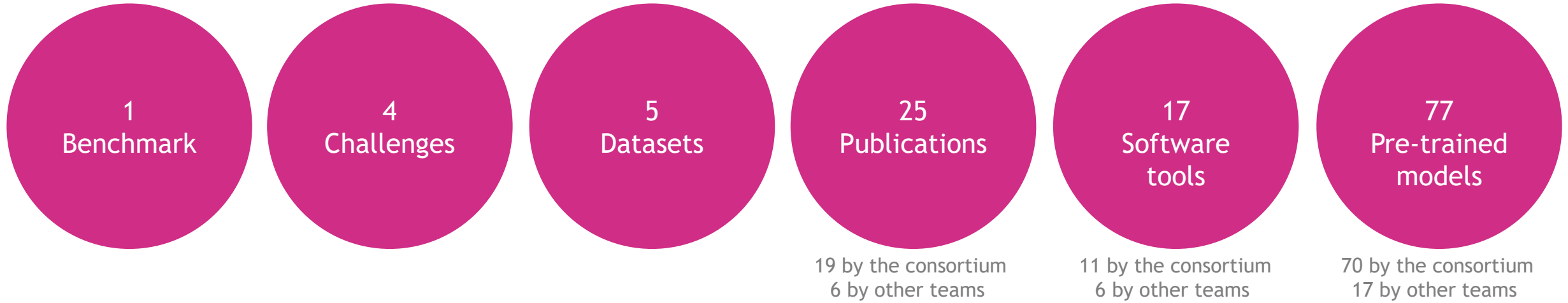
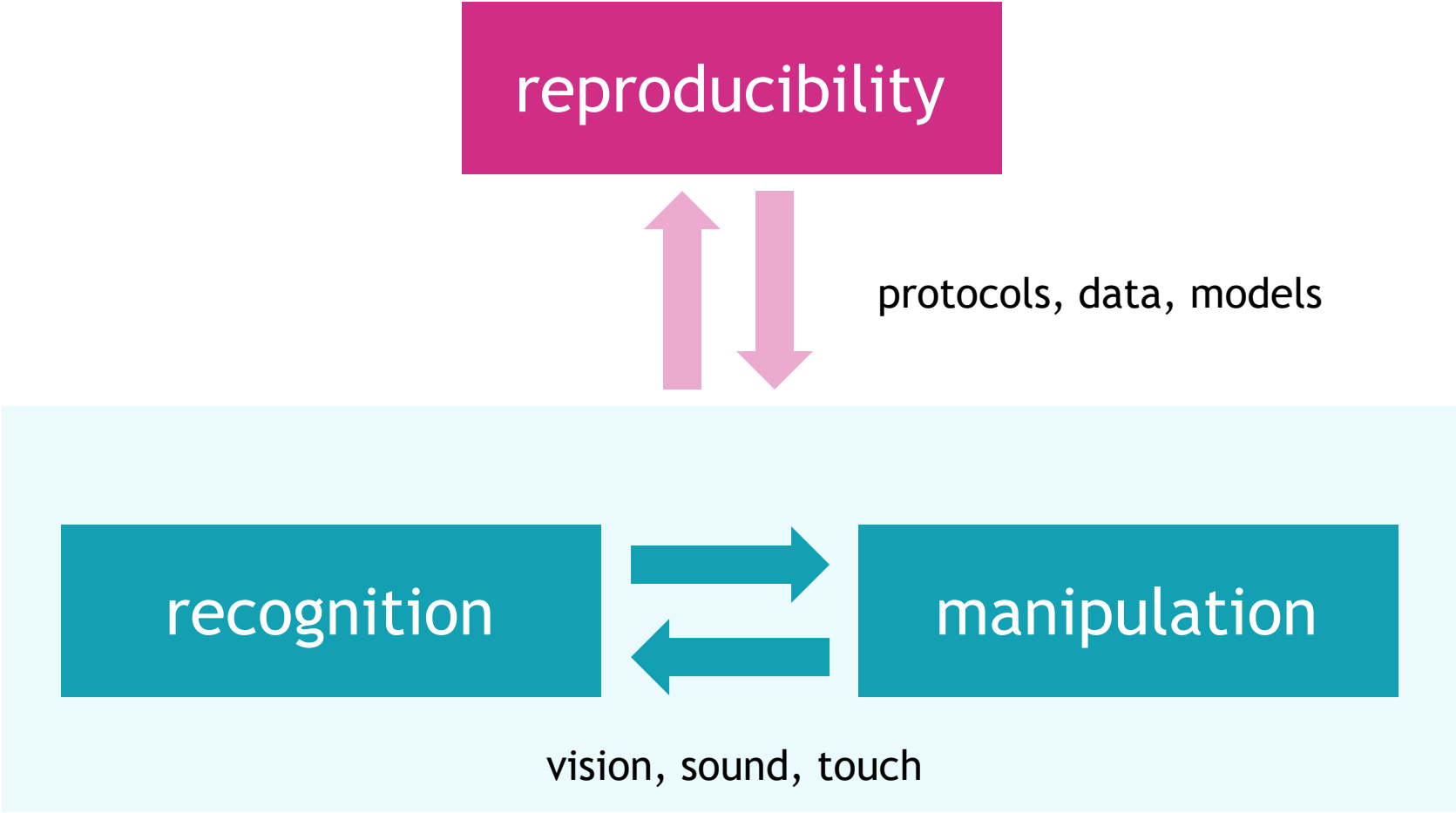## Collaborative Object Recognition, Shared Manipulation And Learning

