Artificial Intelligence Advances in Citrus Sorting

How Deep Learning is impacting citrus grading and sorting in packhouse operations

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About me

Clinton Jeffries

- Area Sales Manager at TOMRA|Food in California

- 7 years with TOMRA, 15 years in Citrus Packing Industry

- Background in Sales and Operation, focused on packhouse equipment and automation

- Fun fact: Spent time "studying" at Griffith University on the Gold Coast almost 20 years ago
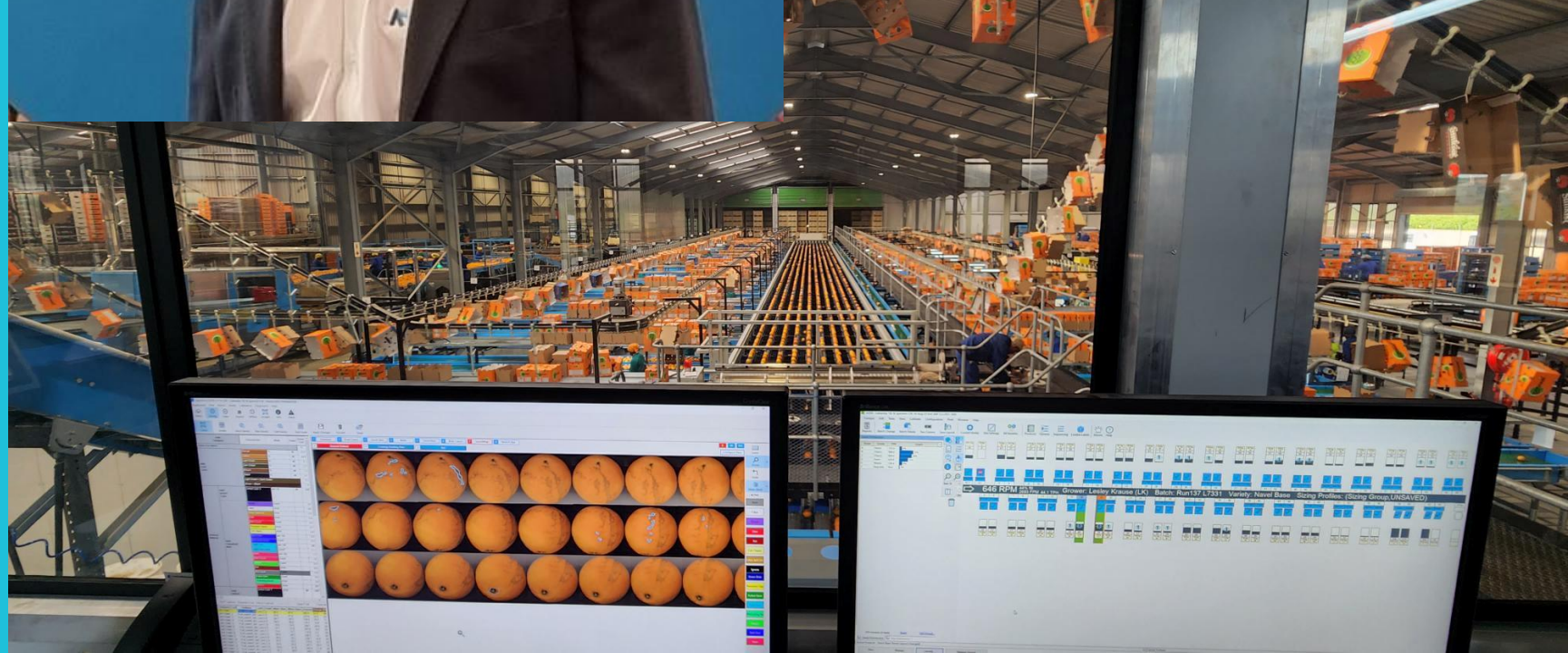
Contents

