

# CLEVER: Stream-based Active Learning for Robust Semantic Perception from Human Instructions

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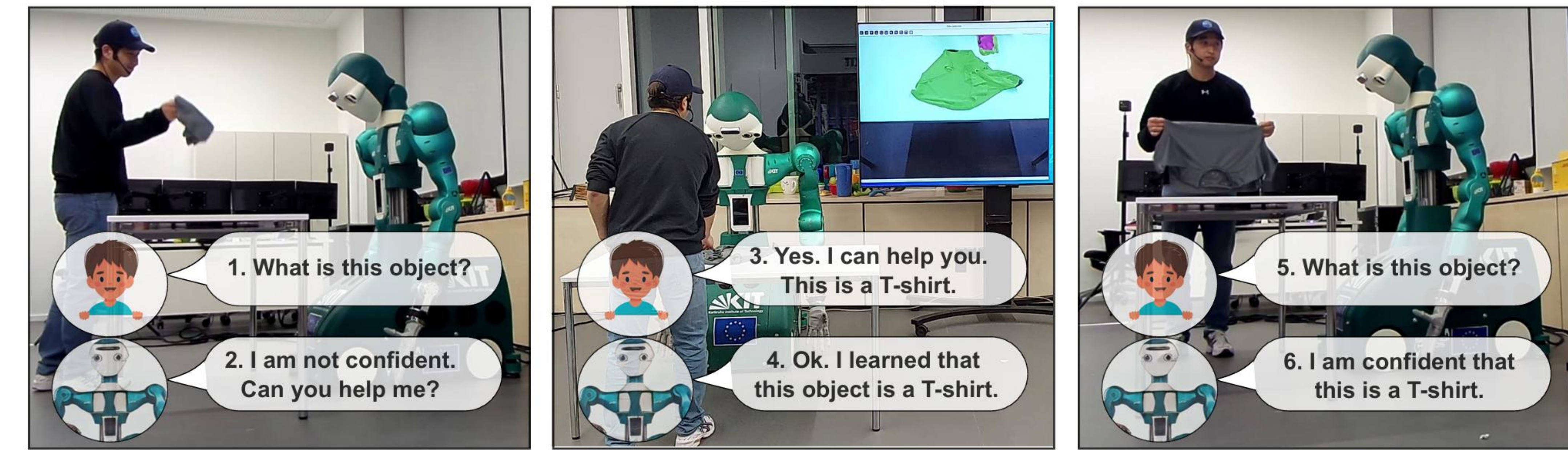


## Problem

- Robustness against distribution shift for deep learning methods.
- Imagine deep learning method for semantic segmentation, trained to perceive apples and bananas
- But we show an image of T-shirts

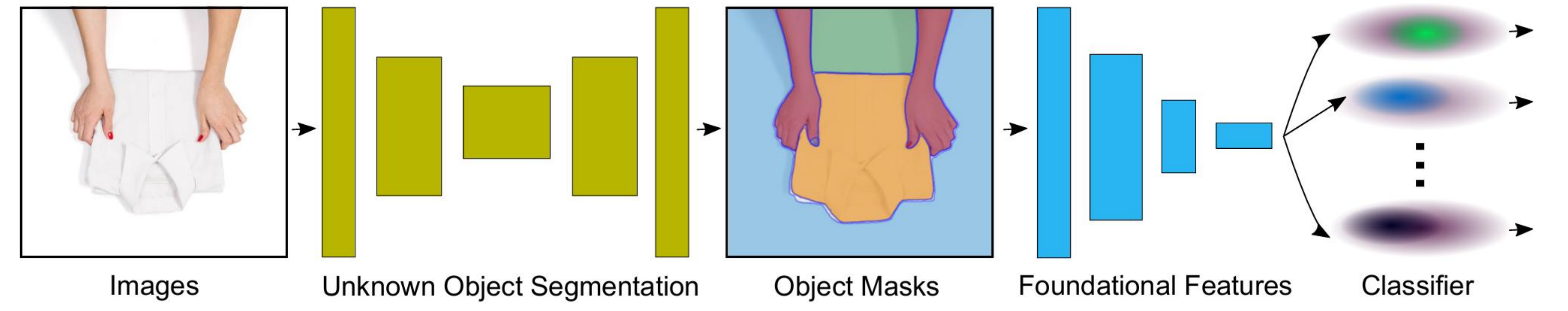
## Main Idea

- Build a stream-based active learner:
1. Ask help from humans with uncertainty estimates
  2. Reduce model uncertainty by continuously learning from human → Enables robust semantic perception

