

Auto Recycling Classification Robot

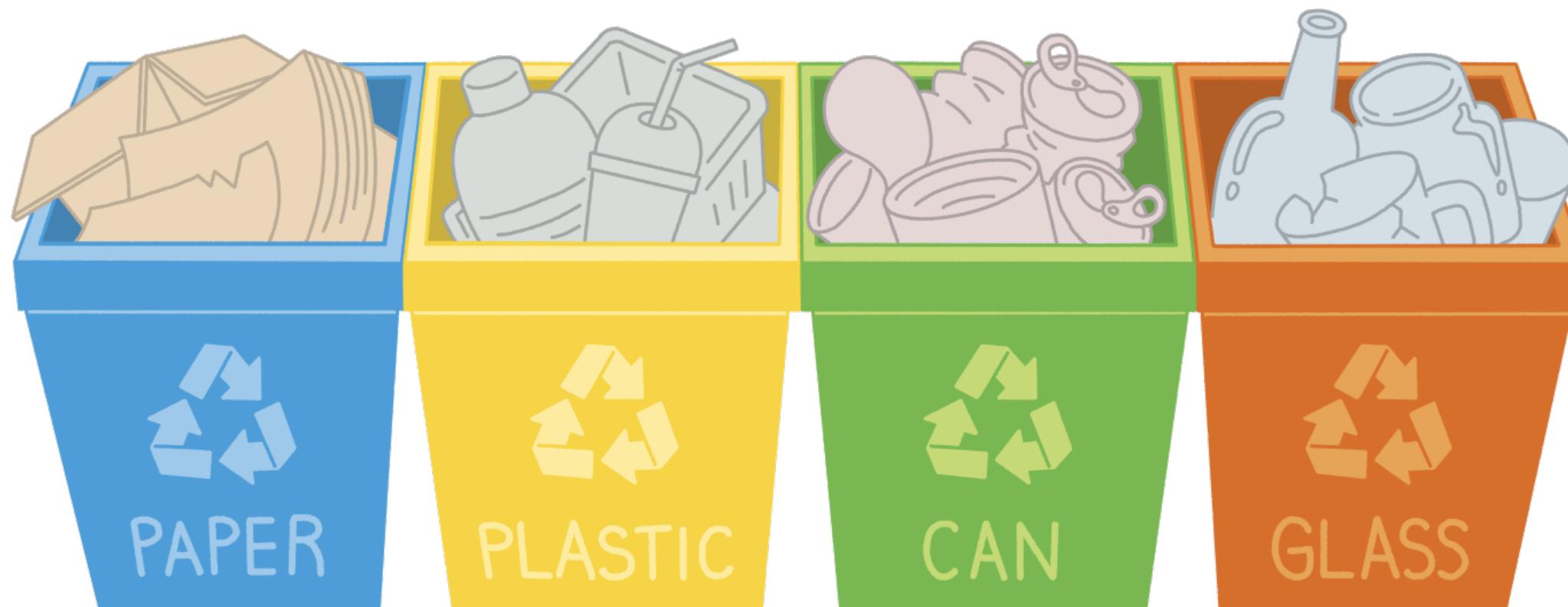
Capstone Design Project
Fall 2022

INVICTUS

Uncomfortable Recycling

Many people in Korea suffer from the hassle of recycling

And yet the recycling rate **is not high.**



Current Garbage Collection Process

Individuals demand annoyance, but poor recycling rates compared to what they demand



Throwing away



Pick Up



Sorting



Recycle

Recyclables
46% discard

Recyclables
35% discard

Recyclables
15% discard

In total,
more than **60%** of recyclables are discarded

Focusing on "Sorting"

Individuals demand annoyance, but poor recycling rates compared to what they demand



High Cost



Low Efficacy



Poor Work
Environment

Recently, the number of disposable products has increased
and the number of garbage has increased rapidly

What we want to make

Auto Recycling Classification Robot



According to a startup called AETECH,

The improvements below are said to be feasible.