- **Introduction to AI and Deep Learning**

- **Machine learning in food sorting**

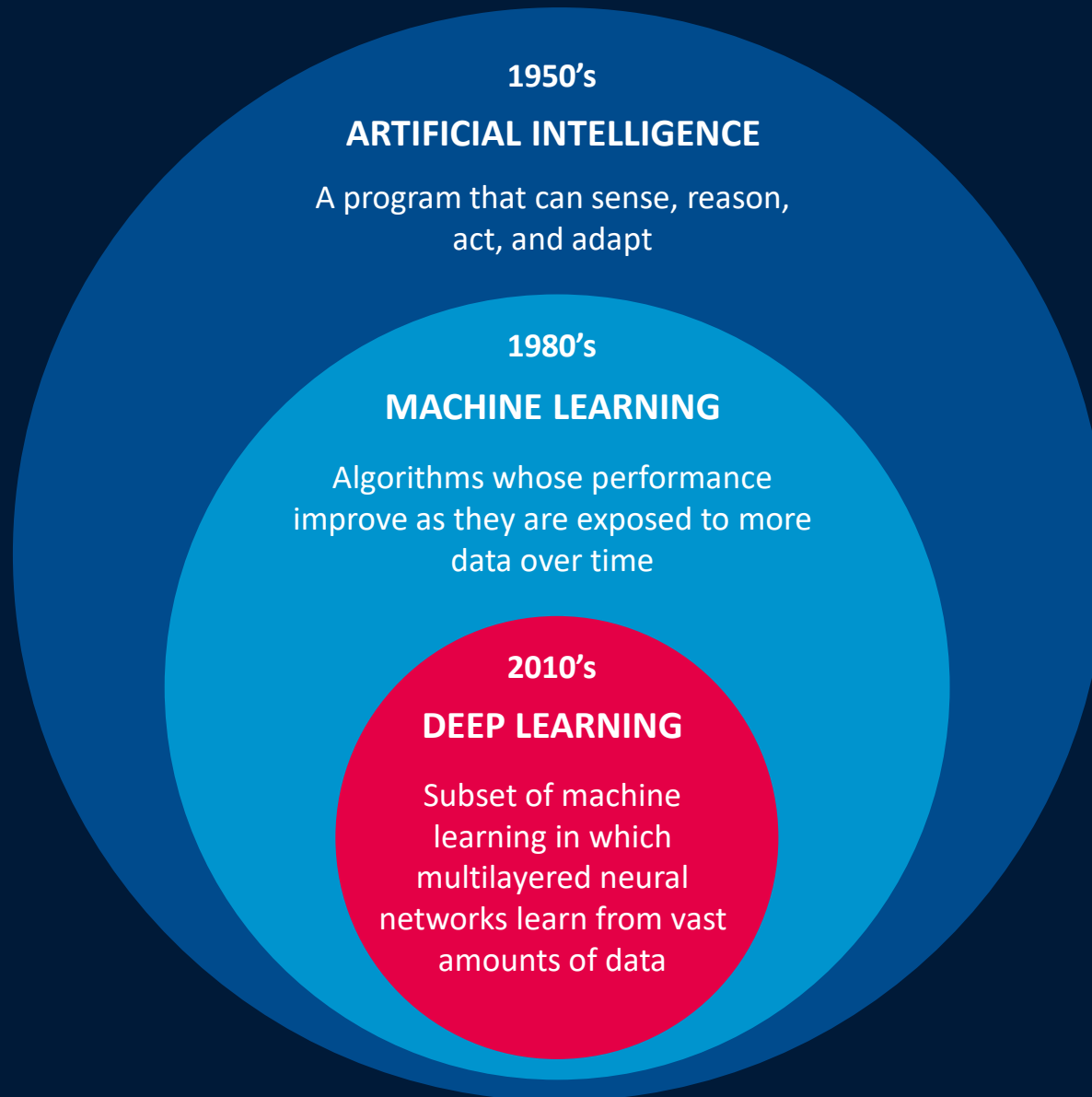- **How AI