

The Great Merge - How ML, AI, and IoT Are Coming Together to Create Industry 4.0



Justin Grammens – Founder + CEO



SOFTWARE DEVELOPMENT DONE RIGHT™

*“This year, 92% of
Industrial companies are
expected to increase
their investment in digital
technologies (4IR)”*

Source: [https://hbr.org/2021/06/5-questions-boards-should-be-
asking-about-digital-transformation](https://hbr.org/2021/06/5-questions-boards-should-be-asking-about-digital-transformation)

Who Am I

- Founder, **Lab651 & Recursive Awesome** – Custom Software and AI Development with a Proven Process
- Co-founder, **Captovation** – AI powered online presentation coaching platform
- Owner, **IoT Weekly News** – Publication covering AIoT
- Host of the “**Conversations on Applied AI Podcast**”
- Adjunct Professor, **University of Saint Thomas** – Teaching graduate courses on IoT & ML
- Co-founder, **Applied AI** – 501(c)(3) non-profit: Monthly meetups & conferences on AI & ML. AI Conference on May 12th! Visit <https://appliedaiconf.com>



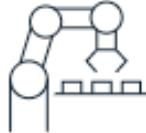
Industry 4.0 can unlock significant value across multiple areas of a factory network.

Example areas of value potential in Industry 4.0 (factory network)



Data, computational power, connectivity

- Blockchain
- Cloud technology
- Internet of Things
- Sensors



Human-machine interaction

- Virtual and augmented reality
- Robotics and automation (collaborative robots, automated guided vehicles)
- Robotic process automation, chatbots



Analytics and intelligence

- Automation of knowledge work
- Big data, advanced analytics, and AI



Advanced production methods

- Additive manufacturing (including 3-D printing)
- Renewable energy

Value potential

15–20%

inventory-holding cost reduction

15–30%

labor productivity increase

30–50%

machine downtime reduction

10–30%

throughput increase

85%

forecasting accuracy improvement

10–20%

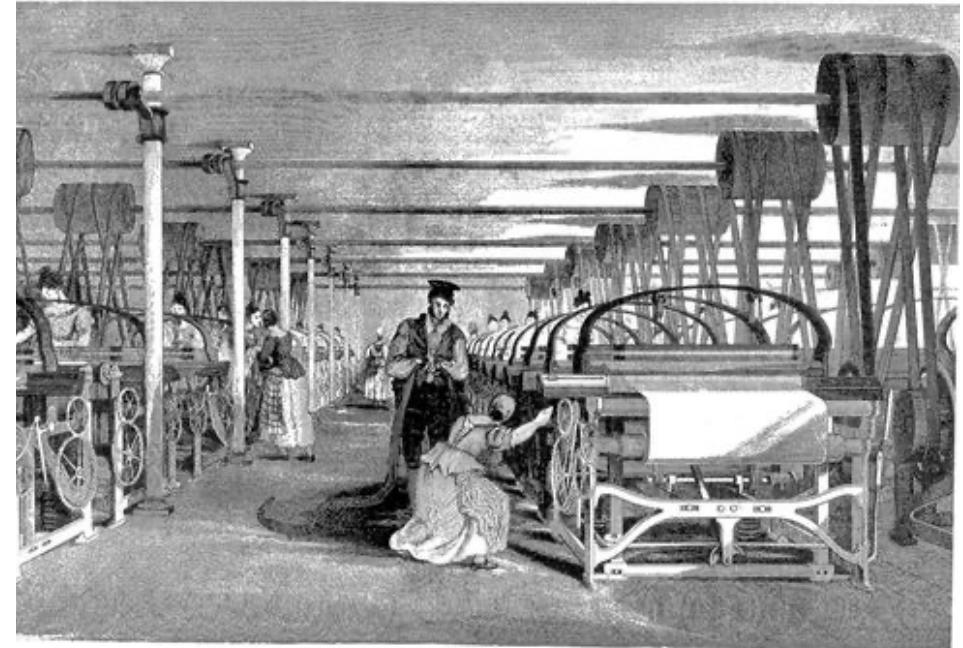
cost-of-quality improvement

What We Will Cover

- Prior Industrial Revolutions
- Overview
 - Power of IoT
 - Capabilities of Machine Learning
 - Potential of Artificial Intelligence
- Business Applications & Case Study
- Challenges & Pilot Purgatory
- Edge Impulse
- Summary / Q&A

1st Industrial Revolution

- Started: 1760-1820
- Processes became mechanized
 - Steam engine
 - Discovery of coal
 - Metal forging & manufacturing
 - Textiles were a leading industry
- Economy moved from agricultural to industrial



Caption: A Roberts loom in a weaving shed in 1835
Source: Wikipedia

2nd Industrial Revolution



Caption: A German railway in 1895

Source: Wikipedia

- Known as the “Technological Revolution”
- Started: 1870-1914
- Widespread adoption of
 - Automobile & Railroad Networks
 - Gas & Water Supply
 - Sewage Systems
 - Electricity and Telephones

3rd Industrial Revolution

- Known as the “Digital Revolution”
- Started: 1960-2010
- Shift from mechanical and analog to digital electronics
- Devices and technologies
 - Personal Computers
 - Cellular phones
 - Internet