Increasing factory hours

150%

Increase factory hours by
430 minutes or more

Actual operating hours are
270 to 300 minutes on average



Increasing the speed
of recycling selection

200%

50 robots on average,
100 on dual

The average person is per minute
Available in 25 to 30 categories



Reduced work area

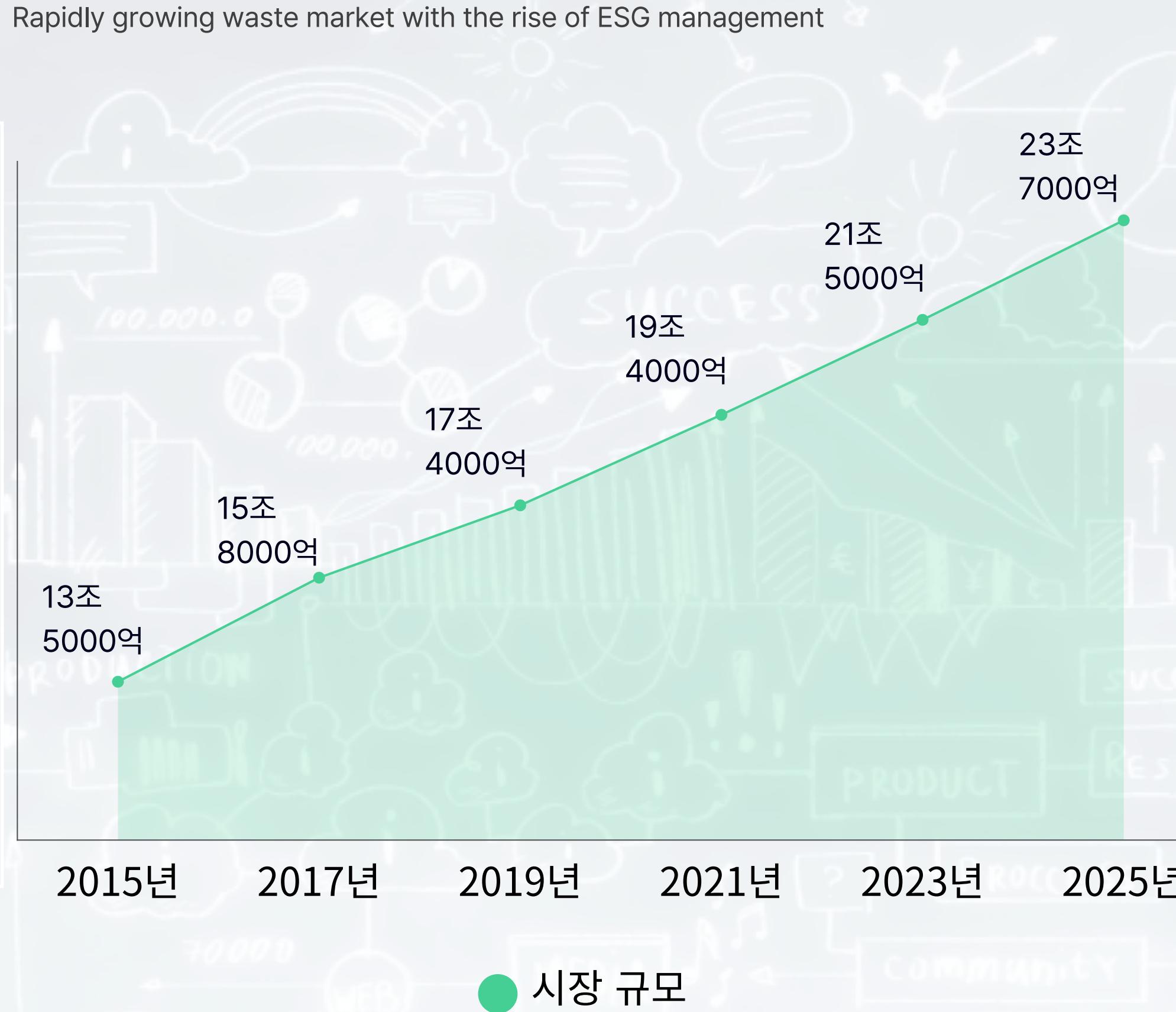
125%

Three-quarters of a
person's scope of work

In the same area where three people can work,
Four robots can be installed

Korea Waste Market Size

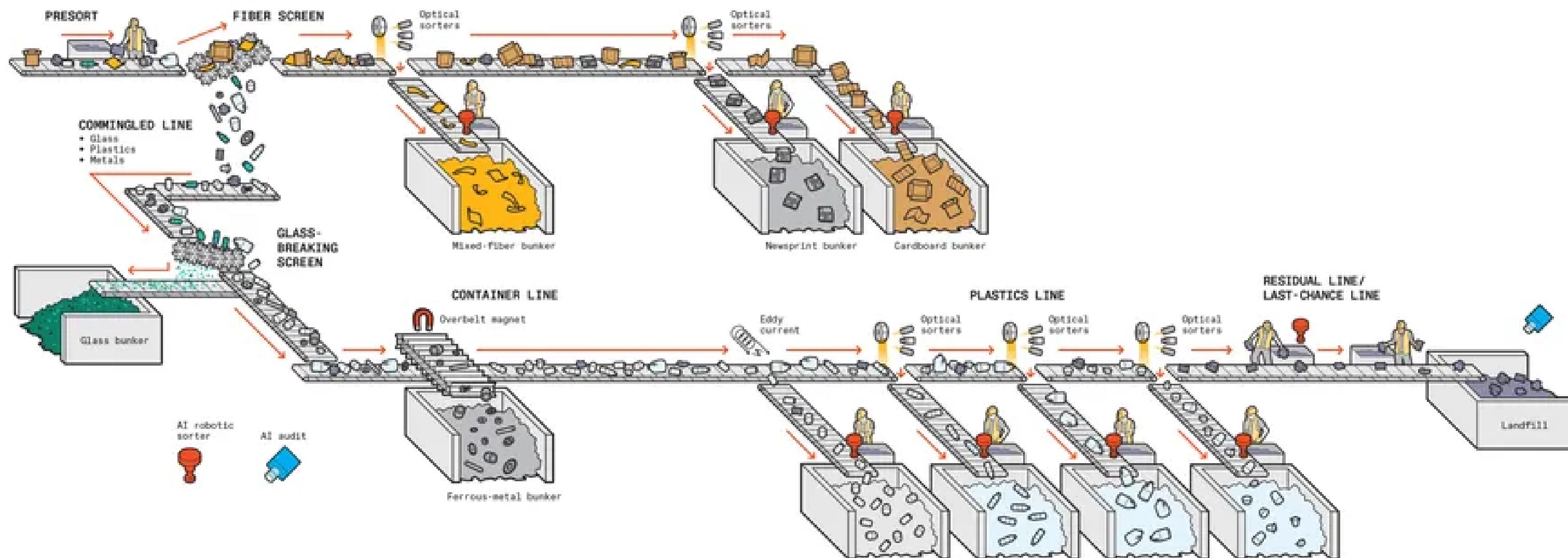
Rapidly growing waste market with the rise of ESG management



Foreign example

The whole structure of sorting garbage

Inside the Sorting Center



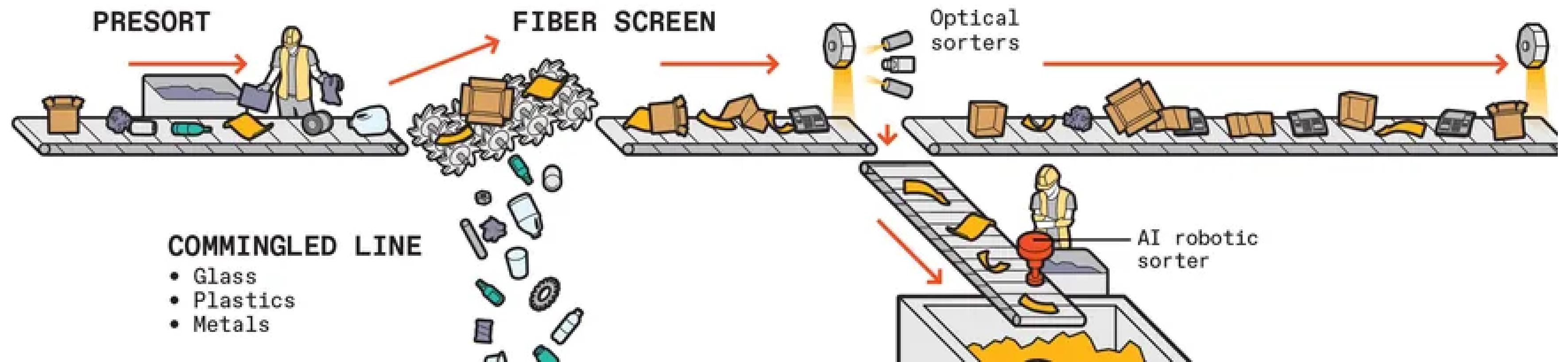
The United States puts recycled waste in one container and collects it.

The collected garbage is classified in the **recycling facility**.

The above picture is the overall picture of the **Sorting Center**.