is shifting expectations in the industry**
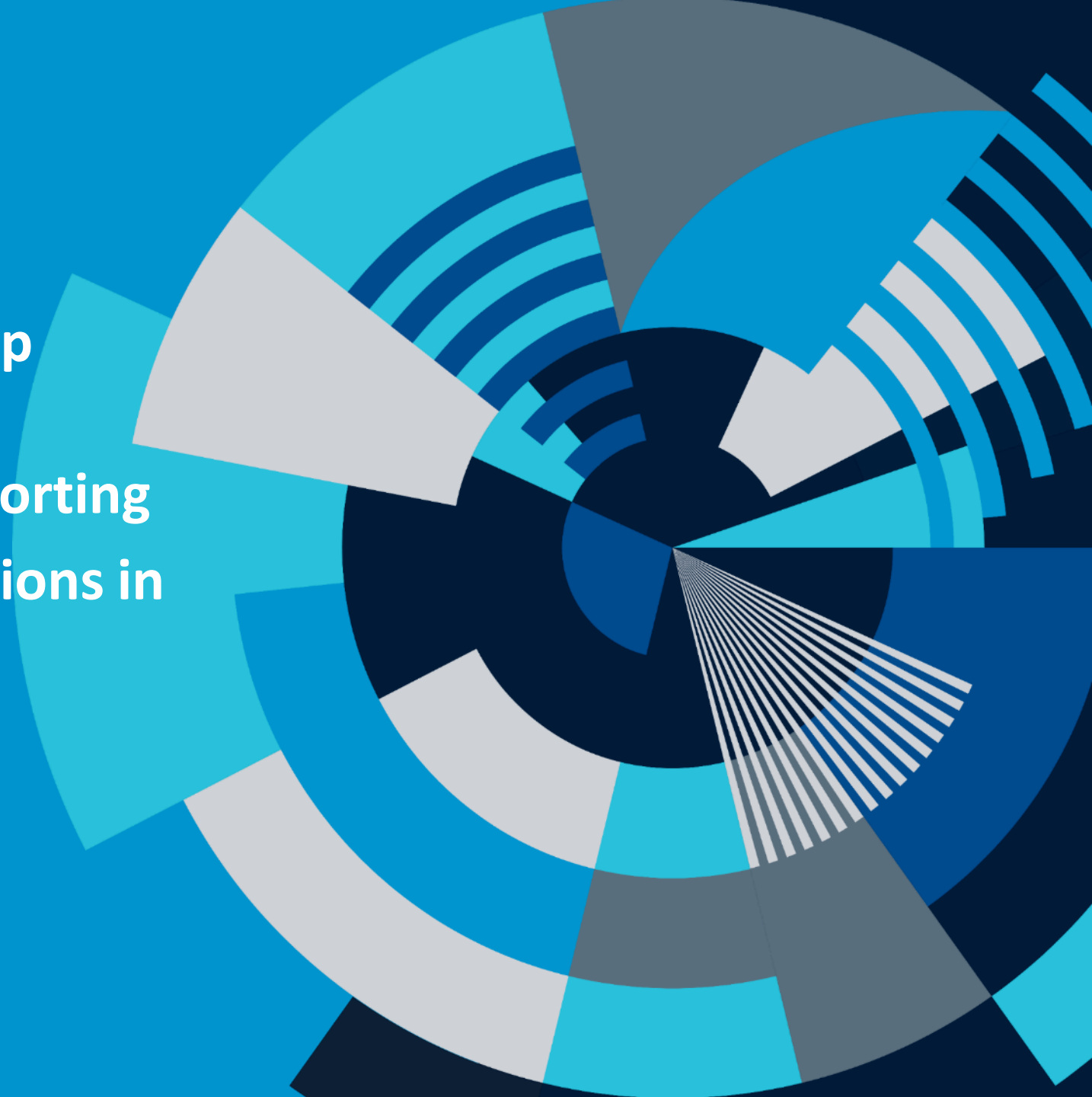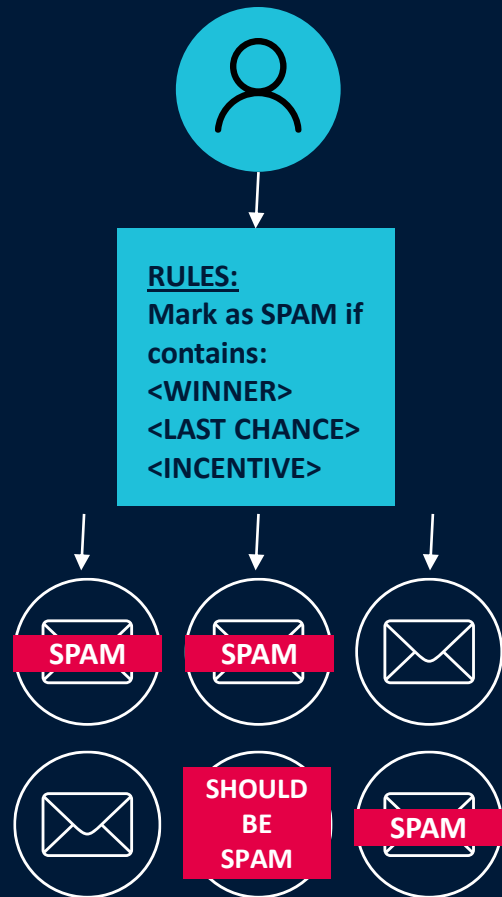
Structure