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CORSMAL in a nutshell

1 Benchmark

4 Challenges

5 Datasets

25 Publications

19 by the consortium
6 by other teams

17 Software tools

11 by the consortium
6 by other teams

77 Pre-trained models

70 by the consortium
17 by other teams

Focus: human-to-robot handovers

Human grasping — Human manipulation — Robot grasping — Robot manipulation — Robot delivery

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Collaborative object recognition,
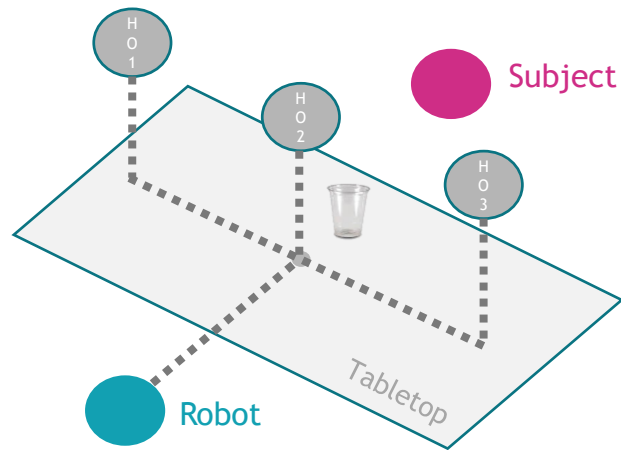shared manipulation and learning
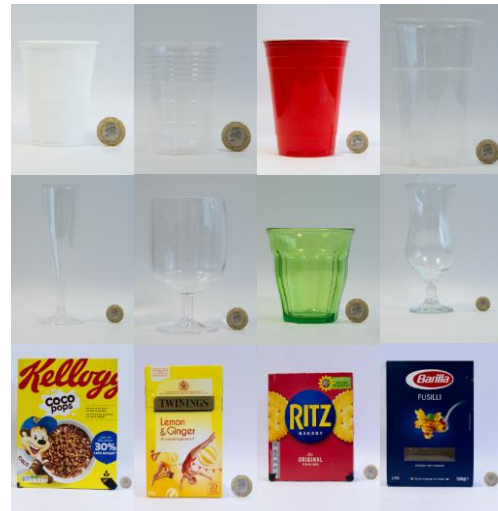
Example

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Collaborative object recognition,
shared manipulation and learning

Reproducibility: protocol, data, models, challenge

Benchmark and **baseline algorithms** for human-to-robot handovers distributed to (and used by) the community

Multi-modal datasets: containers manipulated by a human or by a robot

Machine learning models distributed to (and complemented by) the community

Platform for participants to submit the results of the **CORSMAL Challenge** and continuously updated **leaderboard**