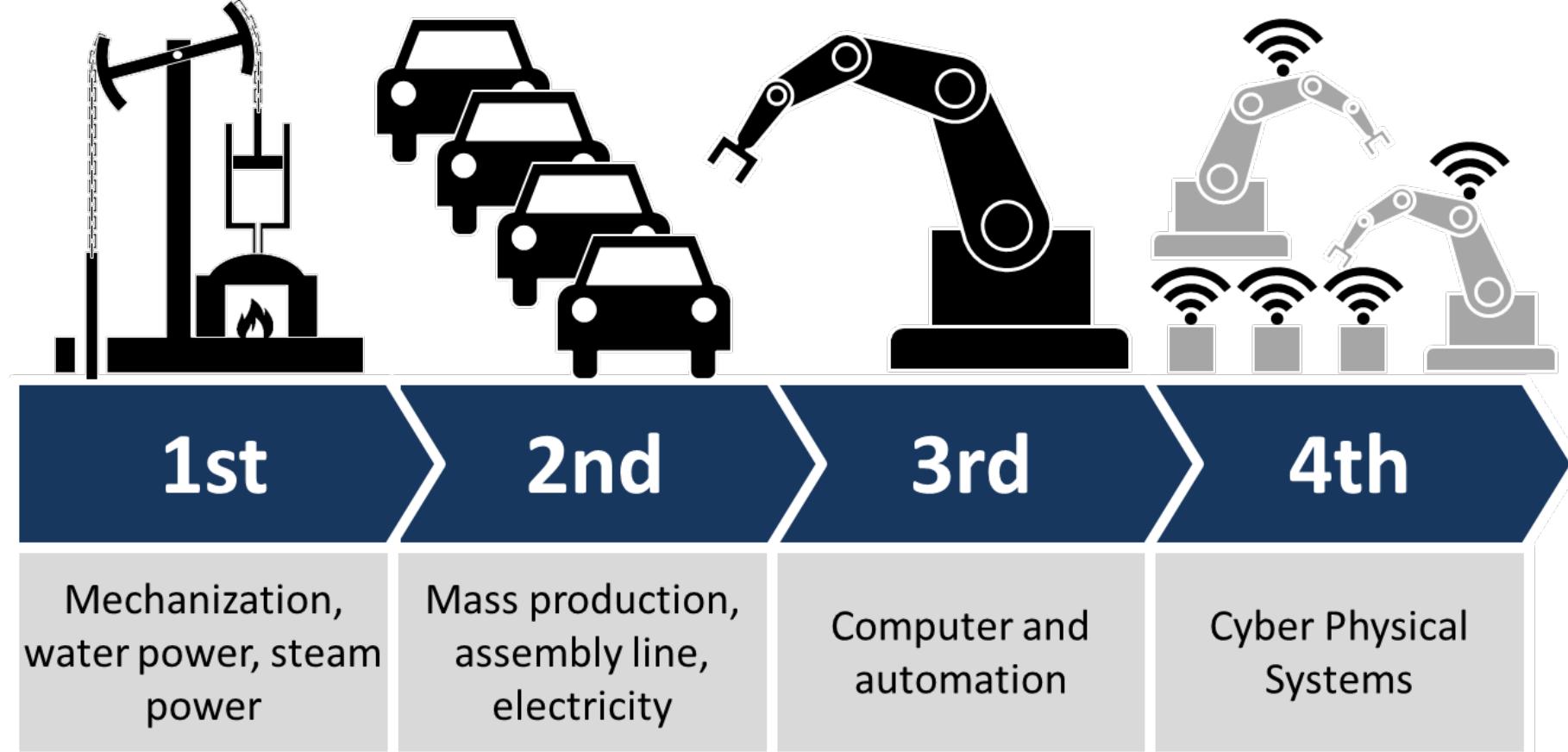


Caption: 1975 in the Apple garage
Source: Apple Computer

4th Industrial Revolution



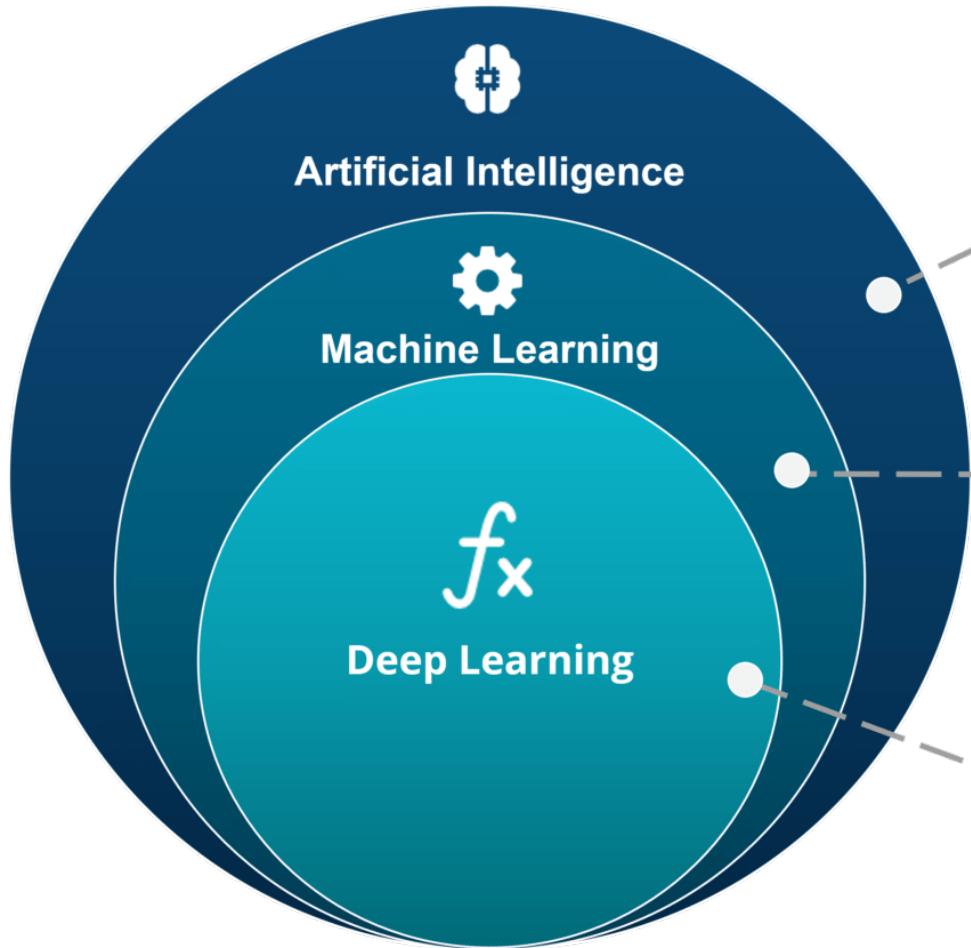
- Known as “Industry 4.0” (Cyber Physical Systems)
- Time period: 2010 - ?
- Trends towards automation and data exchange
- Interconnection between machines, devices, sensors and people
- Technology components
 - IoT
 - AI & Machine Learning
 - Robotics
 - AR/VR Devices & Wearables



All these completely changed the traditional way that an industry or market operates

Power of IoT

- The Internet of Things (IoT) refers to the network of interconnected physical devices embedded with sensors, software, and other technologies to collect, transmit, and exchange data.
- Today, we'll focus on the business applications
 - Quality Control
 - Predictive Maintenance
 - Supply Chain Management
 - Remote Location Monitoring
- Generating massive amounts of data



ARTIFICIAL INTELLIGENCE

A technique which enables machines to mimic human behaviour

MACHINE LEARNING

Subset of AI technique which use statistical methods to enable machines to improve with experience