Introduction to AI and Deep Learning
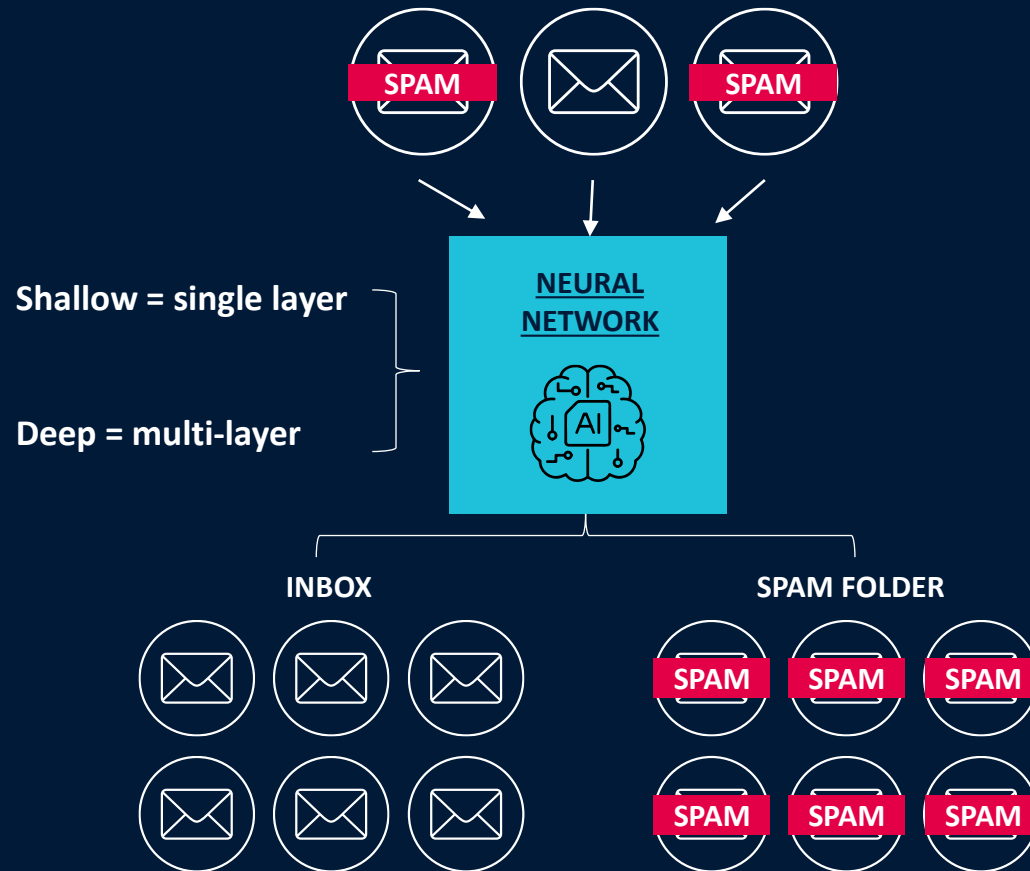
Deep Learning is a subset of Machine Learning

