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re:Invent
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ROB302

Building perception for manipulation robots at Amazon

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Agenda

- Robots at Amazon
- Robotic manipulation
- Robin: Package manipulation
- Scaling Robin perception
- Applying Robin lessons to item manipulation

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Robots at Amazon



Robotics and AI



Amazon Astro



Amazon Prime Air

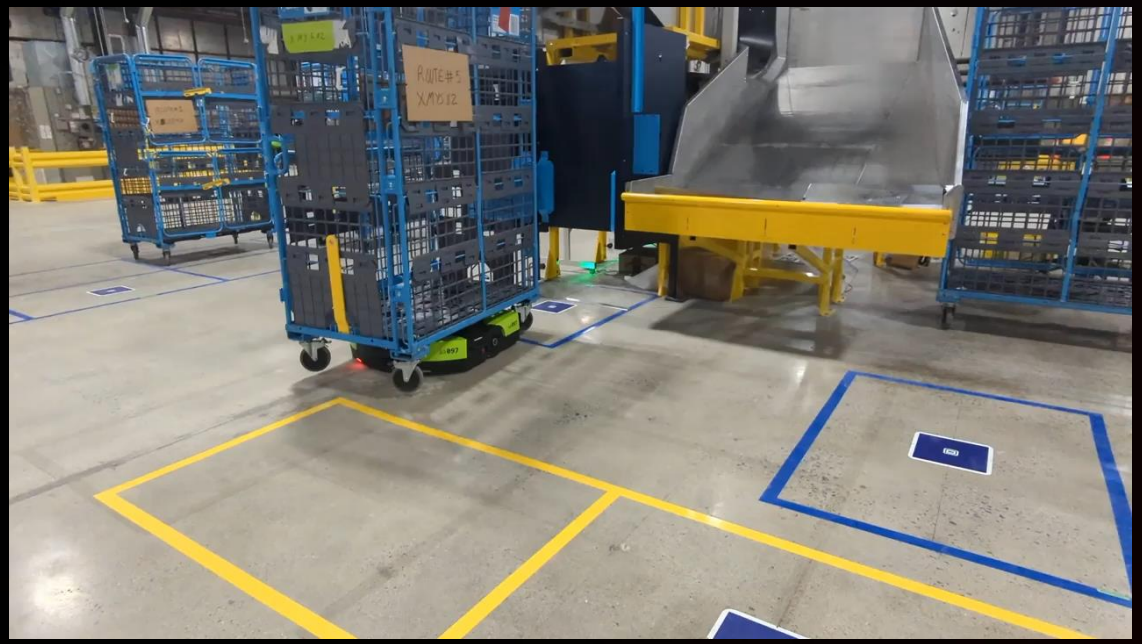


Amazon Robotics
(Kiva Systems)

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Robots at Amazon





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Robotic manipulation

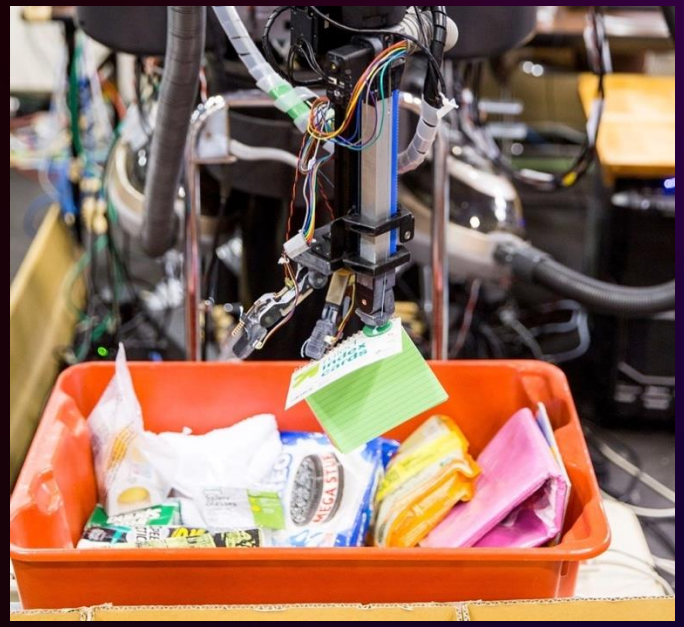
Package manipulation





Item manipulation





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Robotic manipulation: Packages

Set of classes (jiffy, box, etc.)