DEEP LEARNING

Subset of ML which make the computation of multi-layer neural network feasible

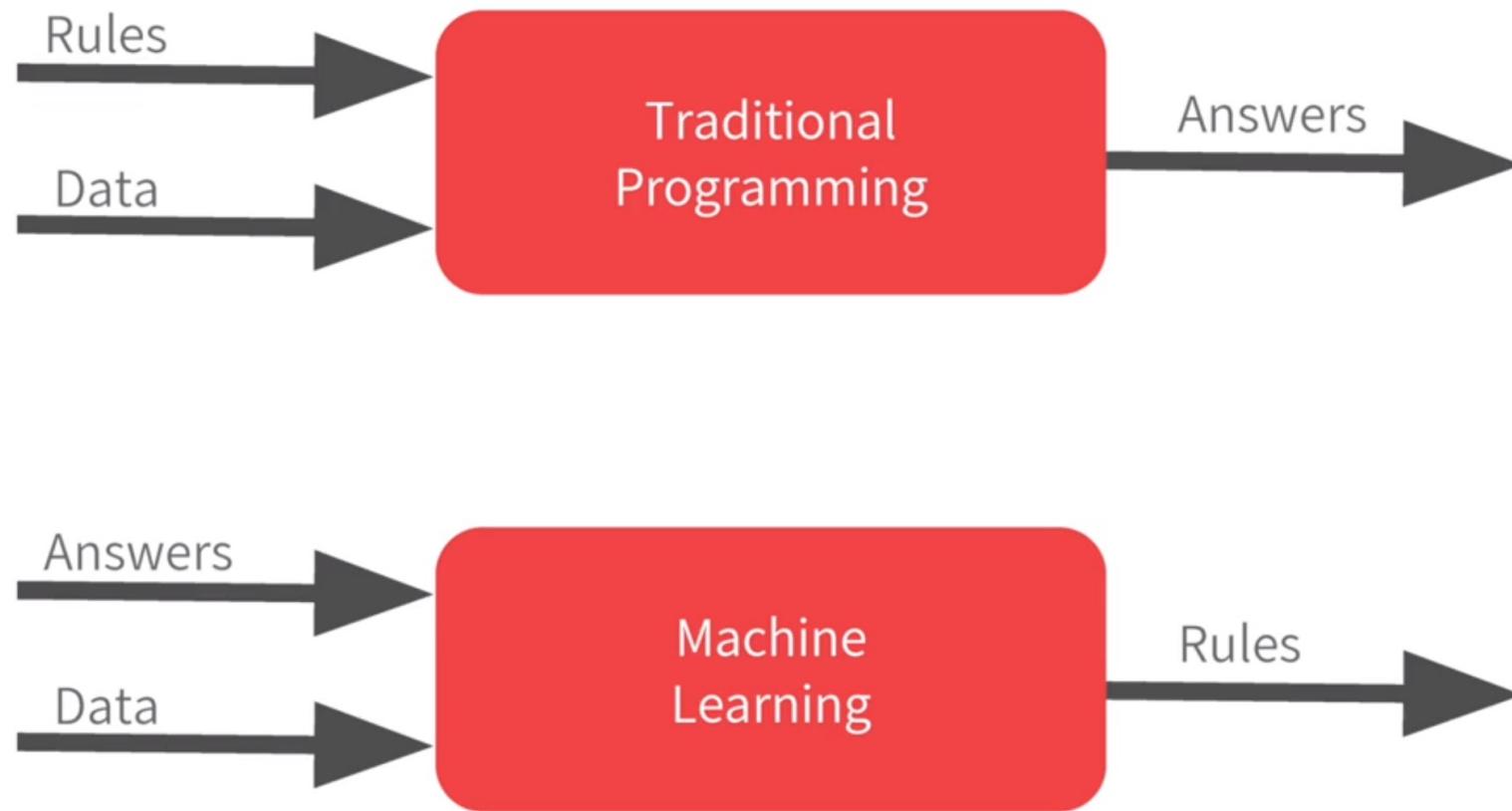
Capabilities of Machine Learning

Machine learning (ML) is a field of inquiry devoted to understanding and building methods that 'learn', that is, methods that **leverage data to improve performance on some set of tasks.**

Source: Wikipedia

It has been a new way of looking at the problem!

Capabilities of Machine Learning



Activity Recognition



```
if(speed<4){  
    status=WALKING;  
}
```

```
if(speed<4){  
    status=WALKING;  
} else {  
    status=RUNNING;  
}
```

```
if(speed<4){  
    status=WALKING;  
} else if(speed<12){  
    status=RUNNING;  
} else {  
    status=BIKING;  
}
```