1950's

ARTIFICIAL INTELLIGENCE

A program that can sense, reason, act, and adapt

1980's

MACHINE LEARNING

Algorithms whose performance improve as they are exposed to more data over time

2010's

DEEP LEARNING

Subset of machine learning in which multilayered neural networks learn from vast amounts of data

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Machine Learning is a fundamentally different way of solving problems

Classical approach

Machine Learning

RULES:
Mark as SPAM if contains:
<WINNER>
<LAST CHANCE>
<INCENTIVE>

SPAM   SPAM

SHOULD BE SPAM   SPAM

Define and use **rules based** on patterns observed by people

SPAM   SPAM

Shallow = single layer

Deep = multi-layer

NEURAL NETWORK

AI

INBOX   SPAM FOLDER

SPAM   SPAM   SPAM

SPAM   SPAM   SPAM

Provide **enough examples** to a computer system, so it can identify patterns in the examples to train an artificial neural network

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Simplified model of Machine Learning

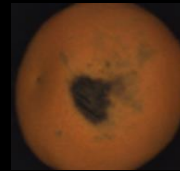Structure

Machine learning in food sorting

Machine learning for fruit sorting with Spectrim since 2016

- **Unparalleled performance** when operated correctly

- **Requires training and experience** to setup effectively

- **Needs re-training** for rare defects and new varieties

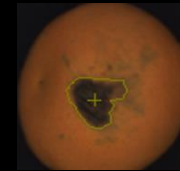- Requires skilled **and experienced machine operators**

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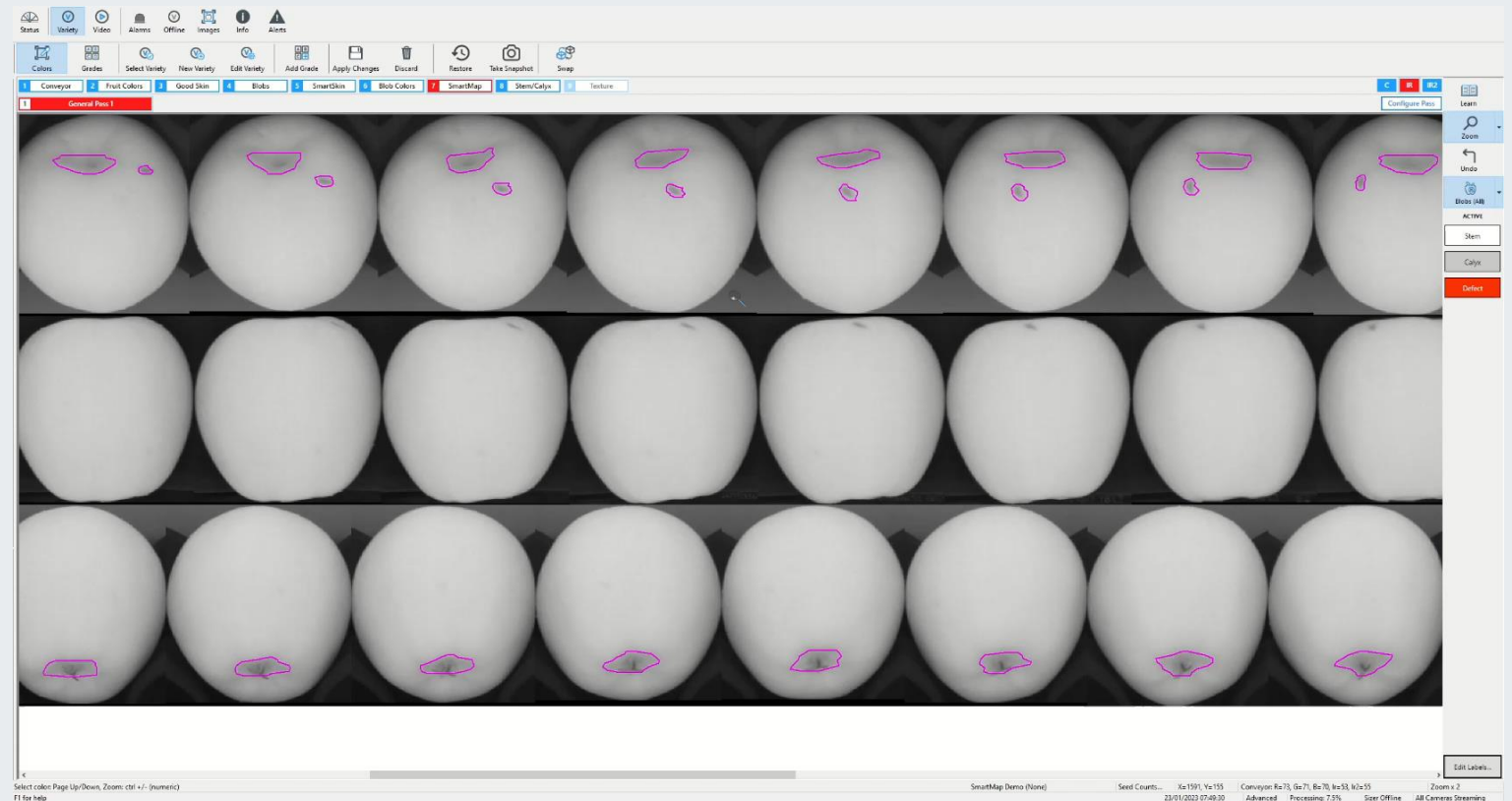
Preconditions for high performance Deep Learning technology