1) Pre sorting

Remove non-recyclable waste such as bicycles, large pieces of plastic film, propane containers, and car transmissions first

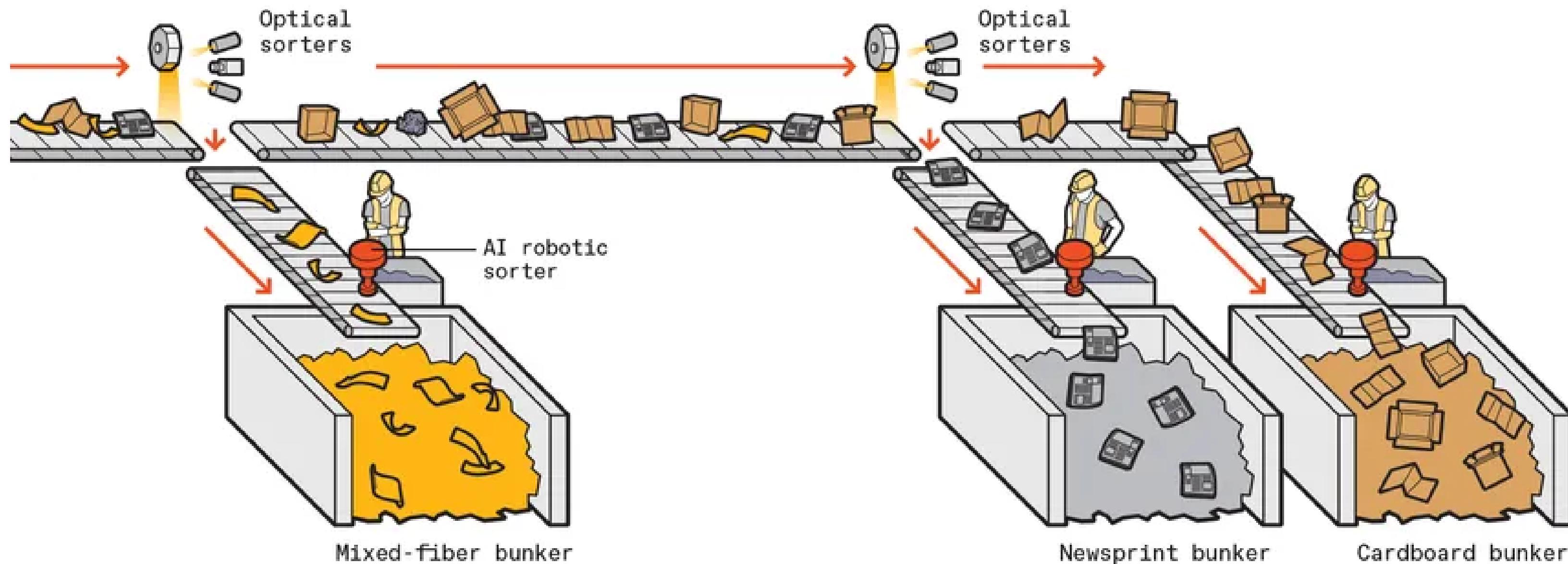


Put the trash on the conveyor belt and do a pre-sort first.

People clean up big, problematic items that shouldn't have been on the pickup truck.

2) Fiber sorting

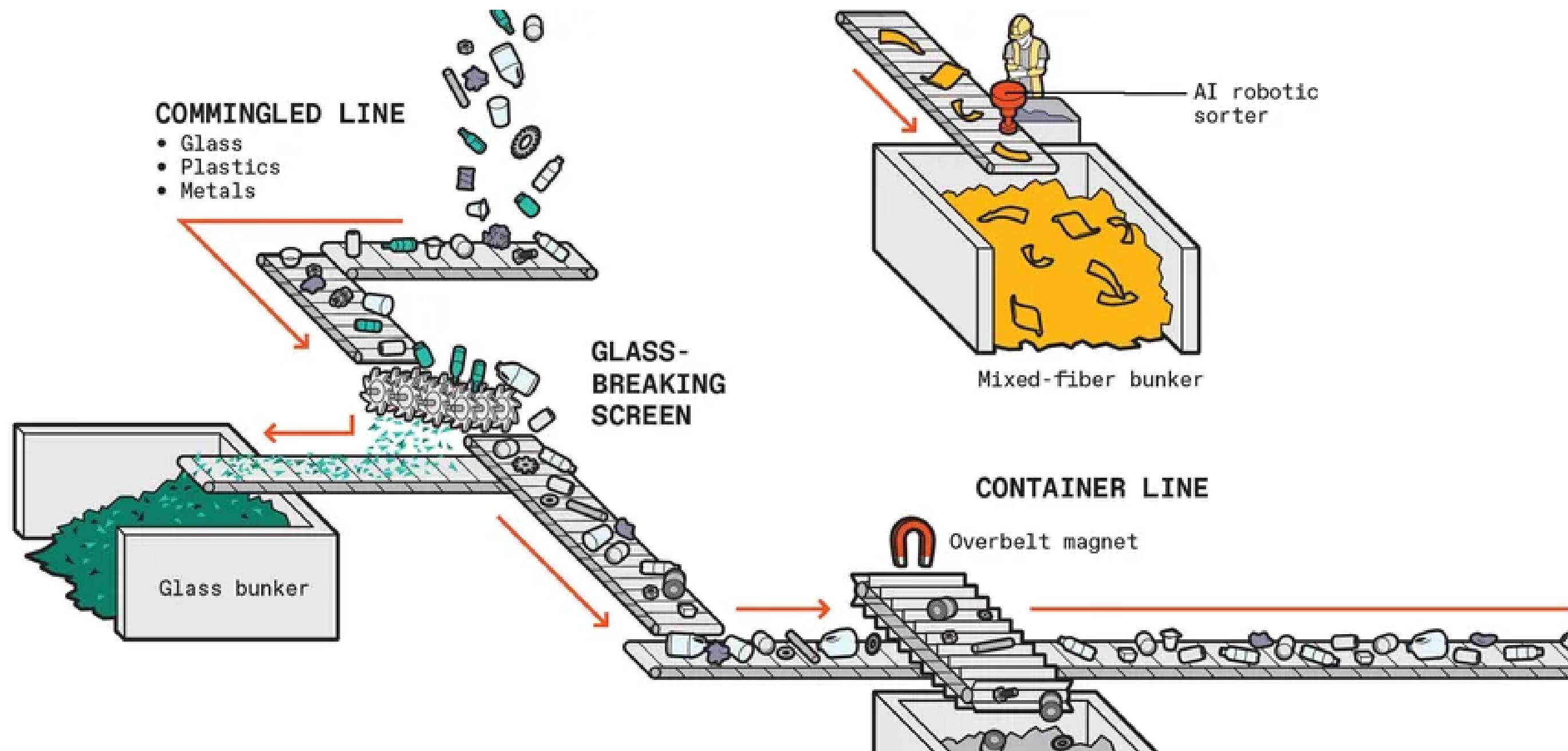
As a step of sorting fibers, products such as office paper, cardboard, magazines, and 2D products are handled.



A classifier using optical hyperspectral imaging technology primarily separates fibers from the rest of the plastic and metal. Optical Sorter uses optical methods such as infrared NOT A.I.