Team	Description	Task 1	Task 2	Task 3	Public	Private	Overall
Because It's Tacti...	GRU+ Random Forest for filling properties estimation. LoDE with RGB-D-IR data from selected frames in a video for volume estimation.	✓	✓	✓	64.98	65.15	65.06
HVRL	Log-Mel spectrogram-based audio features as input to VGG-based CNN and LSTM for filling properties estimation. Container volume from the shape approximation as cuboid of the 3D point cloud obtained with RGB-D data and object detection with Mask R-CNN.	✓	✓	✓	63.32	61.01	62.16
Concatenation	Multi-modal learning with audio features and prior of container categories through object detection for inferring container capacity and fluid properties.				52.80	54.14	53.47
NTNU-ERC	MFCC features in a 20s-window + neural network to classify filling type. Object detection and selection of the closest contours (up to 700 mm) in the depth data + regression with a CNN for container capacity.				38.56	39.80	39.18
Random	Baseline with random estimations for each task.	✓	✓	✓	38.47	31.65	35.06
Challengers	Sound-based classification of filling type and level with STFT and 5-layers fully connected neural network.	✓	✓		29.25	23.21	26.23
SCC-Net	Sound-based hierarchical ensemble of DNNs to jointly classify filling type and level.	✓	✓		28.02	22.92	25.47
Mask R-CNN + R...	Vision baseline for filling properties estimation.			✓	19.46	9.59	14.53
Mask R-CNN + R...	Vision baseline for filling properties estimation.			✓	15.15	9.96	12.56
Mask R-CNN + R...	Vision baseline for filling properties estimation.			✓	17.28	6.99	12.14
Mask R-CNN + R...	Vision baseline for filling properties estimation.			✓	12.95	10.25	11.60

CORSMAL Protocol and Code
github.com/CORSMAL/Benchmark
ieeexplore.ieee.org/document/8968407
IEEE RA-L Open Access

CORSMAL Datasets
doi.org/10.17636/101CORSMAL1
doi.org/10.17636/corsmal2
doi.org/10.5281/zenodo.6372438
doi.org/10.5281/zenodo.4642577

CORSMAL Pre-trained Models
doi.org/10.5281/zenodo.4518950
doi.org/10.5281/zenodo.5525332
doi.org/10.5281/zenodo.4770061
doi.org/10.5281/zenodo.4518951

CORSMAL Challenge and Evaluation Toolkit
corsmal.eecs.qmul.ac.uk/challenge.html
github.com/CORSMAL/CORSMALChallengeEvalToolkit

Open Science

Challenge: Main events, organisers, sponsors & participants

Project partners

Queen Mary University of London

SORBONNE UNIVERSITÉ

EPFL

Joined the Challenge organisers team

WPI Worcester Polytechnic Institute

UTS University of Technology Sydney

Challenge events at major international conferences

ICME 2020

ICPR 2020 — 25th INTERNATIONAL CONFERENCE ON PATTERN RECOGNITION — Milan, Italy 10 | 15 January 2021