| 1	2	3	4	5	6
High-quality imaging systems	Accurate data labeling (tedious)	Rich and high-quality image training data	Deep industry expertise	DL technology engineering expertise	Organizational capability and tools to support and scale DL

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Deep Learning application for fruit sorting

- **Higher performance:** Uses pixel-detail nuances and richer information in image data

- **Higher simplicity for operators** during setup and operation

- **Higher adaptability and accuracy** with unseen fruit/defects through multi-layer artificial neural network

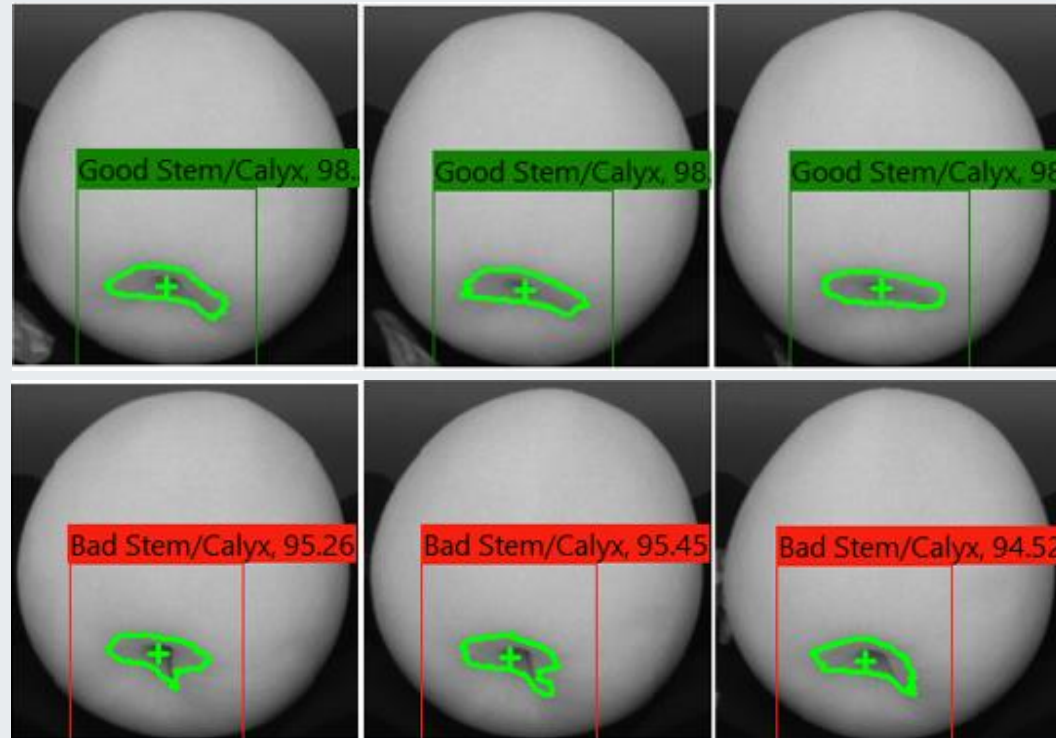- **Surpassing human sorting** capabilities through extremely fine differentiation
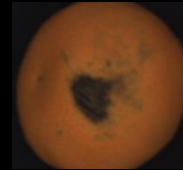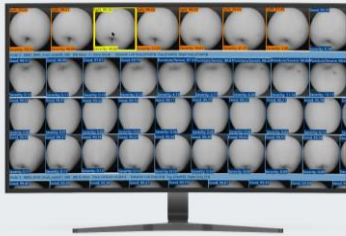
Spectrim X with LUCAi Deep Learning