3) Non Fiber sorting

The process of sorting nonfibers mainly deals with glass, iron, and metal

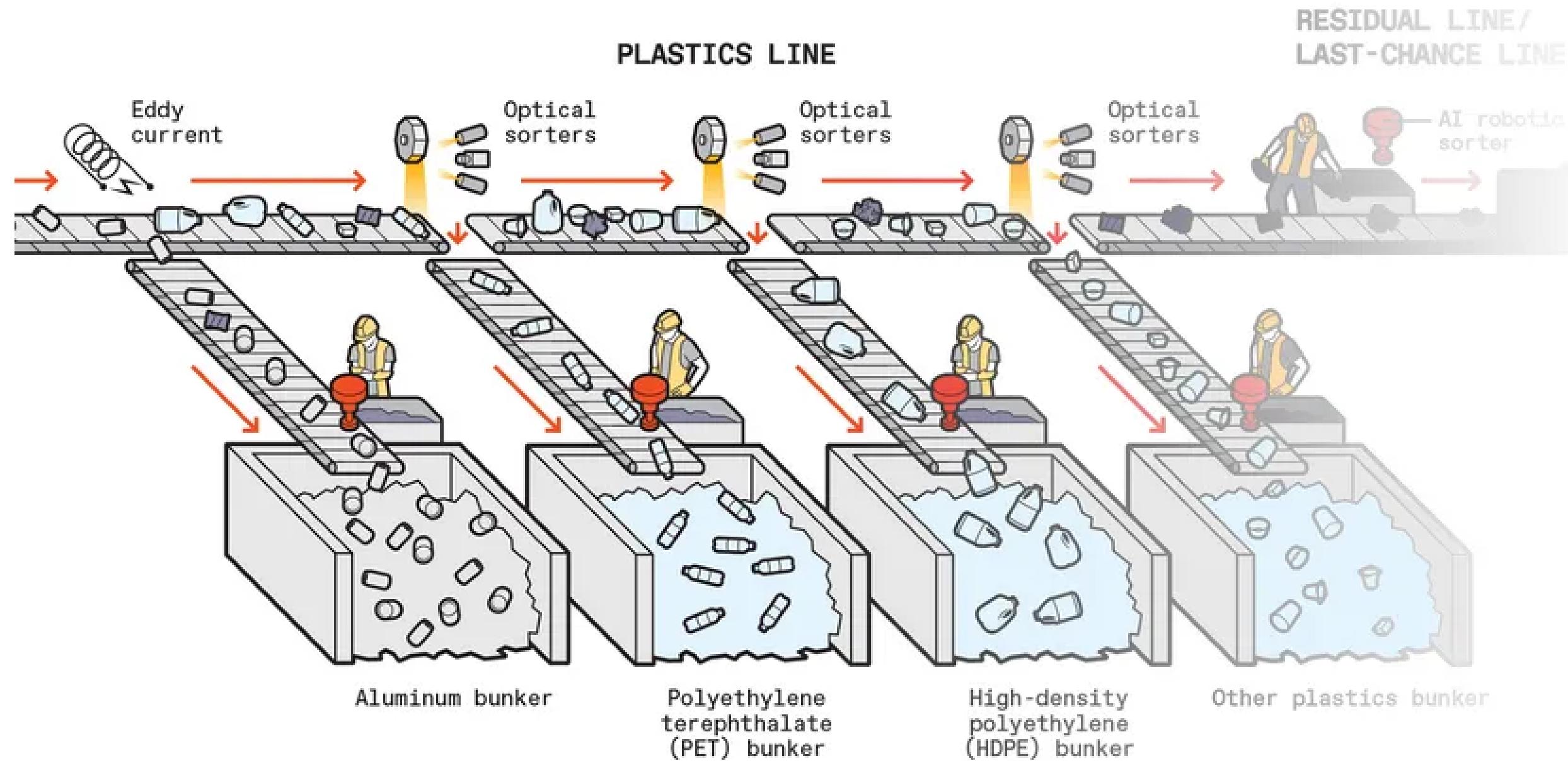


Machine breaks the glass, and the glass falls to the floor and is classified.

The remaining waste passes under an eddy current inductor that shocks the machining magnet and nonferrous metal to other collection areas.

4) Extra Sorting

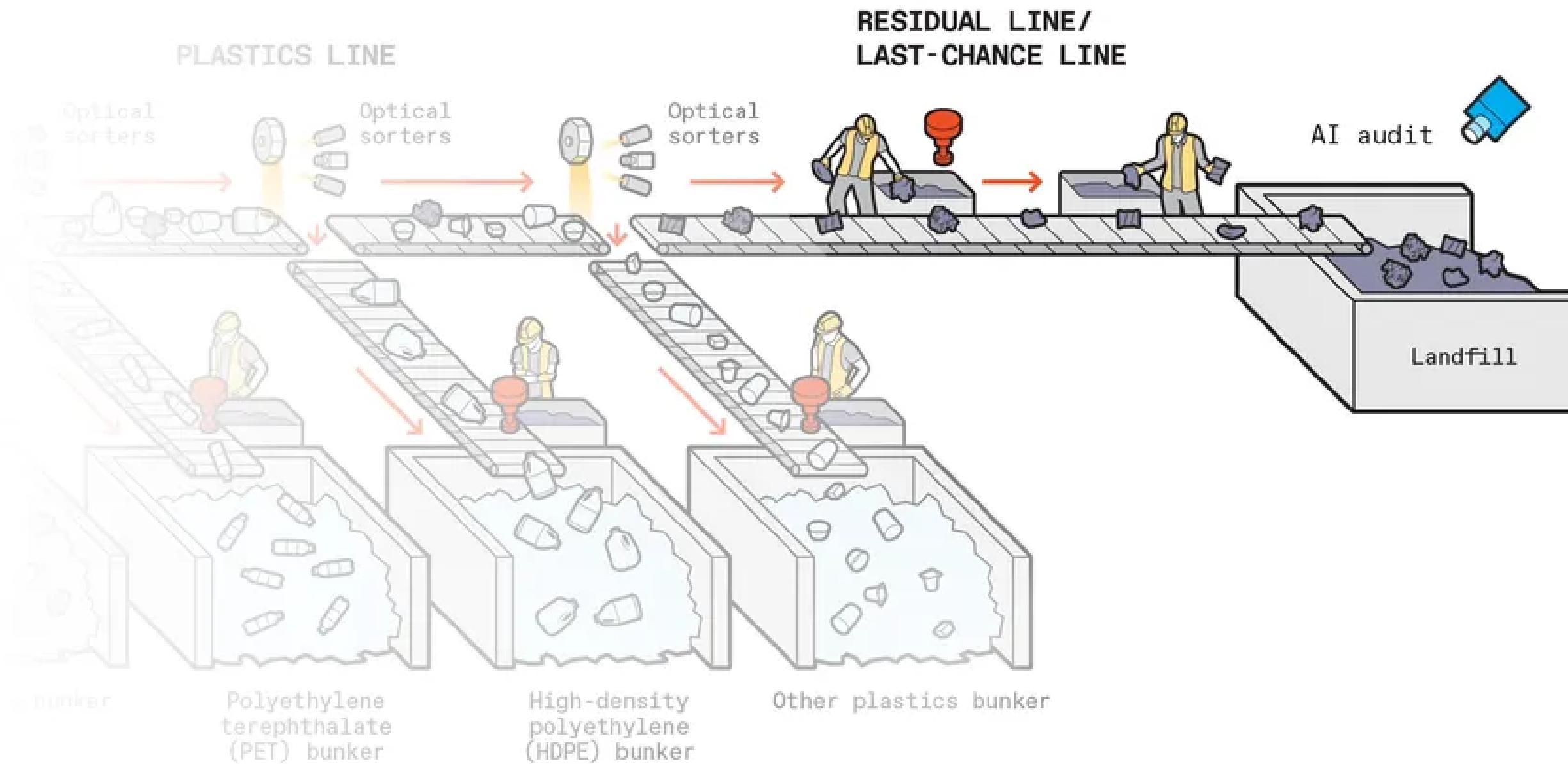
This step mainly deals with aluminum, plastics (HDPE, PET, and the rest)



At this point, most plastics remain. There are various types of plastic, and they should be classified by type. Superspectral separators can remove plastics, such as HDPE in cleaning bottles and PET in water bottles, into one type at a time.