Deformable



Variety



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Robotic manipulation: Items

Rectangular



Bagged



Compressible



Irregular



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Challenges: Novel packages and items

How to manipulate an unseen set of items

. . . something humans do all the time!





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Challenges: Sensing reflective surfaces





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Challenges: Manipulating deformables

Deformable packages



Deformable items

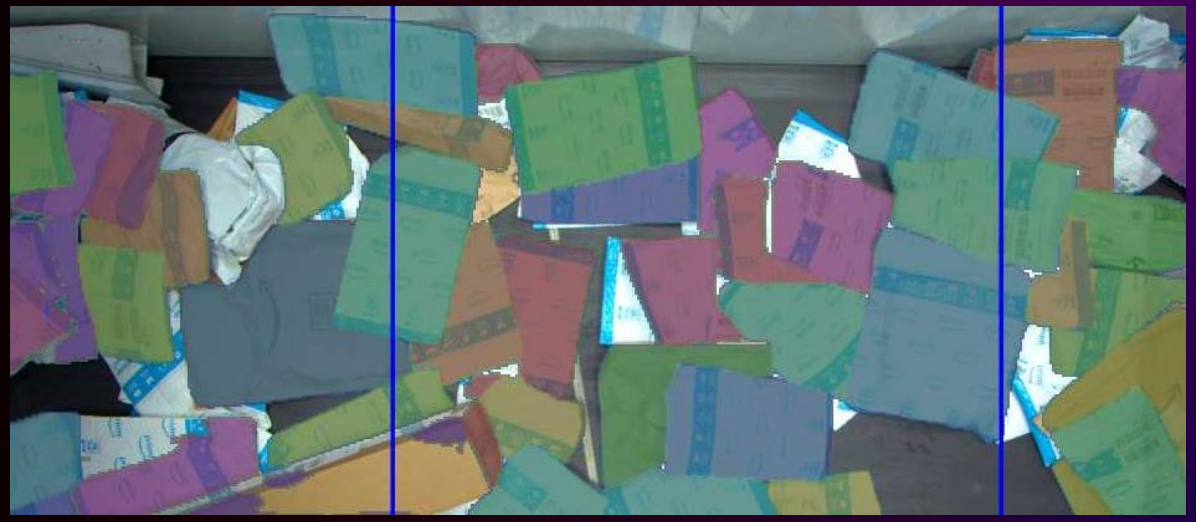


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Challenges: Perception in clutter