ICASSP 2022 Singapore

Challenge prizes: Sponsors

The Alan Turing Institute

Institute of Applied Data Science — Queen Mary University of London

ZEBRA

UCL

慶應義塾 Keio University

國立臺灣師範大學 National Taiwan Normal University

Università di Genova

UNIVERSITY OF BIRMINGHAM

Tampere University

CityU 香港城市大學 City University of Hong Kong

भारतीय प्रौद्योगिकी संस्थान भुवनेश्वर Indian Institute of Technology Bhubaneswar

भारतीय प्रौद्योगिकी संस्थान हैदराबाद Indian Institute of Technology Hyderabad

Participants

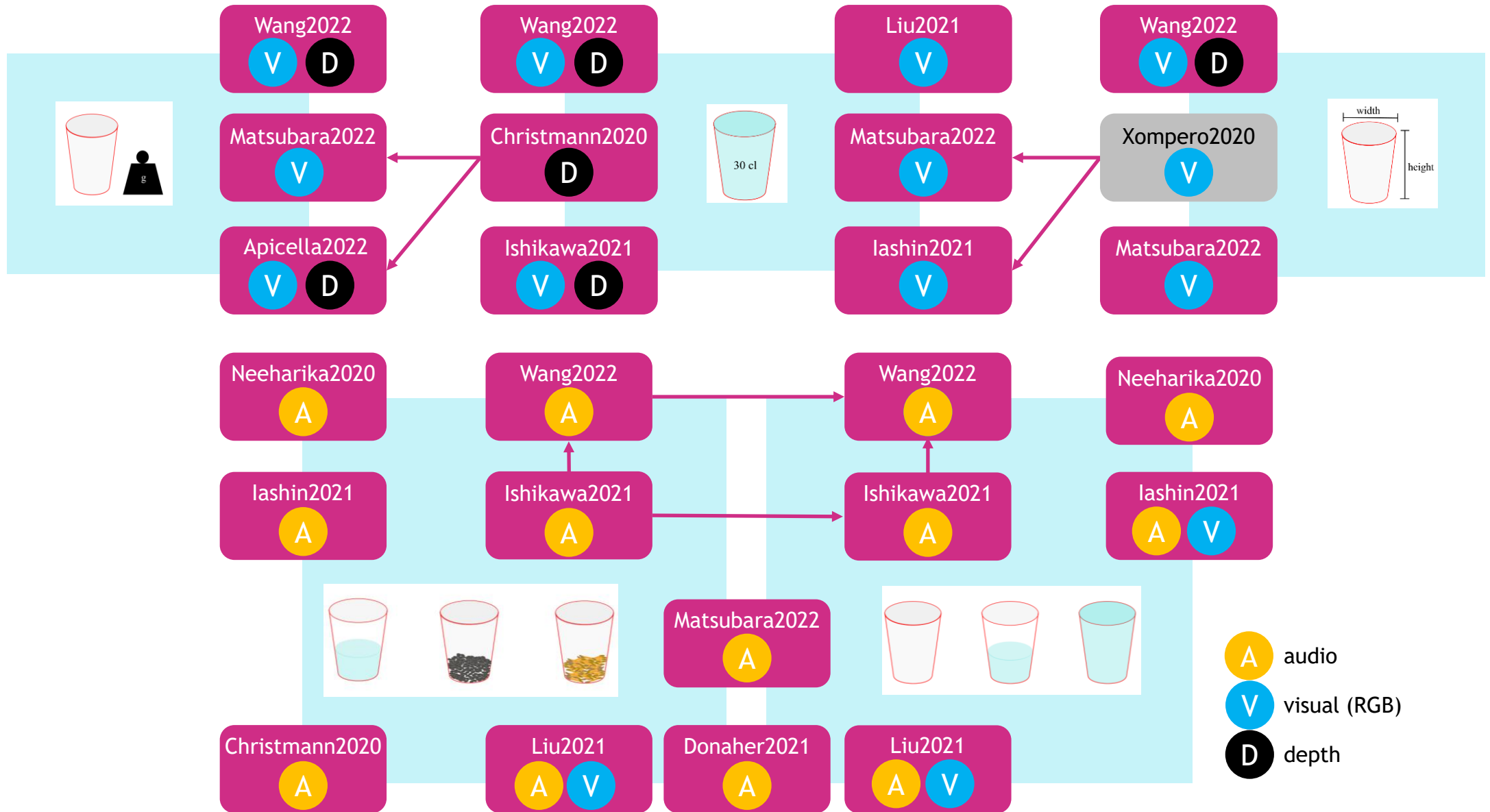# Challenge tasks: Physical properties estimation
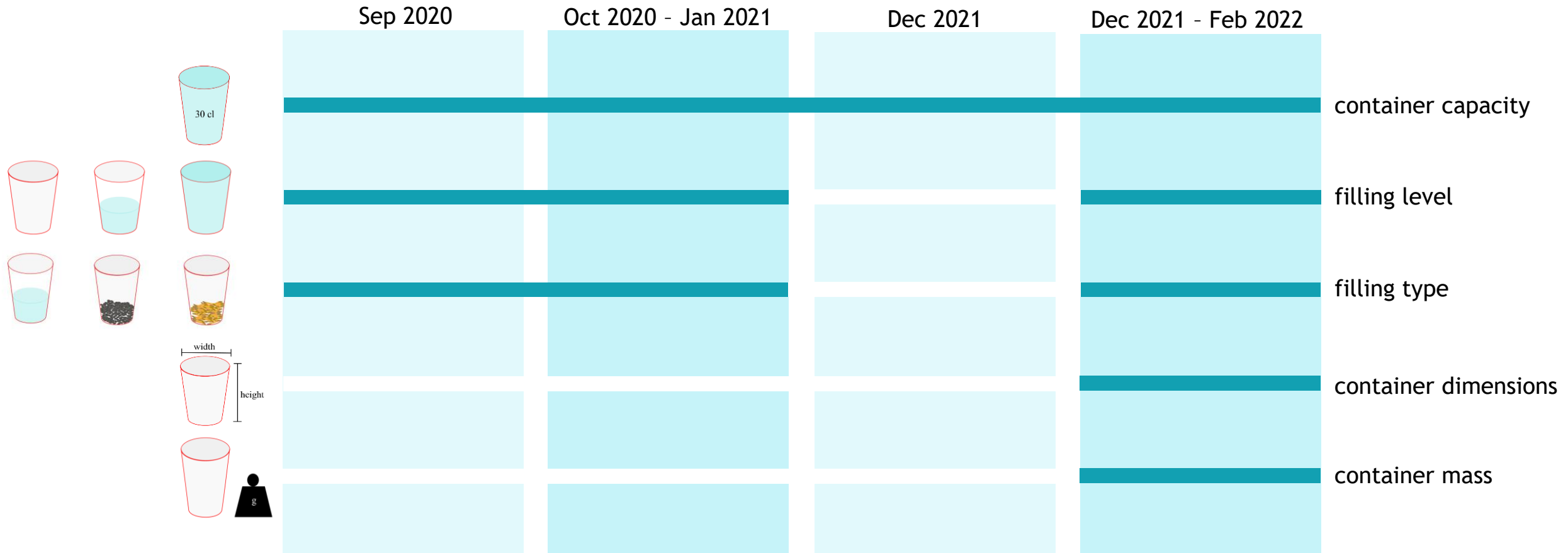
Models shared by challenge participants for the five tasks