5) Final Sorting

It's the final step in sorting out garbage



So far, garbage that has not been selected is finally checked once more by human workers.

At this time, **the red icon means the location where the AI-based robot system can enter.**

How to make

Object Detection identifies recyclables and physically extracts them



1. Object Detection

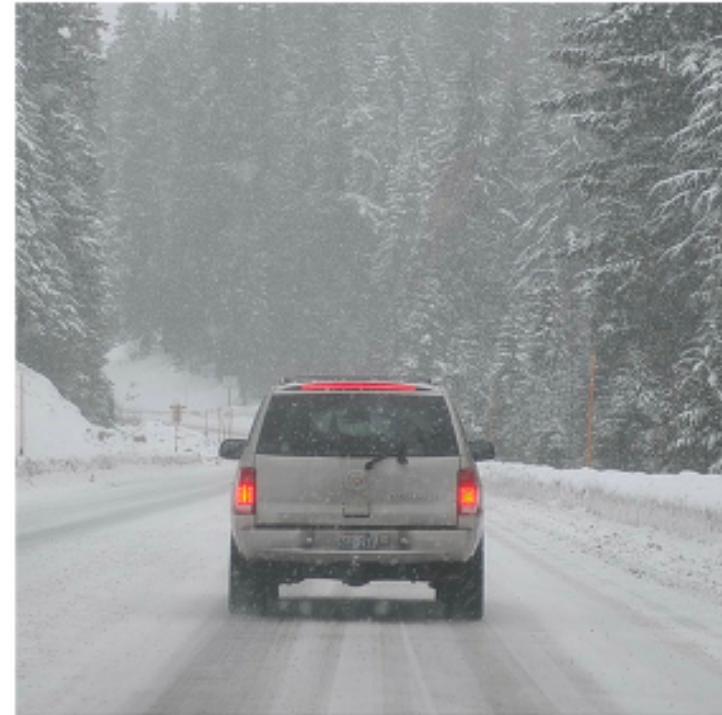


2. Robotics

Object Detection

Image classification VS Classification with localization VS Detection

Image classification



Simple image classification