Given an image of a cluttered scene, segment all items in the scene

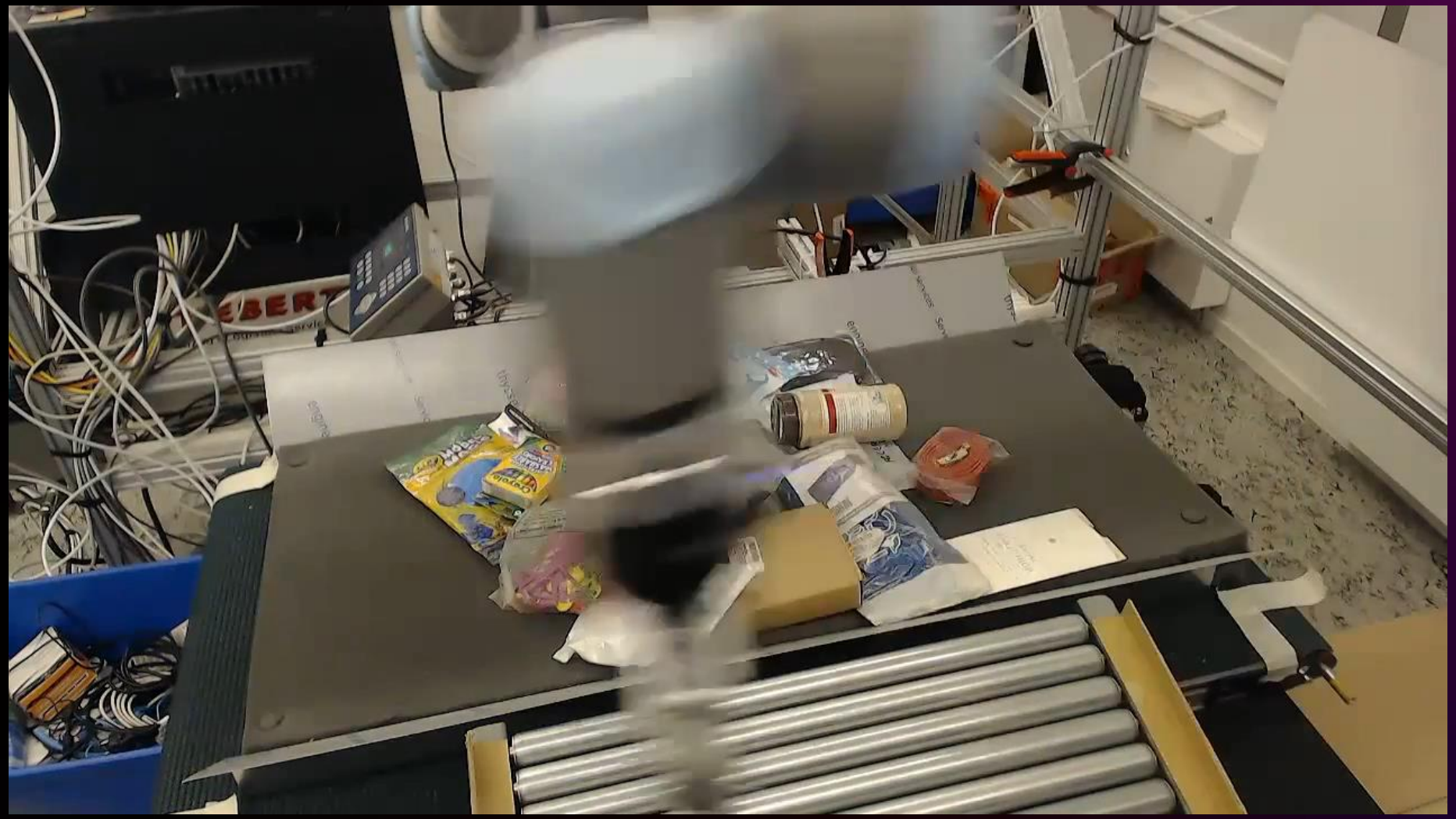




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Challenges: Interacting with clutter



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Robin: Package manipulation



How do we get packages where they need to go?

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What is Robin?

Package arrives on conveyor

↓

Instance segmentation model identifies packages

↓

Robot picks package and places it on the carrier robot

↓

Segmentation model checks there is only 1 package on the carrier robot

↓

Carrier robot takes the package to its destination



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Robin perception: Pick segmentation

Package arrives on conveyor

↓

Instance segmentation model identifies packages

↓

Robot picks package and places it on the carrier robot

↓

Segmentation model checks there is only 1 package on the carrier robot

↓

Carrier robot takes the package to its destination



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Robin perception: Pick segmentation