share

improve   reproduce

rep   ity

compare

protocols, data, models

recognition → manipulation

vision, sound, touch

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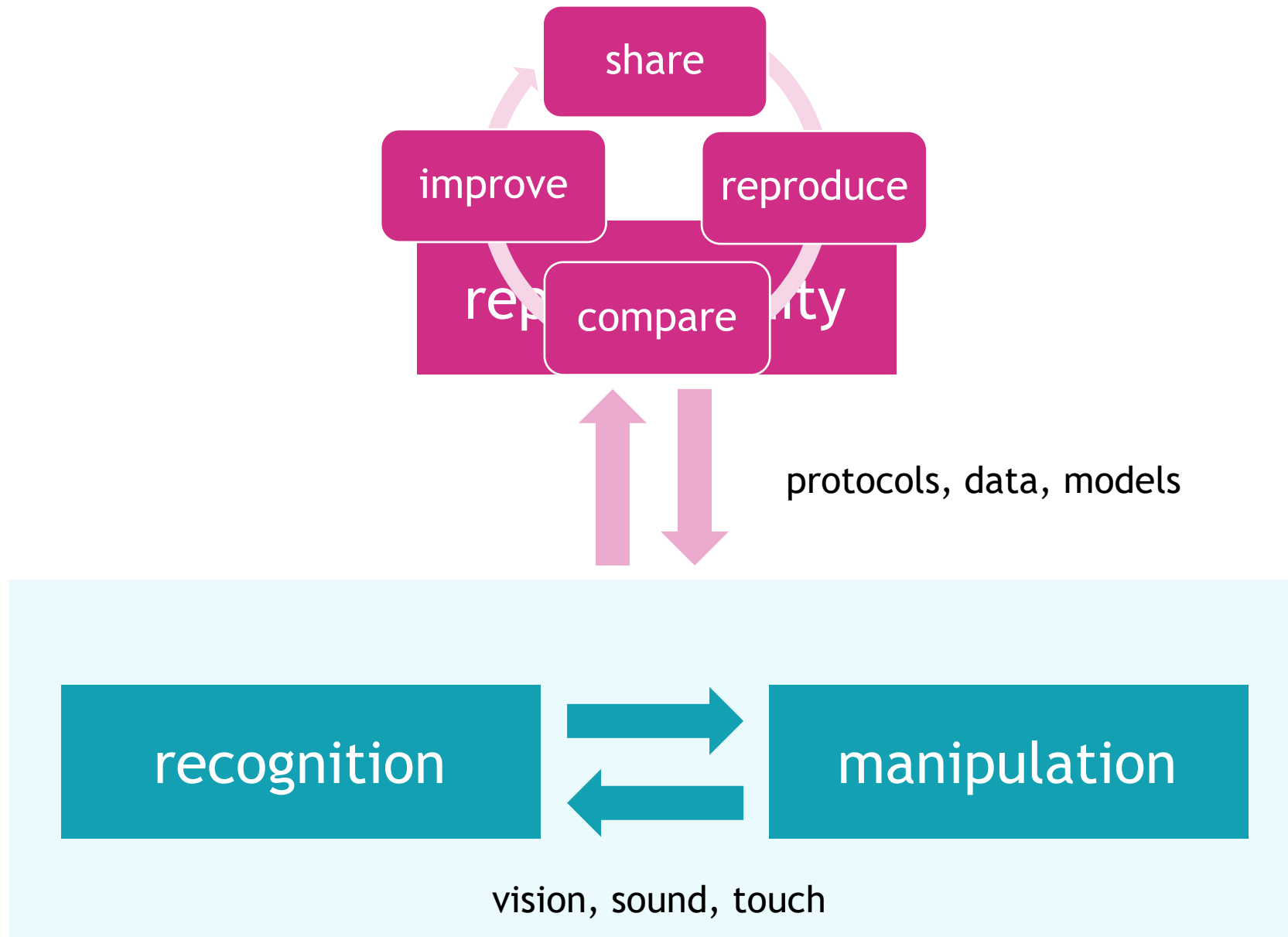
Transfer learning for model fine tuning