// Oh crap

Activity Recognition



0101001010100101010
1001010101001011101
0100101010010101001
0101001010100101010

1010100101001010101
0101010010010010001
0010011111010101111
1010100100111101011

1001010011111010101
1101010111010101110
1010101111010101011
1111110001111010101

111111111010011101
0011111010111110101
0101110101010101110
1010101010100111110

Label = WALKING

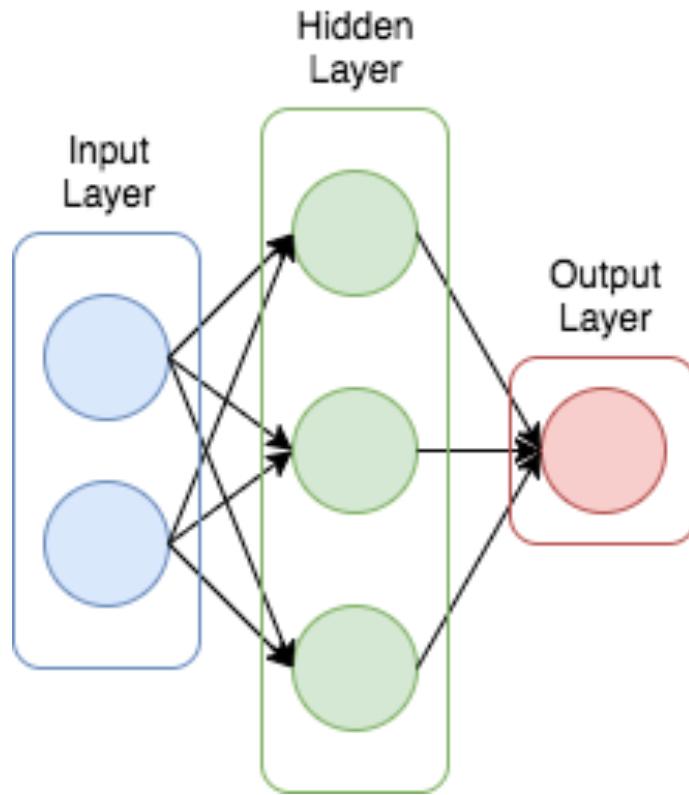
Label = RUNNING

Label = BIKING

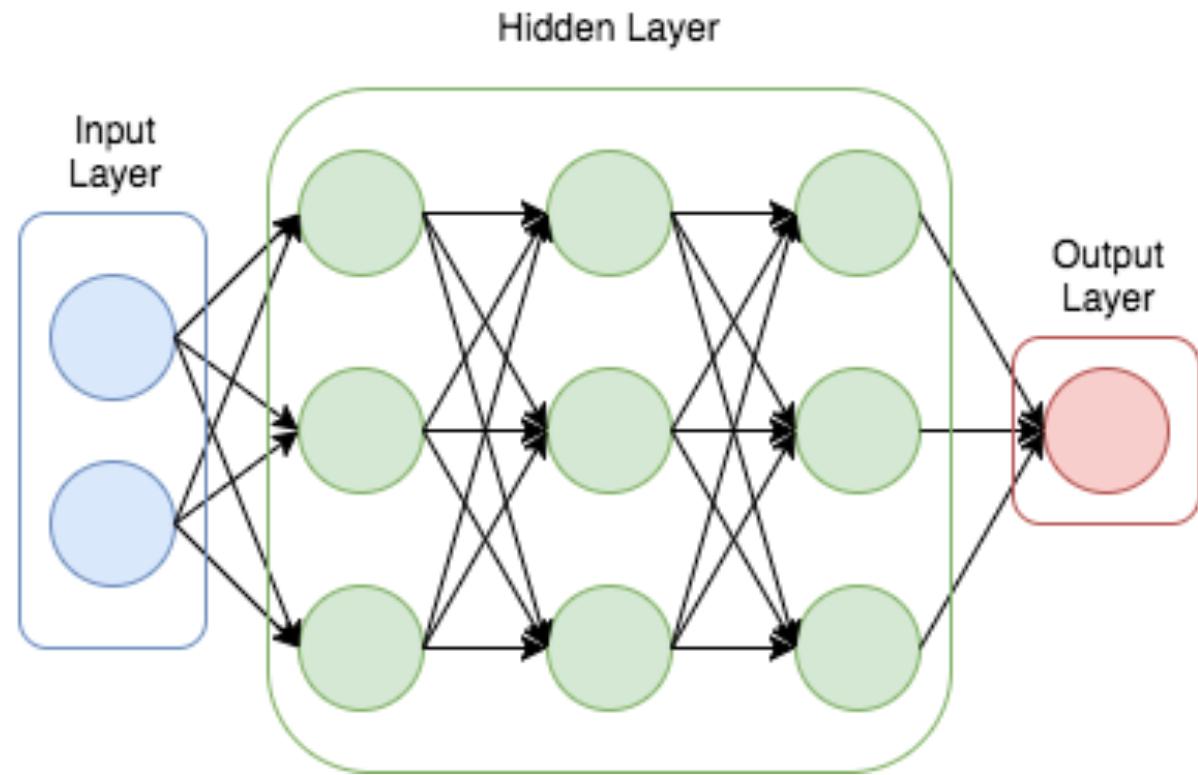
Label = GOLFING

Capabilities of Machine Learning

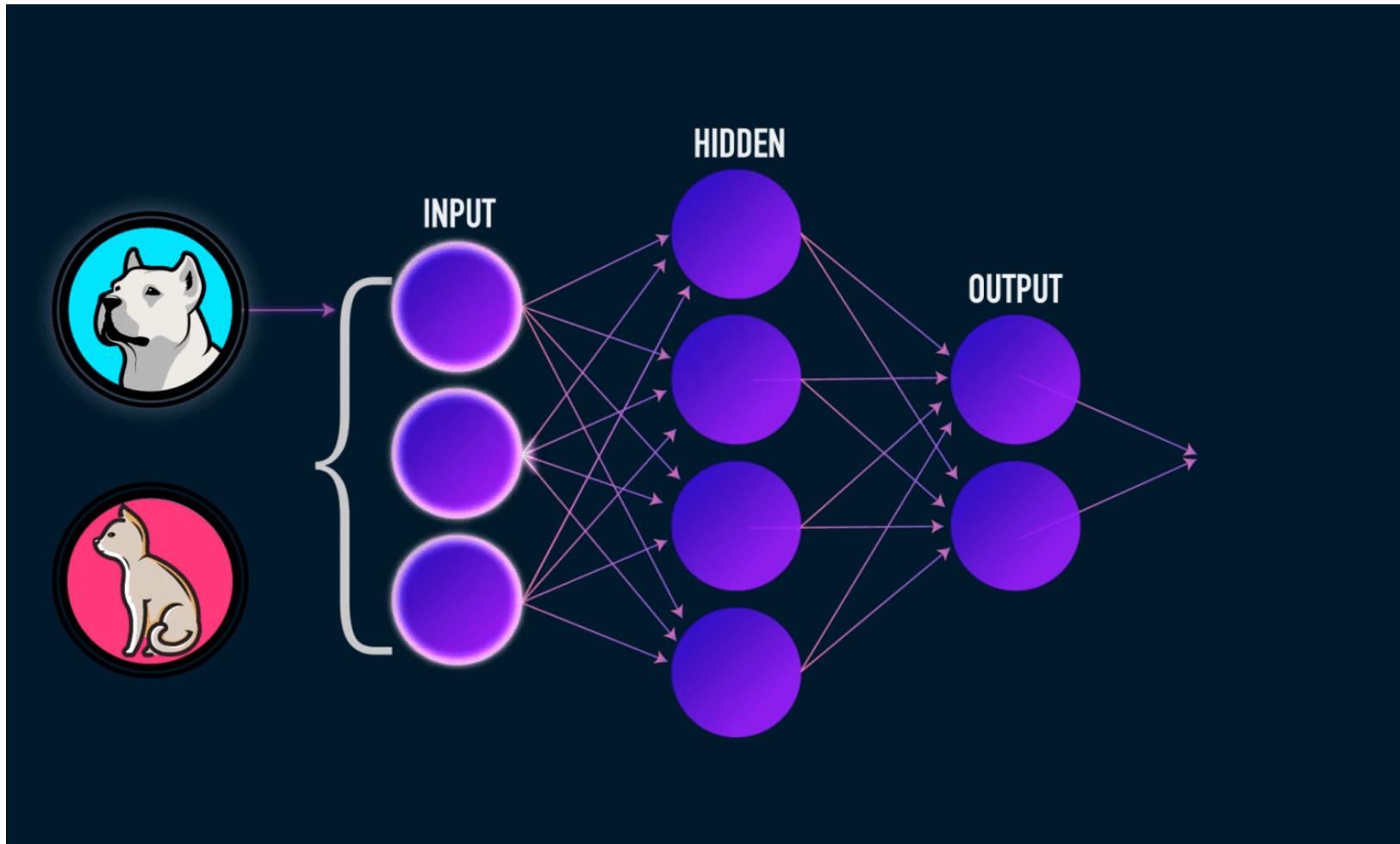
Neural Network



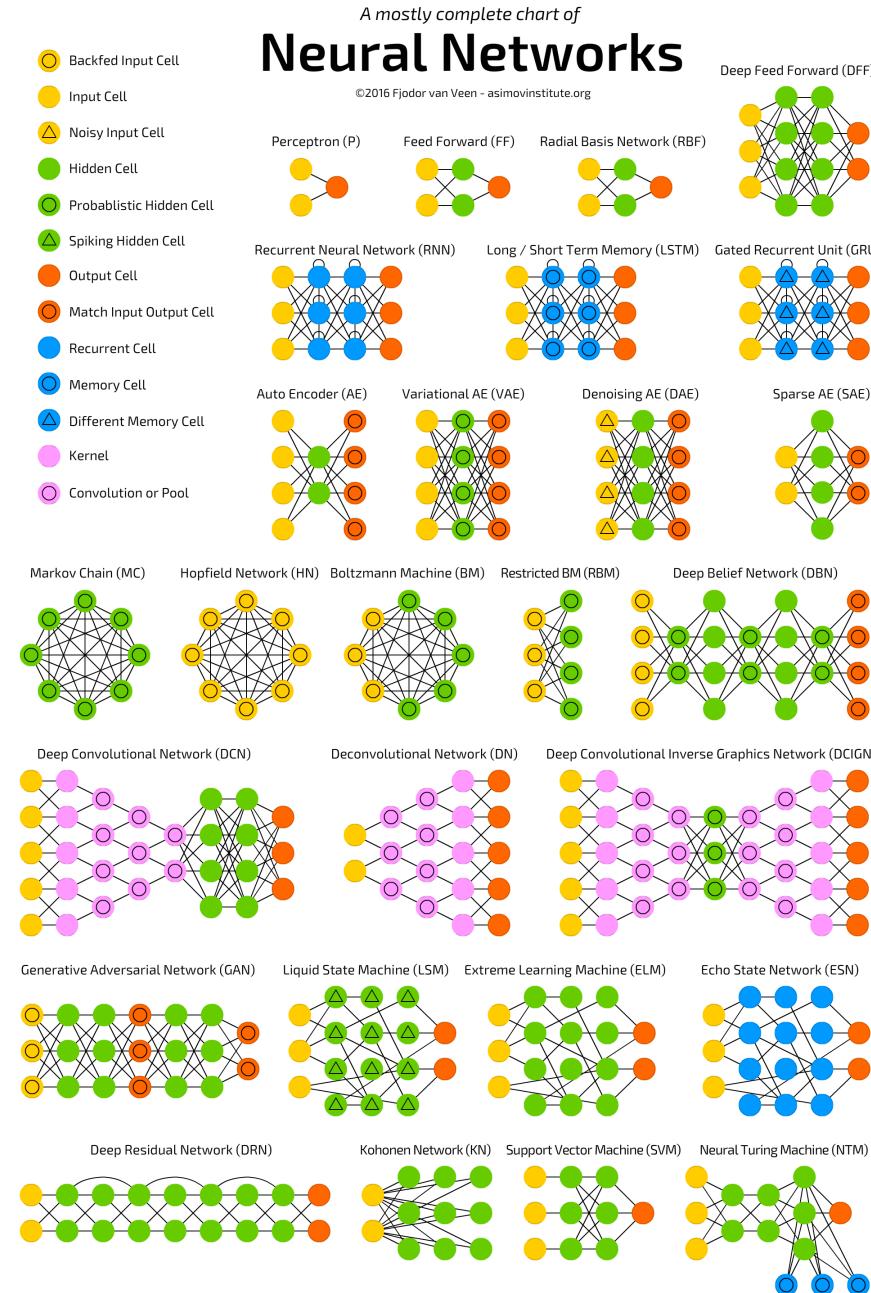
Deep Neural Network



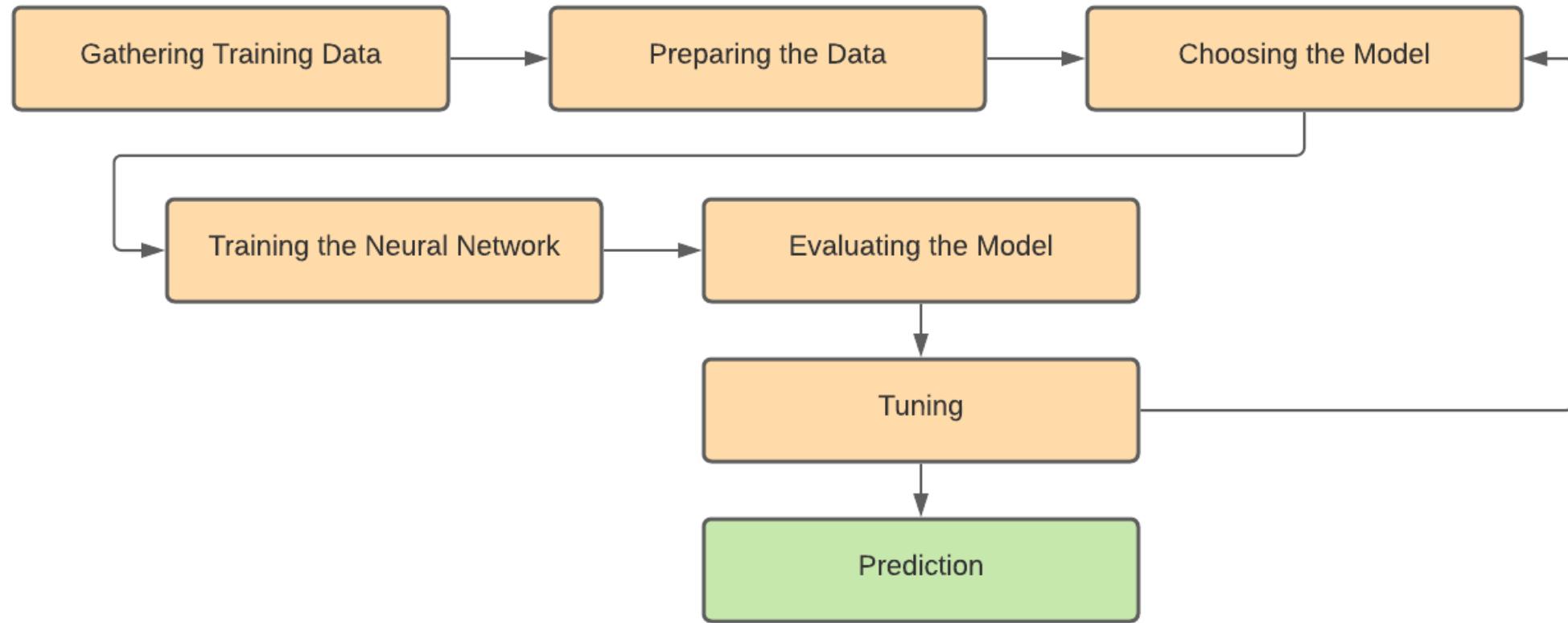
Capabilities of Machine Learning



It's a wild
and crazy
world out
there....