Up to **40,000 images per second**

High-quality imaging system allows to use in-house fruit captures of over 20 seasons for high-quality DL model development and training

Split, 99.17

Severity: 54.26

Includes unique severity rating for classifications

Removes **>99% of all hard-to detect stem defects**

Continuous development and validation of models for more fruit categories and varieties

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Structure

How AI is shifting expectations in the industry

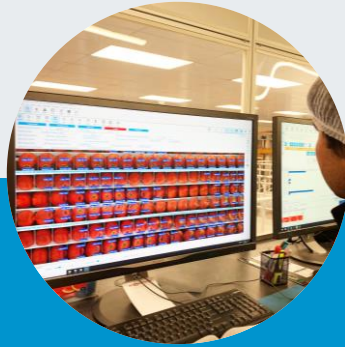# Shift of industry expectations in food sorting

Higher grading accuracy

- **Reduction of food loss**

- **Increased pack-out and returns**

- **Enabling fully-automated packing automation without intensive human QC**

- **Creating of new fruit qualities (e.g. borderline grades)**

Shift of industry expectations in food sorting

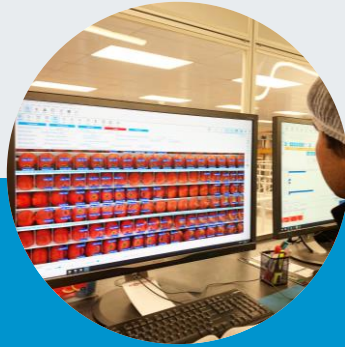Higher grading accuracy

Simplified machine operation

- **Reduced initial and ongoing operator training**

- **Less dependency on machine operator experience for excellent results**

- **Less human errors**

- **Freeing-up operators for other tasks**

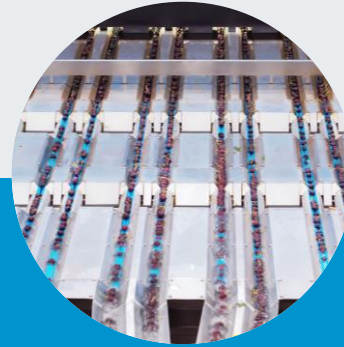# Shift of industry expectations in food sorting