adversarial example

source domain

<castle>
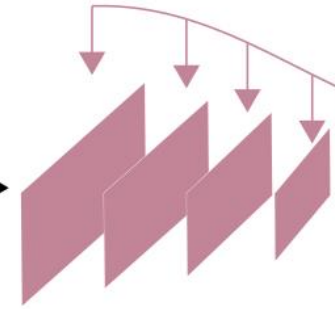
Adversarial training

target domain

<full>

Fine-tuning

Transfer learning
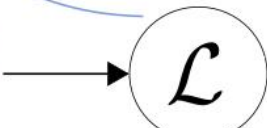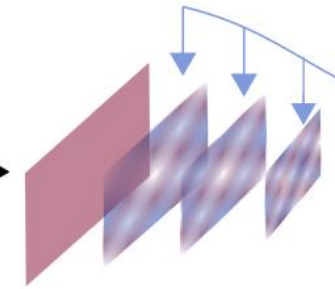
CORSMAL
Collaborative object recognition,
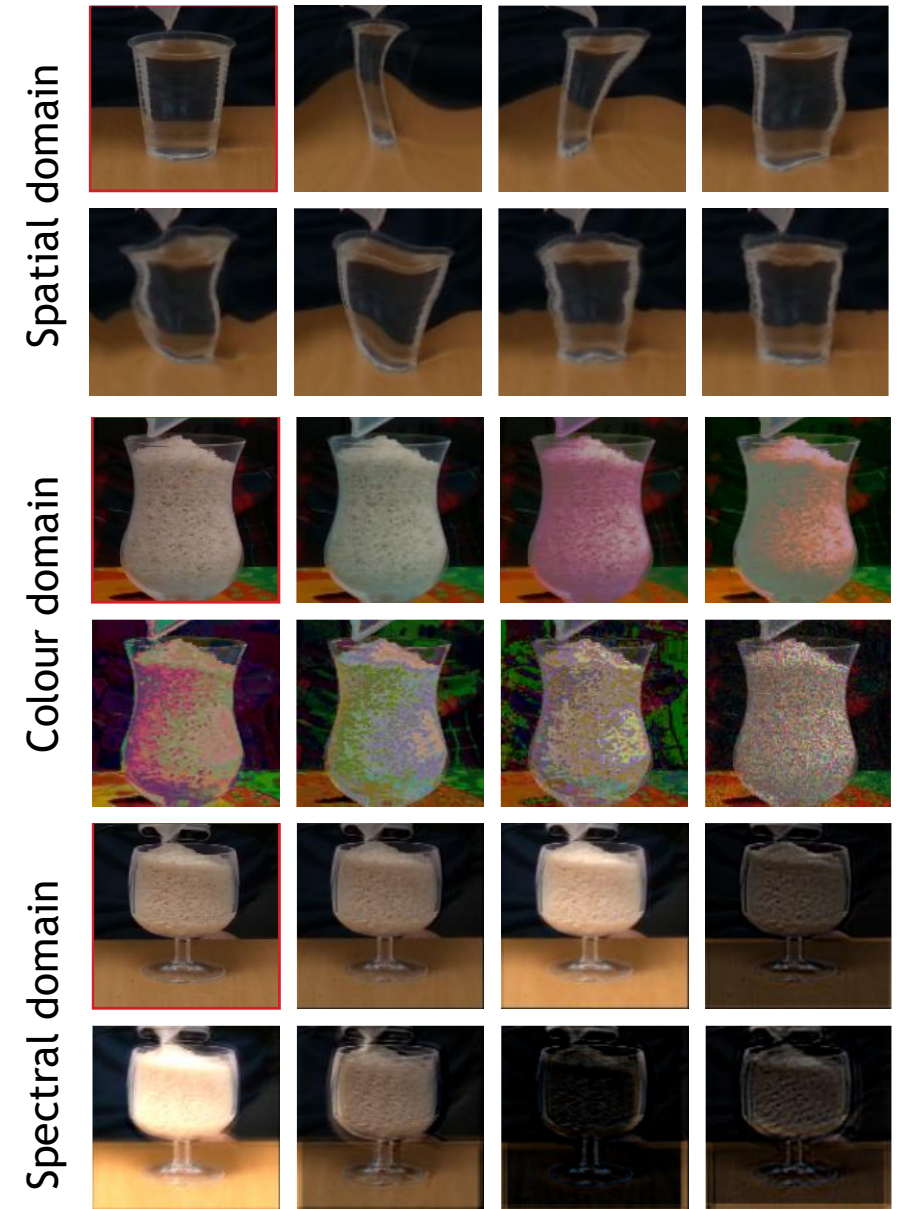shared manipulation and learning