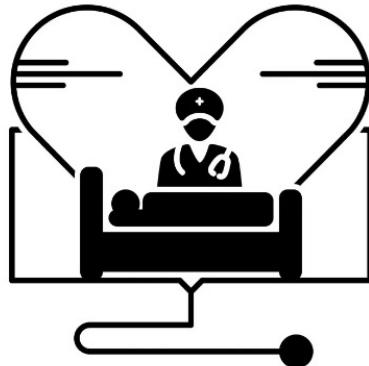
Machine Learning Steps



Types of Industries



Transportation



Healthcare



Agriculture



Financial



Retail

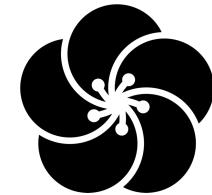
Types of Use Cases



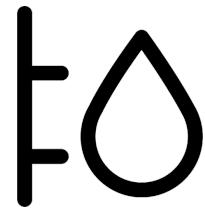
Asset Tracking



Compliance



Automatic
Replenishment

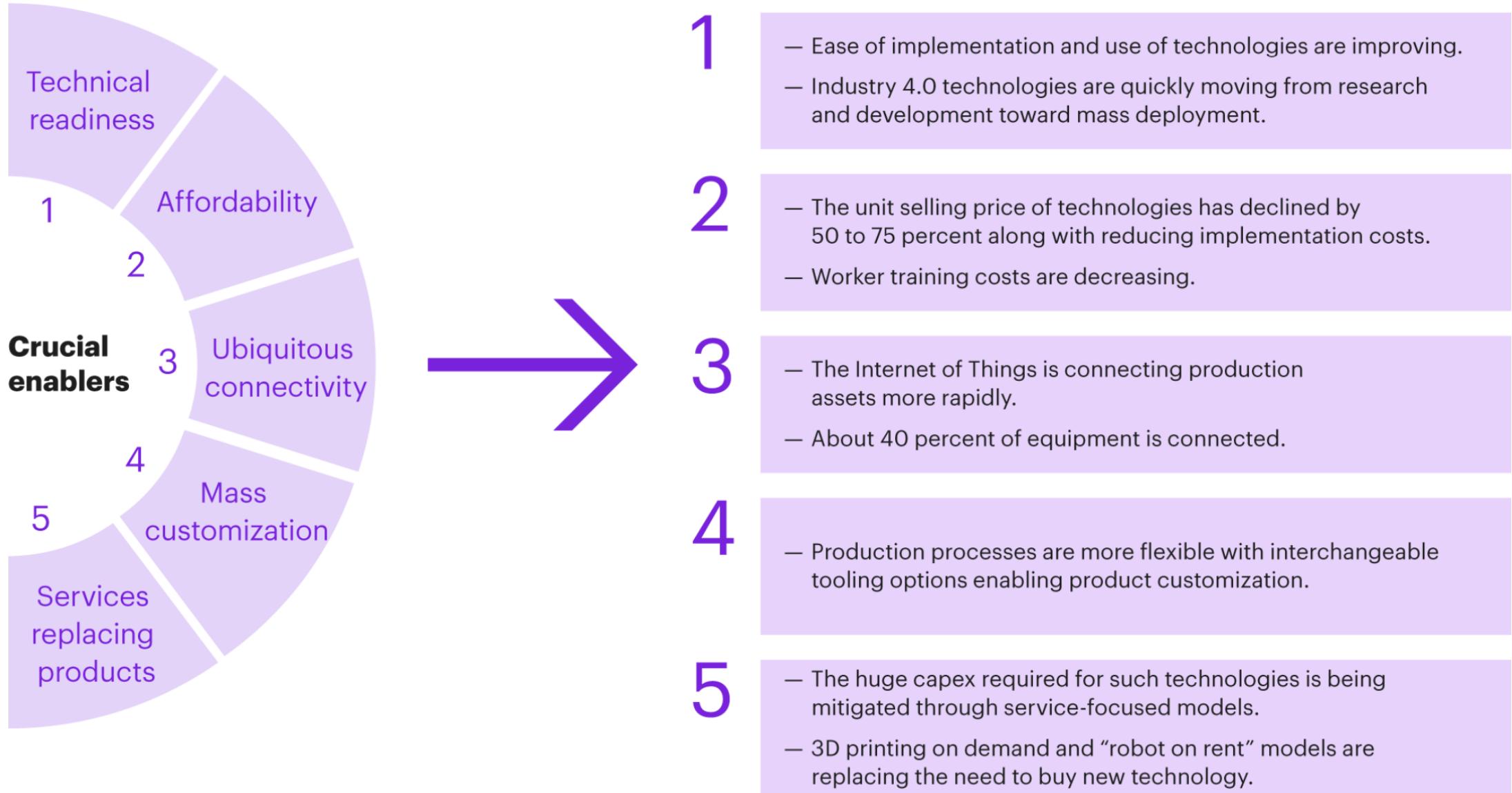


Environmental
Reporting, Shrink/
Waste



Preventative
Maintenance

Five factors are accelerating the Fourth Industrial Revolution



Source: Kearney analysis

Examples



Business Application - Sugar Creek



Transformation: Selling a more efficient production facility.

Beer spillage due to foaming, resulting in lost revenue. Implemented real-time data analysis and visualization.

USE CASE – Shrink / Waste

BENEFITS

- Monitoring of fill times, temperature, pH, gravity, pressure, etc.
- System “learns” the perfect pour
- Saved \$120,000/year

Business Application - Eaton

LifeSense system monitors and detects impending hydraulic hose failure and alerts operators and maintenance crews so they can schedule maintenance and plan downtime.

USE CASE - Preventative Maintenance

BENEFITS

- Predict and replace the hose before a failure
- Avoids downtime
- Avoids environmental mess of hydraulic fluid
- Avoids injury to employees



Transformation: Selling a proactive service, not just a hose.

Business Application - Radia

Smart industrial grade paint mixer – installs at Lowe's and Home Depot. Tracks vibration, voltage, error codes. The machine can shutdown or send a request for support if issue arise.



USE CASE - Preventative Maintenance

BENEFITS

- More efficient service calls (parts)
- Spot issues from runtime data before they occur

Transformation: Selling a smart and more reliable product

Business Application - XirgoCam

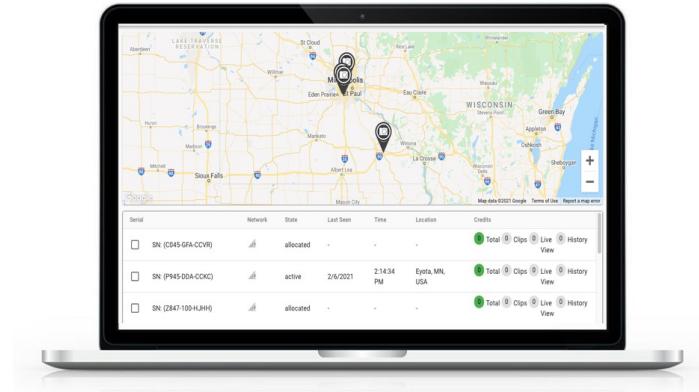
Intelligent Dashcam for drivers and fleet management. Track location, engine (OBD-II), risky driving and driver alertness.