Classification with localization



Identify the location of objects in the image

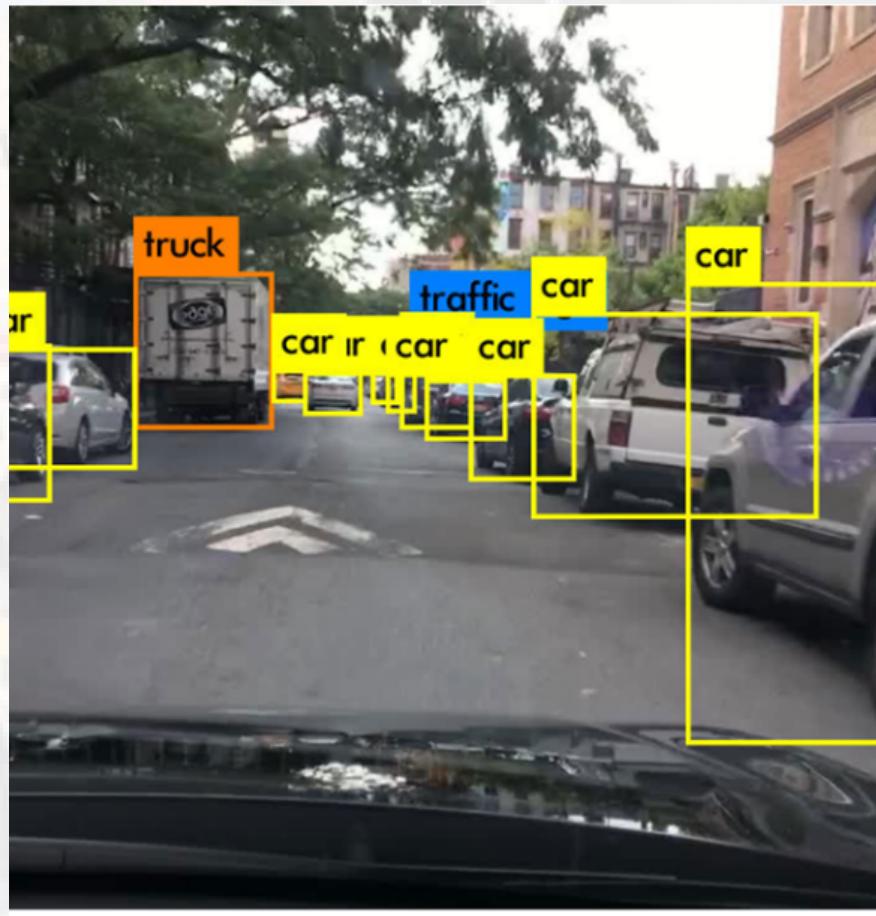
Detection



Recognizing multiple objects

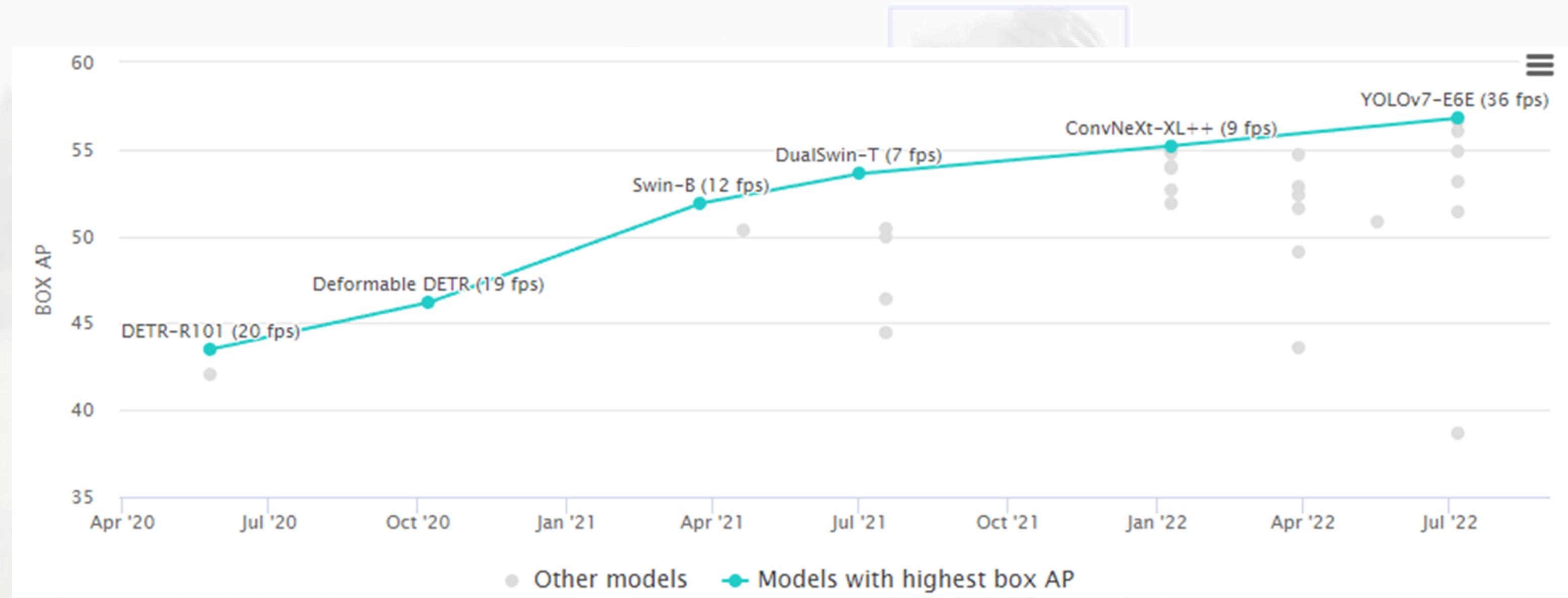
Object Detection

a wide range of applications



Object Detection Open Source

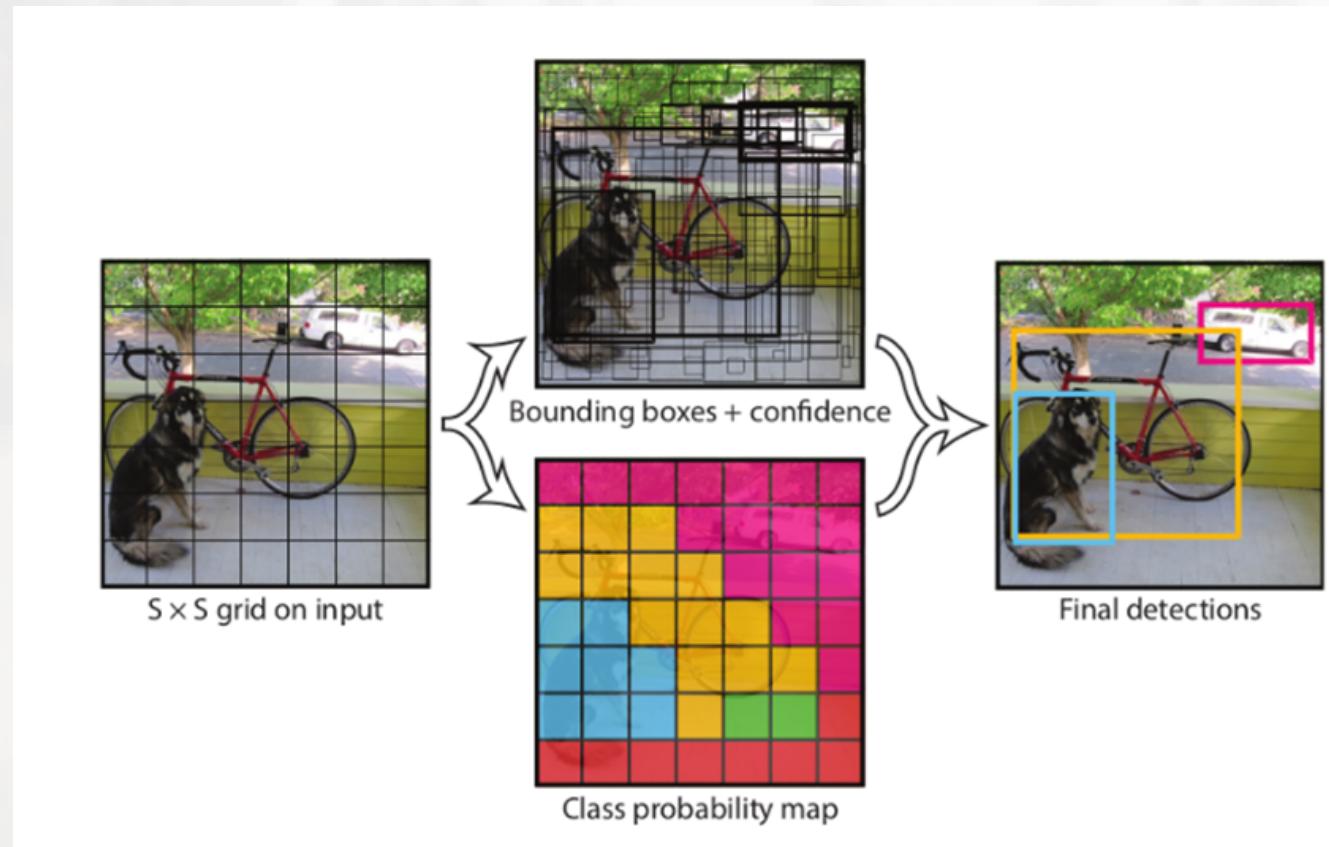
Open-source object detection that enables rapid recognition of objects in images and videos Way



According to the YOLOv7 paper,
the best model scored 56.8% Average Precision (AP),
which is the highest among all known object detectors.