Similar and overlapping



Breadth of packages



Clutter



Similar package types



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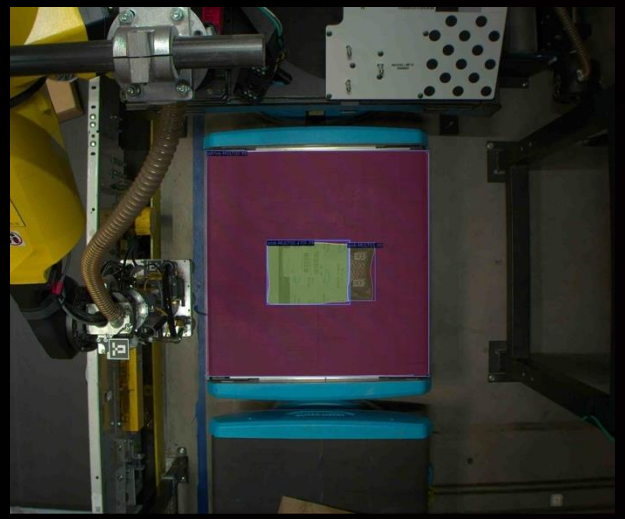
Scaling Robin in production

Challenges

- Model retraining
- Data shifts over time
  - Distribution changes
  - Novel packaging

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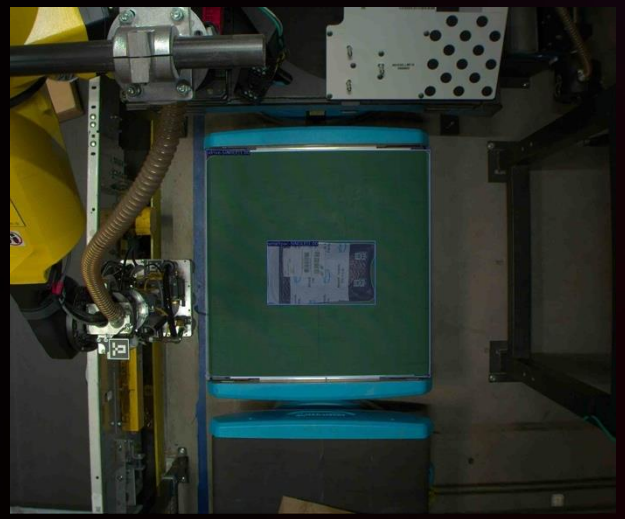
Variants of models over time