USE CASE - Asset Tracking, Compliance, Preventative Maintenance

BENEFITS

- Alerts when drivers are distracted or drowsy
- Remote video capture & security
- Engine performance & maintenance records



Transformation: Selling remote visibility, tracking and maintenance

Pilot Purgatory

“74% Industry 4.0 pilot programs don’t move to production”

<https://www2.deloitte.com/content/dam/Deloitte/us/Documents/process-and-operations/us-iot-pilot-purgatory.pdf>

Case Study – Leather Grading

- Grading of leather has occurred for more than 100 years
- Quality scale from A-F
 - Branding marks
 - Tick bites
 - Holes
 - Other imperfections



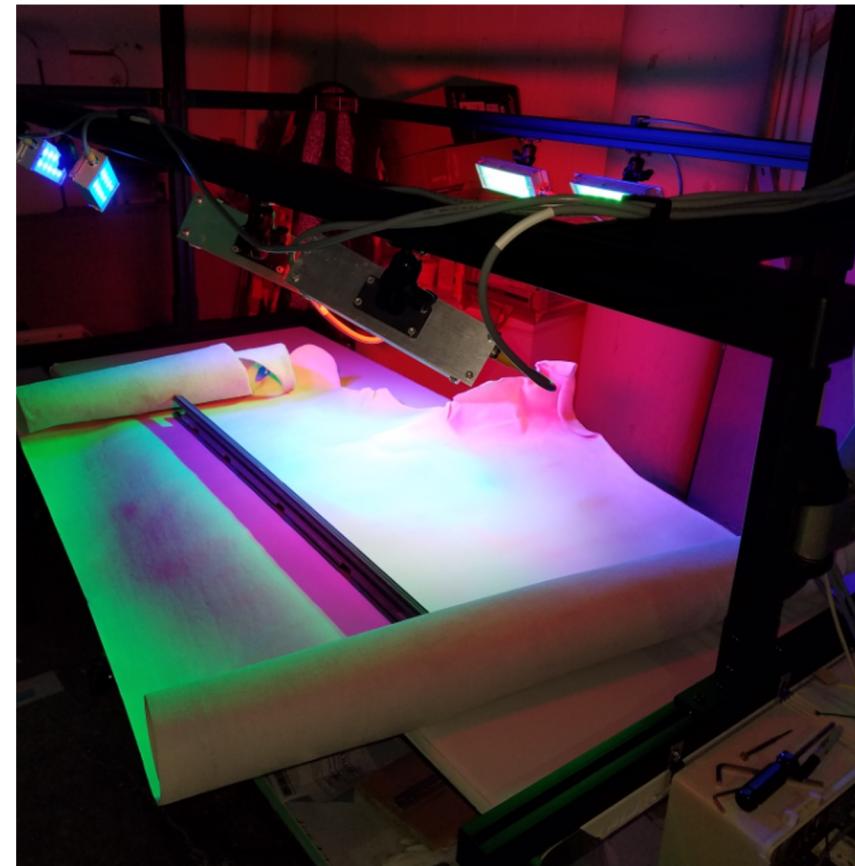
Case Study – Leather Grading

- Flaw detection results in
 - Labor costs
 - High turn over
 - Medical issues
 - Human error
 - Subjective



Case Study – Input Images

- Angled directional lighting was used to accentuate textural features, lights are 120 deg. apart
- Three light colors were used: Red, Green, Blue
- Color changes and combinations accentuate flaws in the leather that have 3D topography