Higher grading accuracy

Simplified machine operation

Higher robustness

- **No slowdown with high defect loads**
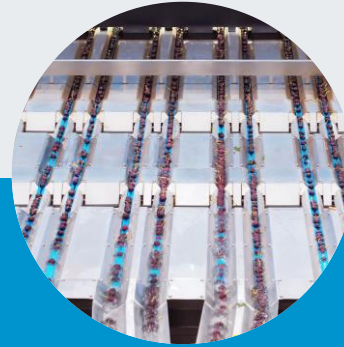
Shift of industry expectations in food sorting
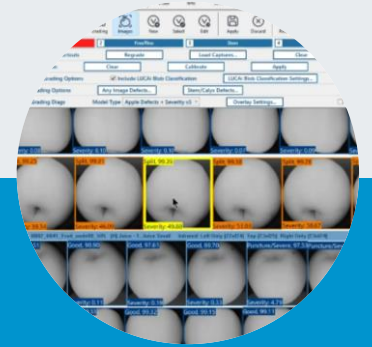
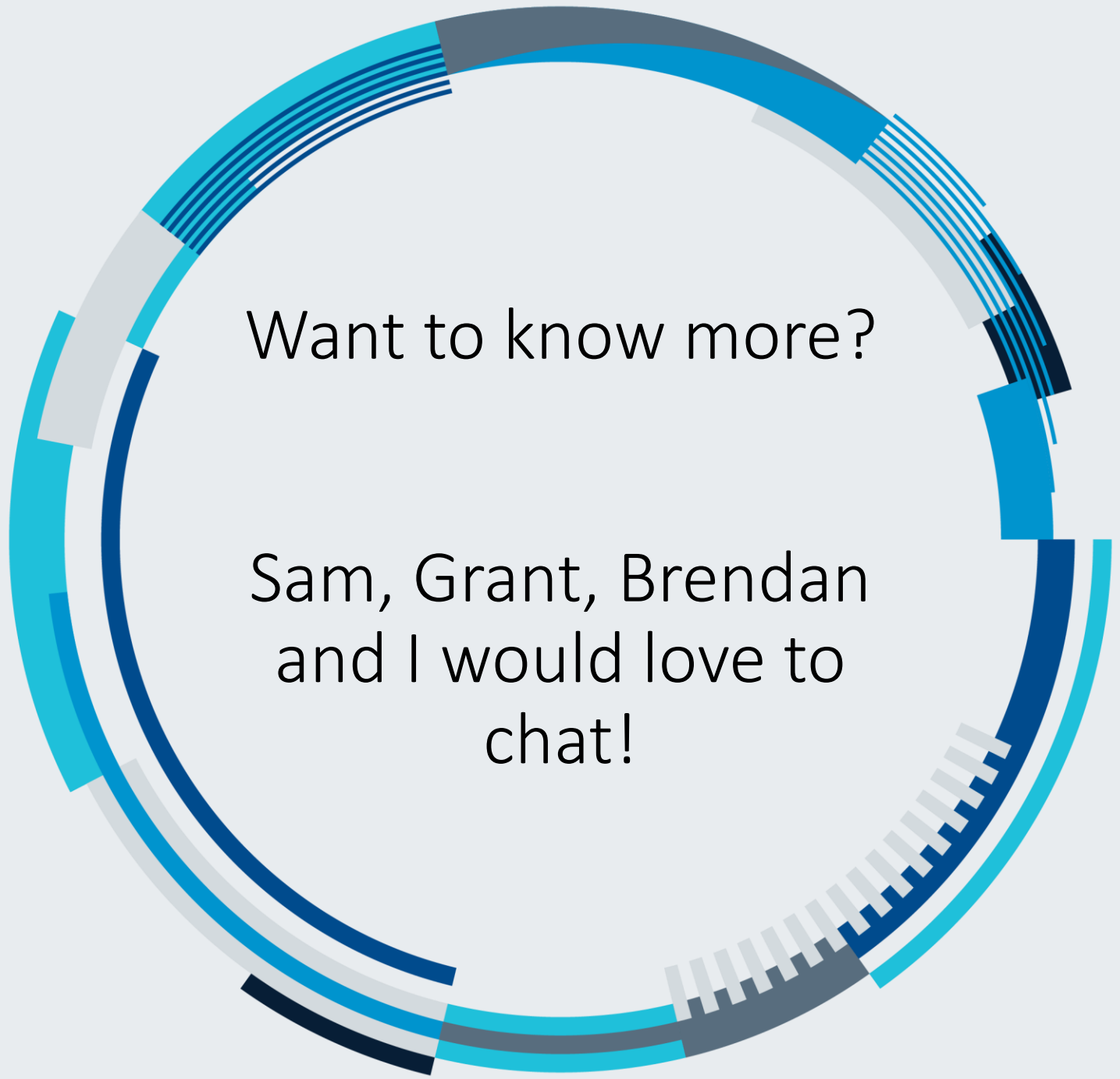Higher grading accuracy

Simplified machine operation

Higher robustness

Customization

- **Customized model development / Modelling services**
- **Evolving models with increasing capabilities**
- **Shifting focus from machines to computer hardware and software**

Want to know more?

Sam, Grant, Brendan and I would love to chat!