Object Detection Open Source

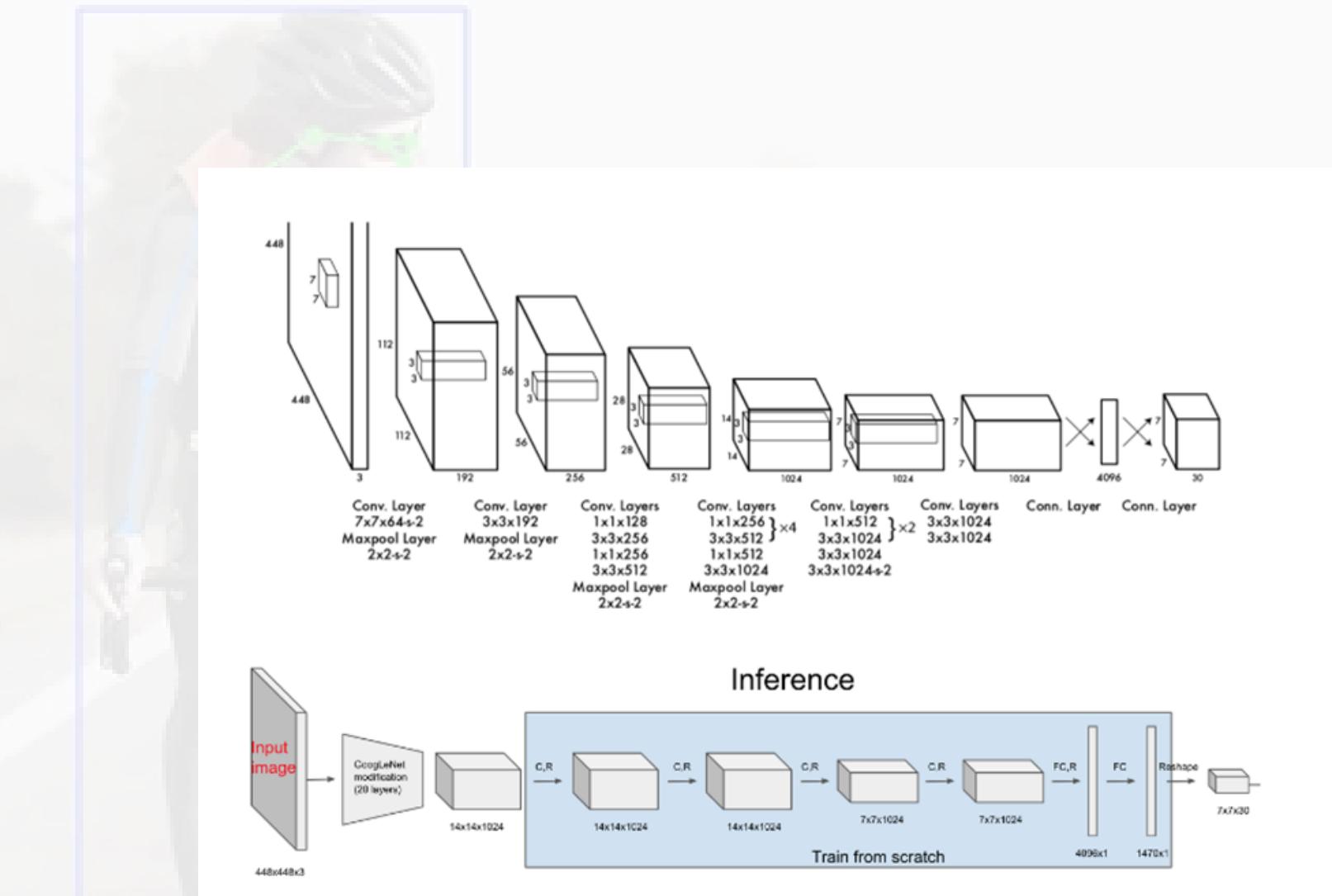
Structure of the YOLO Model



Grid system

There is no overhead at all in the process of obtaining a proposal with the number of GridCells as the number of proposals.

⇒ Speed up due to low number of proposals



Straight-line network

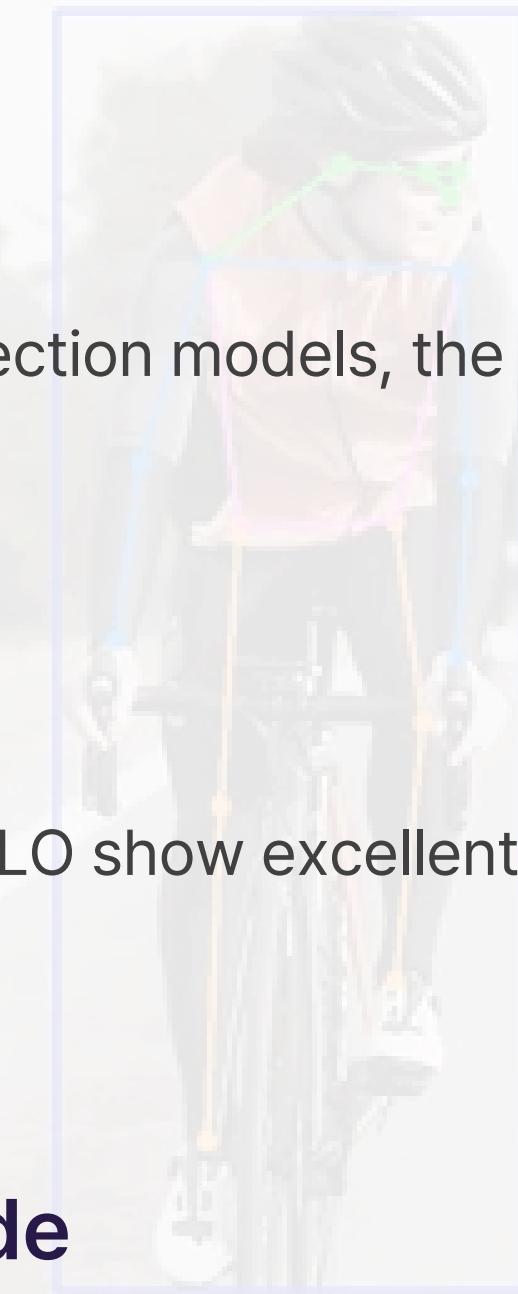
Convolution layer 4 times, full connection layer 2 times and adjust size 7x7x30 to finish.

Advantages of YOLOv7

Compared to the existing R-CNN object detection algorithm

1) Super Fast

Since the learning pipeline is simpler than the existing detection models, the speed of learning and prediction is fast.



2) Great Performance

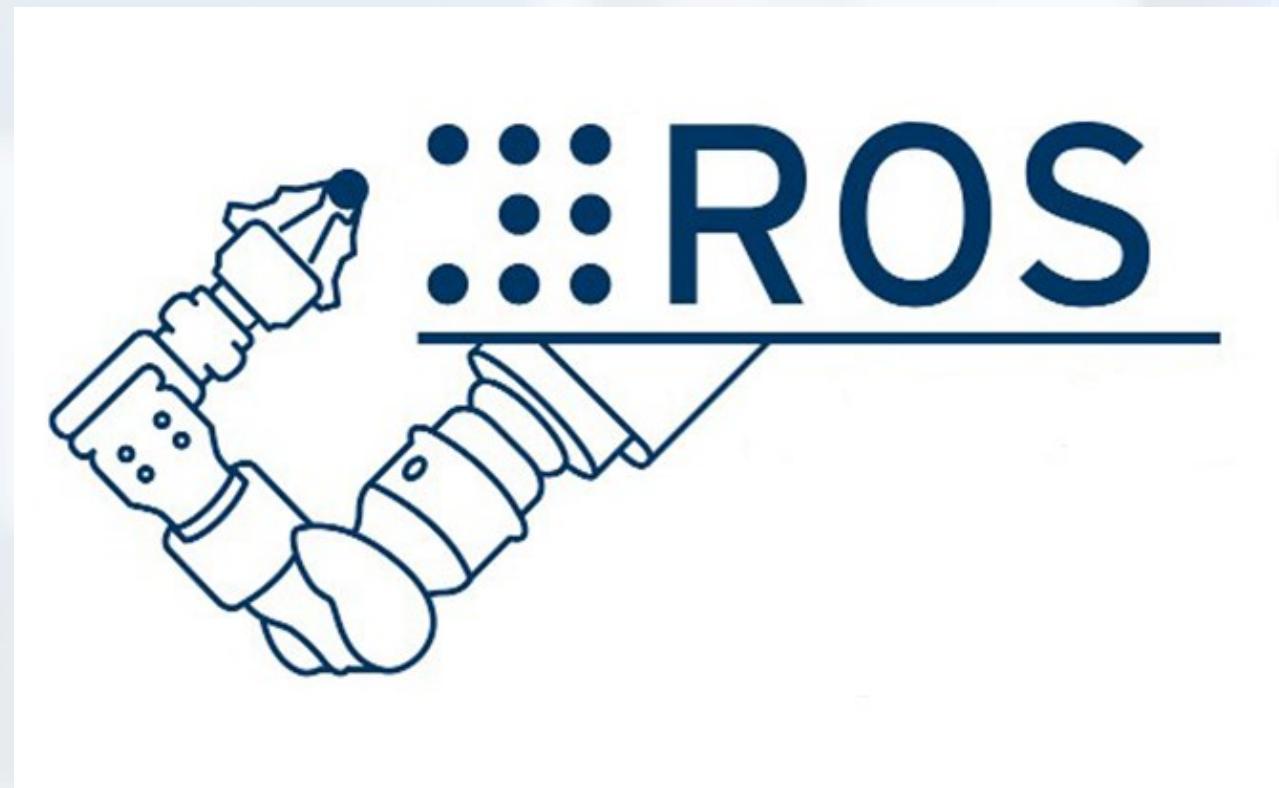
Because of learning the general features of the object, YOLO show excellent performance in scaling to other areas.