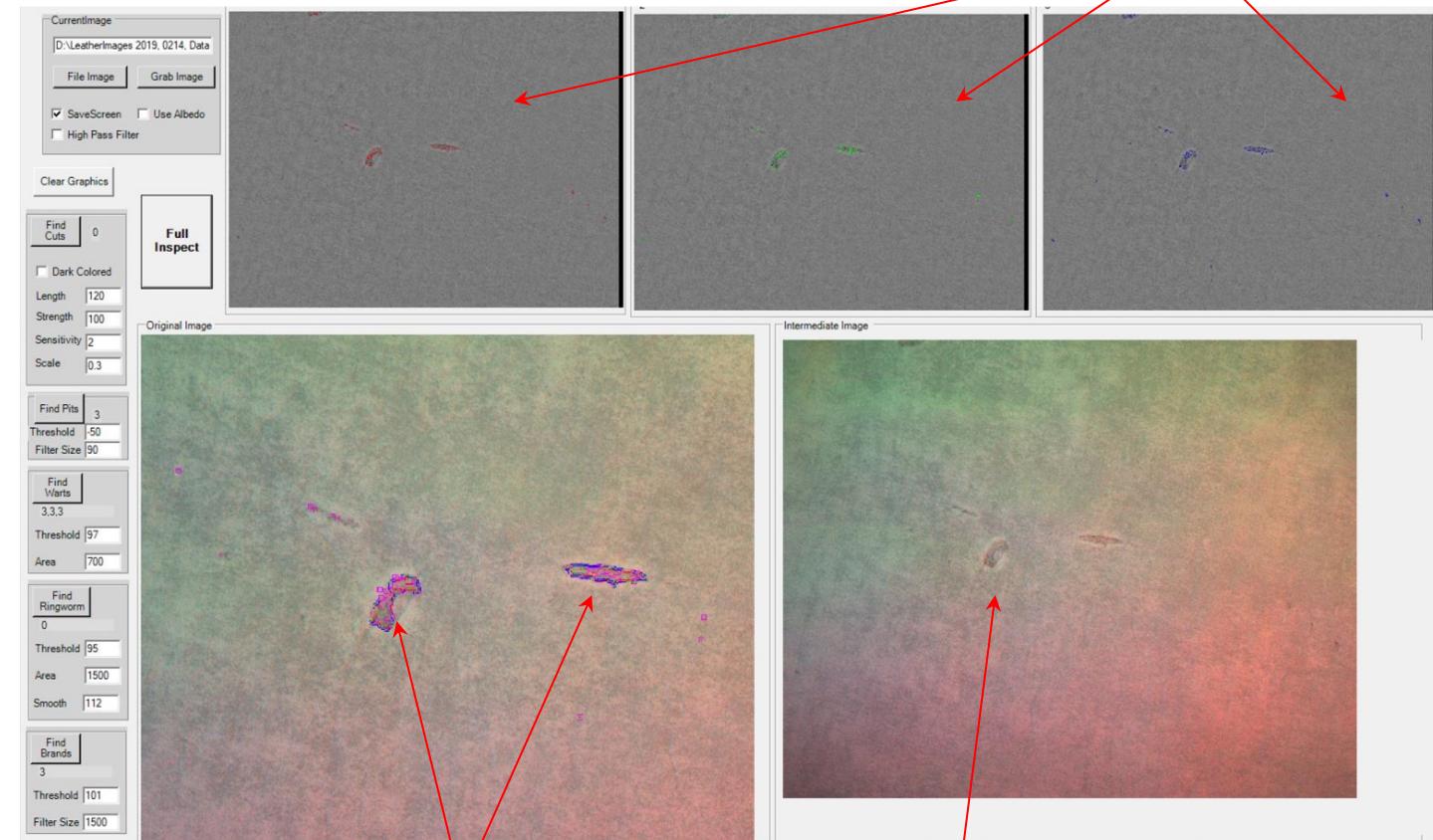


Case Study - Results

The topography
of a flaw is
accentuated by
color differences



Case Study Results



Flaws are tagged by
detection algorithm

Red, Green Blue
Light only

Same as previous
raw image

Case Study – Learnings

- Reinforcement Learning
 - Images taken in bulk
 - Graded and labeled by workers
 - Trained the system using Deep Learning
- Adaptive Flaw Detection
 - The more examples we receive the better it would get
- Challenges
 - Leadership ultimately not invested in making the change
 - Not enough images from workers
 - No incentive from workers to take pictures and grade

Avoiding Pilot Purgatory

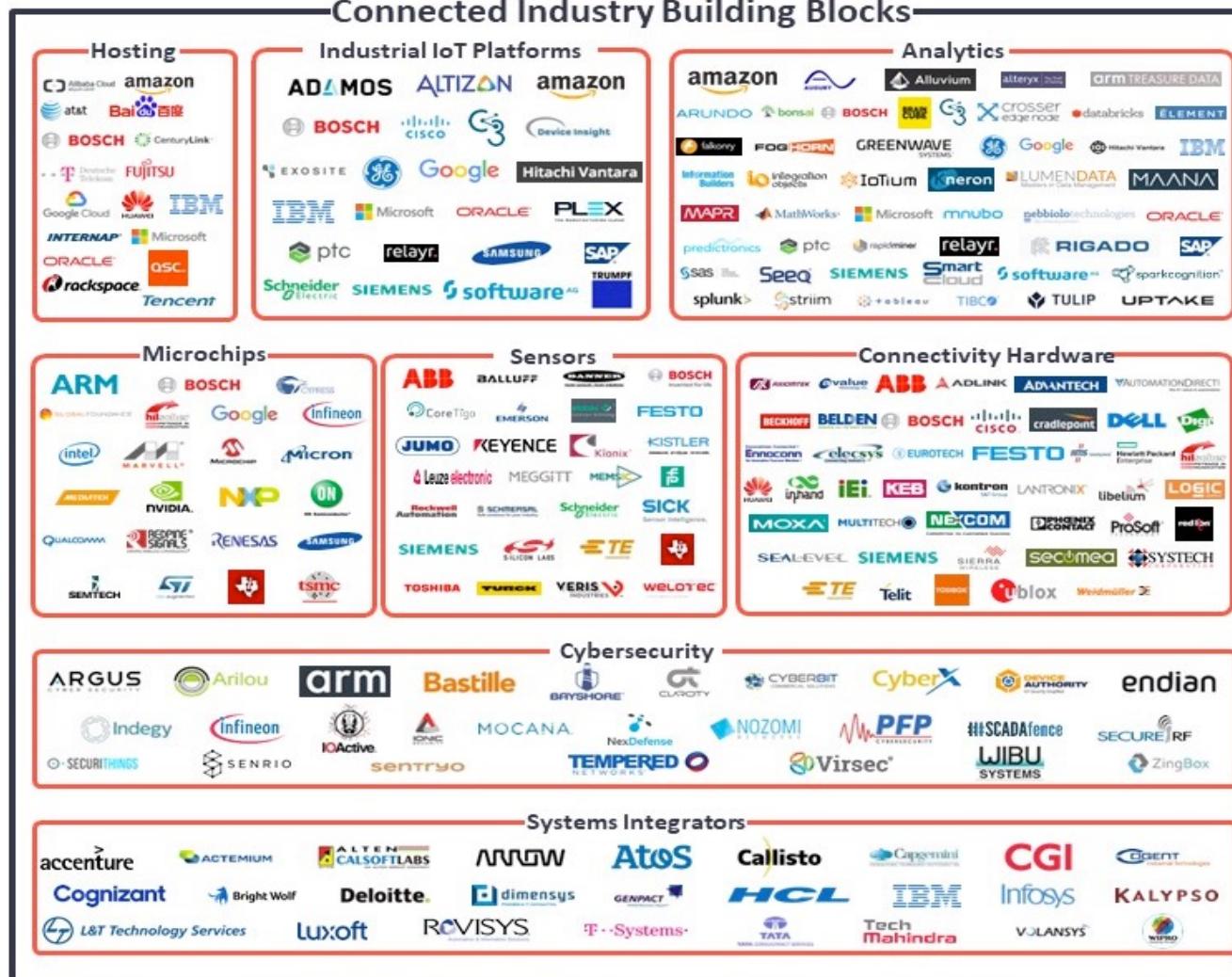
- Formalize the value
- Select use case and location with the largest impact
- Specific goals and measured success
- Understand what it will take to scale
- Communicate well and often
- Don't let “perfect” defeat the good
- Develop a clear roadmap and project plan
- Find those who are open to the change

Adoption Challenge - Vendors

History of mobile application technology vs Industry 4.0



Leading Industry 4.0 Vendors 2019



Source: IoT Analytics, January 2019. Vendor map does not include suppliers of vertical or use case specific solutions (i.e. end-to-end vibration monitoring solutions, etc.). Leading companies were selected based on a number of factors including sophistication of relevant product offerings, number of compelling case studies, and size of Industry 4.0 business. It is possible that some vendors have been missed. To submit a company for consideration in the 2020 vendor map, please contact research@iot-analytics.com with the company information.

Edge Impulse

Optimize AI for the edge

Edge Impulse is the edge AI platform for enterprise teams building innovative products. Optimize your models and deploy to any edge device with ease. Accelerate your product development and minimize risks with a platform built to handle the challenges of working with real-world sensor data.

[Get started](#)[Schedule a demo](#)

Quality Control – Label or Not



Summary

- Industry 4.0 is already here
- There's value in connecting your products, services and equipment
- Low/no-code tools such as Edge Impulse make it easy to get started
- **You must innovate :
Advantages you had
yesterday will not continue**



Thank You

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