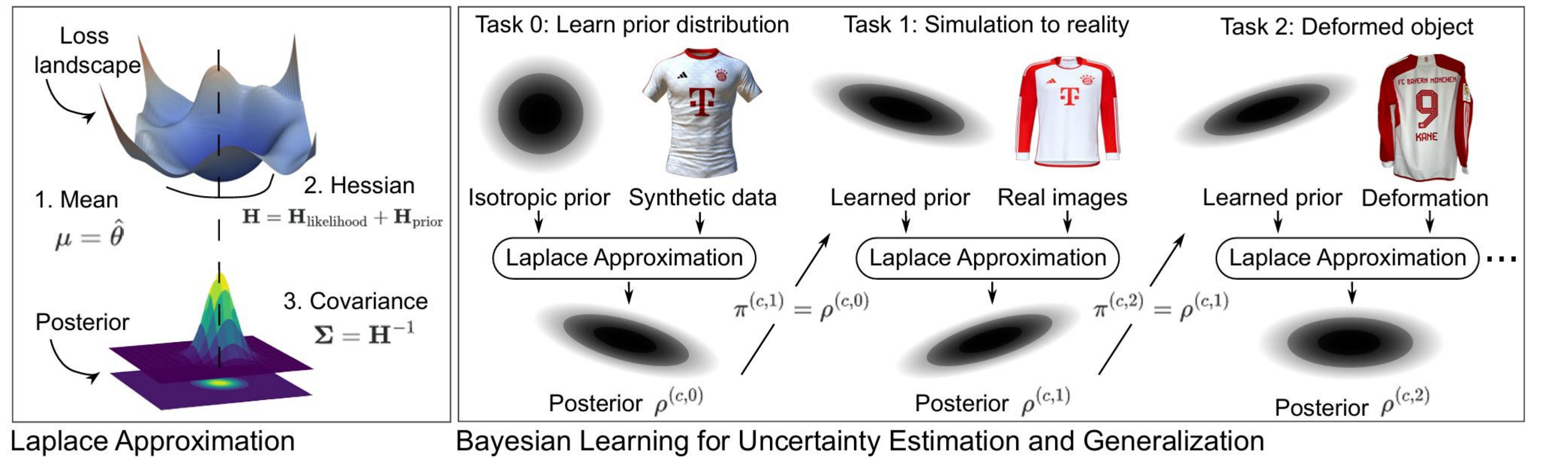


## CLEVER

“To our knowledge, the first stream-based active learner shown in a physical system for perception tasks”



- Multi-head Bayesian Neural Network → No forgetting and fast online learning



- Learn priors →  $0. p(\theta^{(0)}) = \mathcal{N}(\theta^{(0)} | \mathbf{0}, \tau I)$
- Pac-Bayes  $1. p(\theta^{(0)} | D^{(0)})$
- Temporal AL  $2. p(\theta^{(1)}) = p(\theta^{(0)} | D^{(0)})$
- $3. p(\theta^{(1)} | D^{(1)})$  ...

## Results

- Ablation study on elaborate prior

	Success rate	ECE	Precision	Nr. Queries
CLEVERv1	0.887±0.049	0.060±0.017	0.933±0.020	1.539±0.544
CLEVERv2	0.826±0.053	0.092±0.036	0.900±0.034	2.440±0.866
Vanilla	0.801±0.054	0.177±0.021	0.817±0.039	4.320±0.992

- Informative prior helps in all metrics!
- Complete open-set evaluation by asking 13 users to bring their object → Robust semantic perception possible!
- Demonstration on a humanoid robot