3) Consider not only inner side, also outside

Since it occurs through the entire image of the learning process, it learns not only the characteristics of a single object but also the context of the entire image (processed even the surrounding information)

Robotics

A robust design is carried out using ROS and a gripper is implemented using Arduino



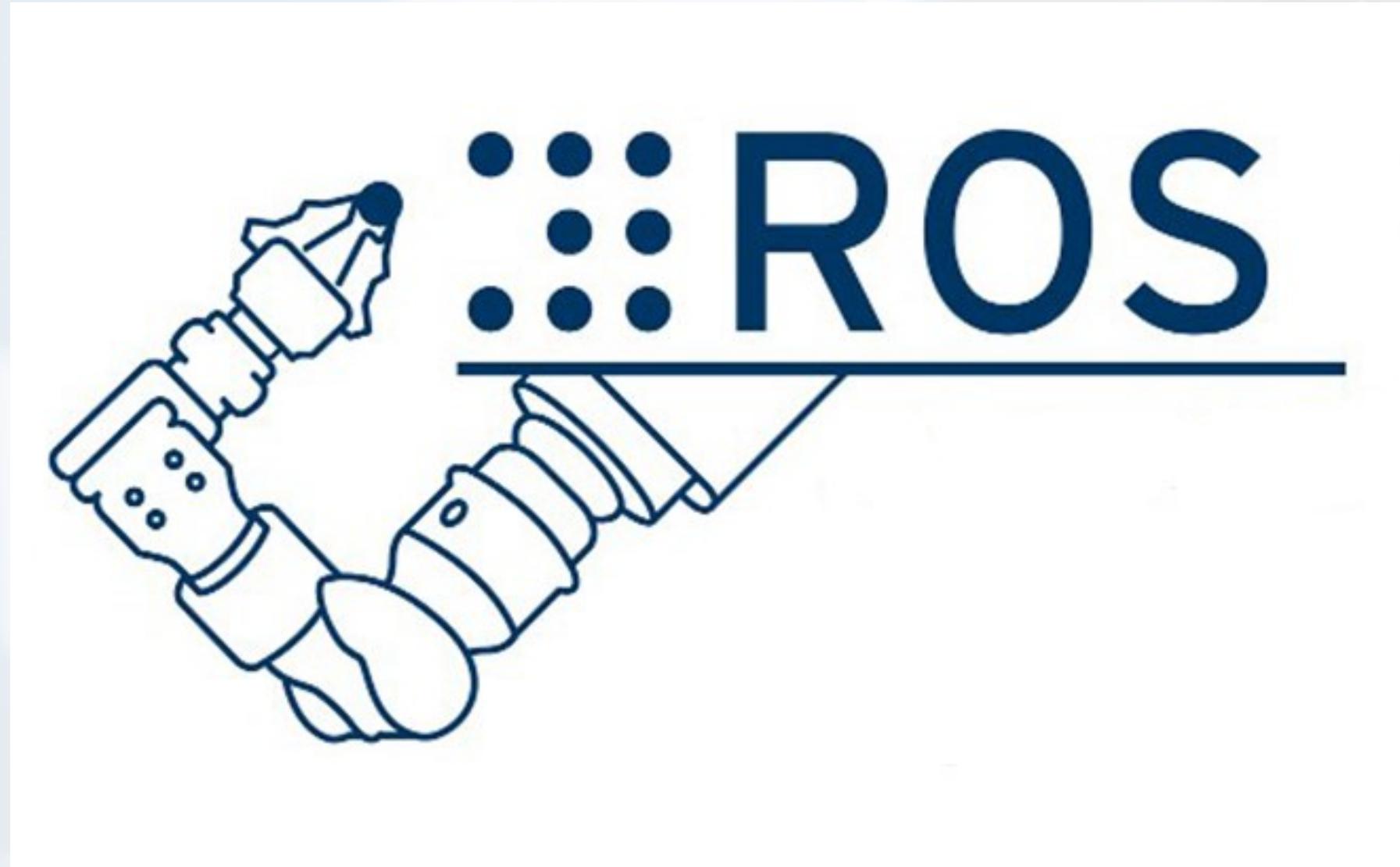
a) Robot Operating System



b) Gripper- Arduino

Robotics

ROS is a robot platform, such as an operating system for developing robot applications.



It provides necessary things when developing robot applications

1. Hardware abstraction
2. Subdevice Control
3. Communication between processes
4. Manage packages
5. Libraries, Debuging tool

Why ROS?

Advantages of ROS

Why Robot SW Platform?

- High Program Reusability
- a communication-based program
- Support for development tools
- Active communities (many open sources)
- the creation of an ecosystem

Why ROS?

- FREE
- the highest number of people

Types of Grippers

Robots to be put into the manufacturing process or to move objects require a mechanical end.



Adhesive gripper

Use adhesive grippers
to lift small objects such as cans and boxes.

The gripper moves things
using liquid adhesion or special adhesives.



Humanoid hands

Humanoid hands can perform much more
delicate movements compared to conventional grippers.

Types of Grippers

Robots to be put into the manufacturing process or to move objects require a mechanical end.



Magnetic gripper

The magnetic gripper is gripped by a permanent magnet. Positioning the gripped object is done using a piston installed inside the permanent magnet gripper.



Mechanical gripper

It is the most widely used gripper type, especially for industrial robots. A pneumatic or hydraulic drive system is usually used.

Realistic compromise

PET&Can Detection and Simple HW Response



PROJECT PLAN



QnA

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