Model 1 from March 2021

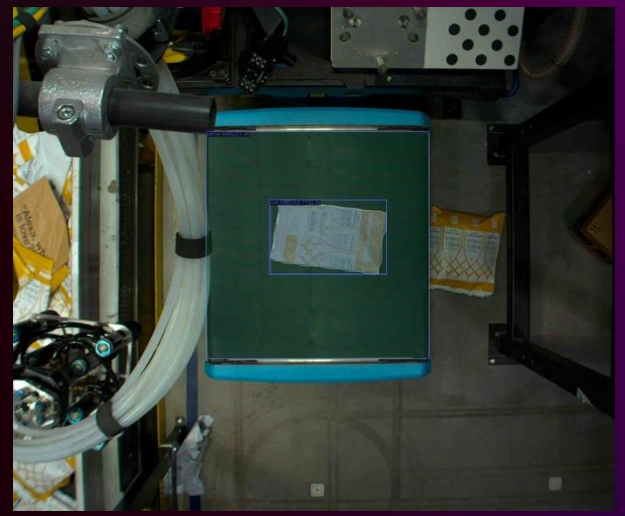
New black smartpac introduced

Model output: MULTI
Package prediction: SIOB



Model 2 from April 2022

Model output: SINGLE
Package prediction: SMARTPAC



Model 3 from July 2022

New gold smartpac introduced

Model output: SINGLE
Package prediction: SMARTPAC

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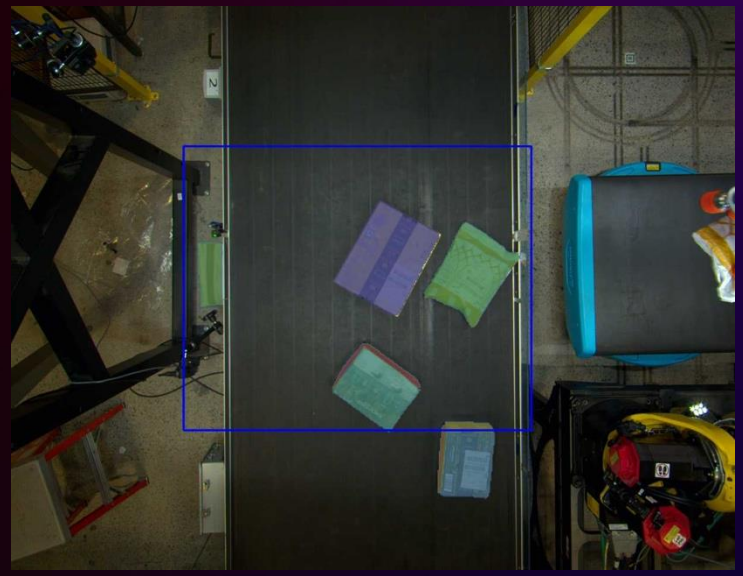
Scaling Robin in production

- New and unseen packaging
- Amazon SageMaker Ground Truth
- Evaluate packages **before** we see them in production









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Scaling Robin in production

Challenges

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Item manipulation: Challenges

Overlapping items in high clutter



Breadth of items





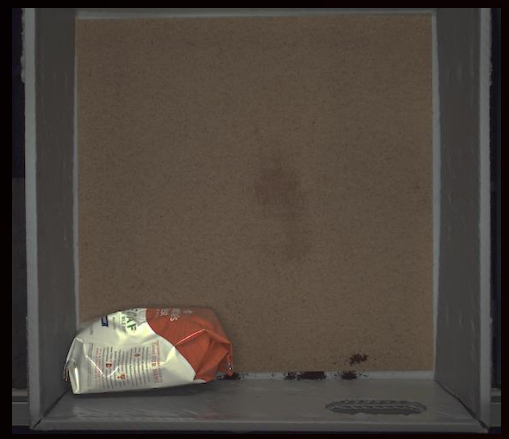






Mitigating and avoiding damage





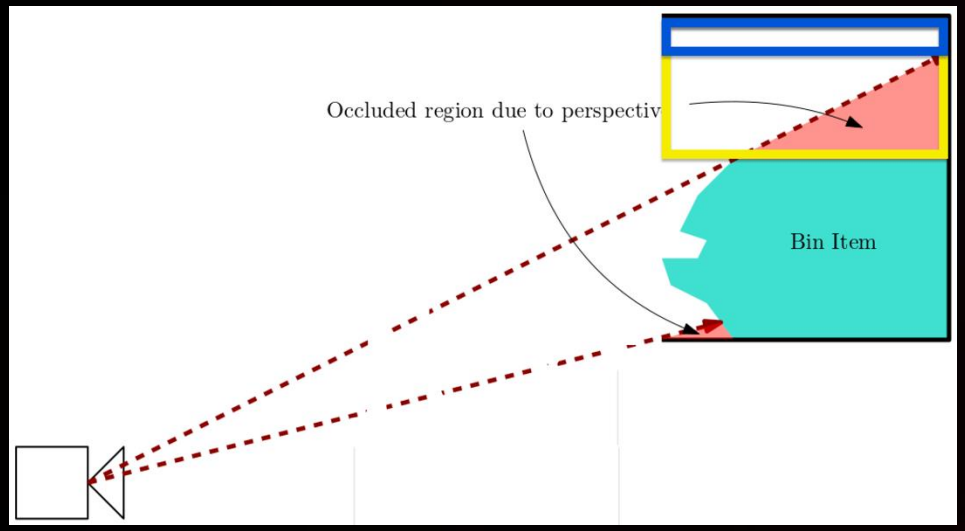
Sensing reflective items



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Item manipulation: Challenges