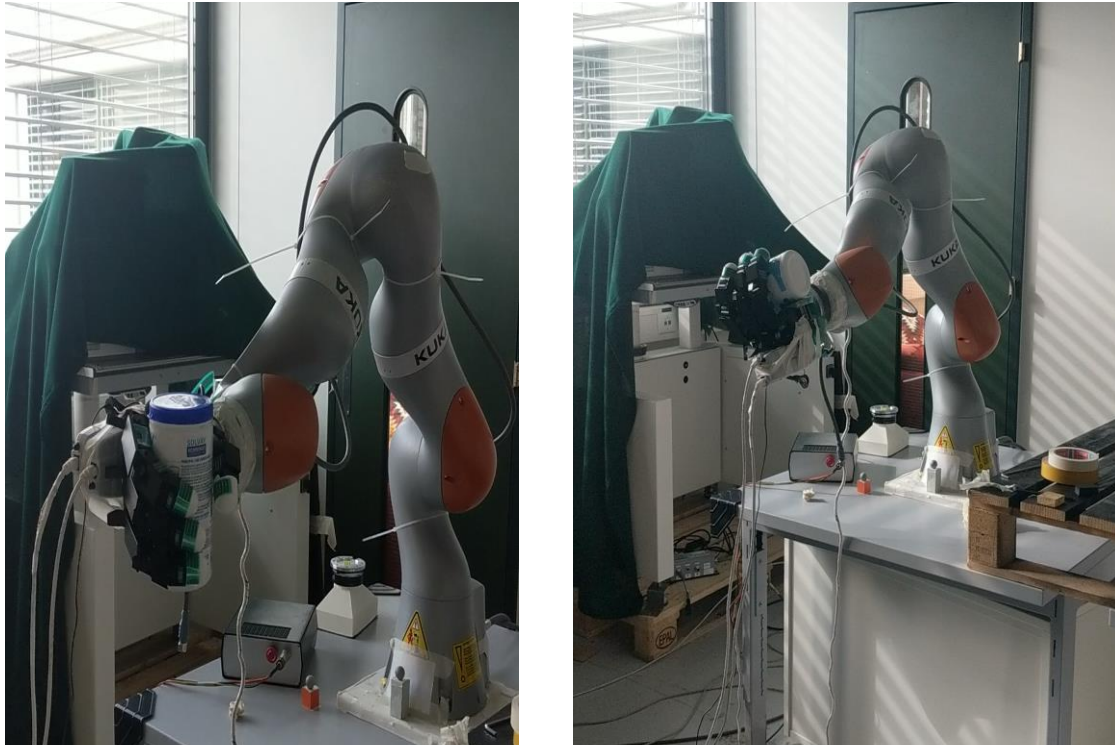# Data augmentation for model training

Filling level estimation

- **High variability**: container shape, transparencies, illumination and background variations, occlusions

- **Augmentations** tailored to the task
  - Diffeomorphisms
  - Random colour jittering
  - FIR filter with random coefficients

- **Mixing strategy** to increase diversity of transformations

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Spatial domain

Colour domain

Spectral domain

Audio-tactile sensory fusion

microphone

tactile sensors

joint sensors

Ground Truth

Echo State Network (ESN) from Tekscan Tactile Data

Prediction

Real-time prediction of the contents of container & inertial properties during robot manipulation
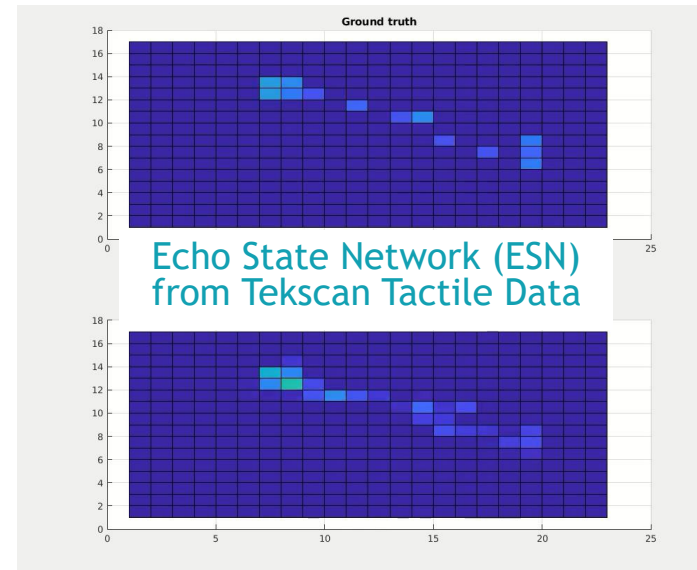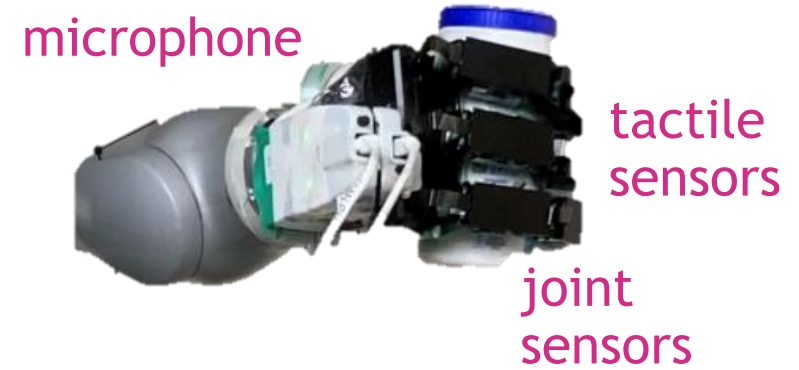
Predict torque in anticipation for adaptive hand control to maintain stable grip on the container during manipulation

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