Perspective



High-contact environment



Occlusion

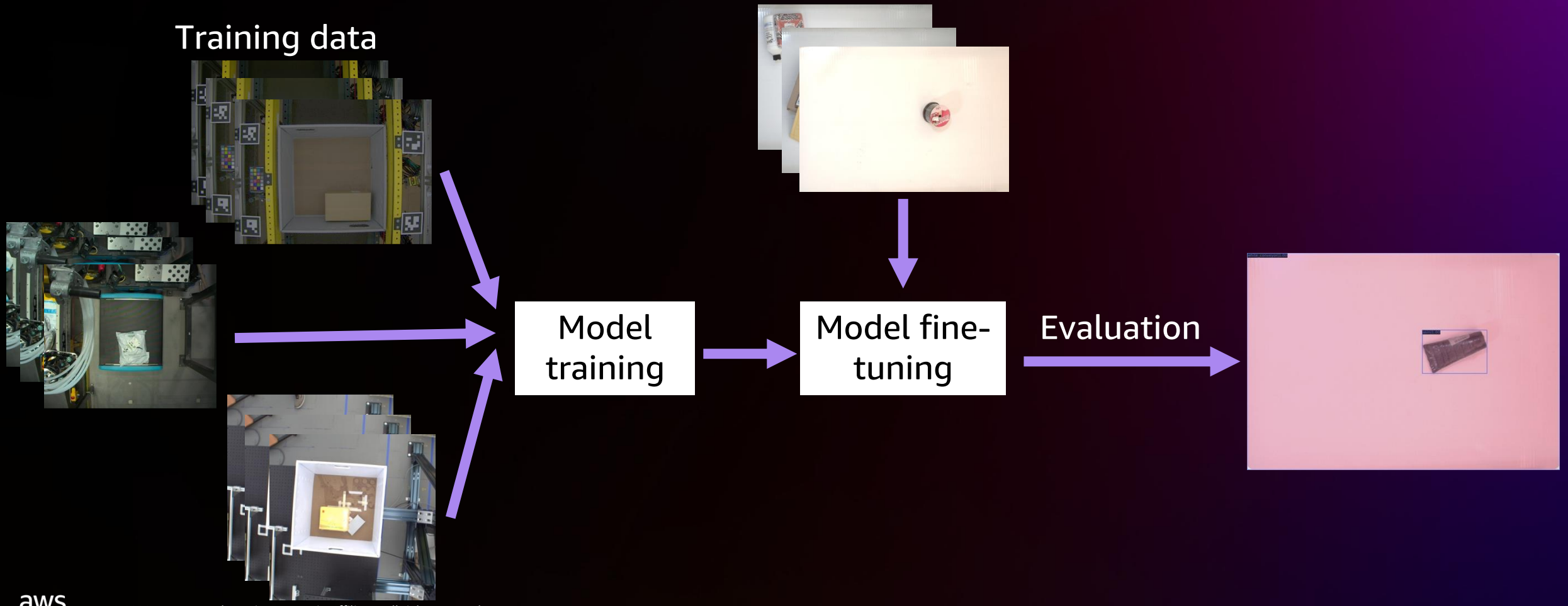




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Applying Robin lessons to item manipulation

- Use data from more mature projects to inform models for newer data



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Conclusion





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Resources



Robin deals with a world where things are changing all around it

Overview of Robin and its perception systems



How Amazon Robotics researchers are solving a “beautiful problem”

Overview of Stow and its perception and motion systems



Amazon’s Janus framework lifts continual learning to the next level

Overview of Janus continual learning



How a universal model is helping one generation of Amazon robots train the next

Overview of Amazon’s universal model



Amazon SageMaker Ground Truth now supports synthetic data generation

The Amazon team that creates synthetic Robin data

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Thank you!

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