



Autodesk BIM 360 IQ



# Applying Machine Learning to Construction

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# APPLYING MACHINE LEARNING TO CONSTRUCTION

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Autodesk BIM 360 IQ

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Data Scientist



# Agenda

- Introduction Autodesk BIM 360 IQ?
- Our production data science process
  - Dealing with no labels (LUSI)
  - Data Science Strategy
  - Using Spark
- Conclusion



Image courtesy of Tesla Motors, Inc.



A black and white historical photograph showing the Chrysler Building under construction in New York City. The building's distinctive Art Deco spire is visible at the top, and its steel skeleton is clearly visible against the sky. The surrounding city skyline of the early 1930s is visible in the background.

**circa 1930**

**construction technology revolution**

A wide-angle aerial photograph of the San Francisco skyline. The most prominent feature is the Salesforce Tower, which is under construction. Its upper portion is covered in a blue protective wrap and features a complex, geometric lattice-like structure at the very top. Several orange construction cranes are attached to the tower's sides. In the foreground, there are several other skyscrapers, some with distinctive facades. To the left, the Bay Bridge spans the water. The background shows the vast expanse of the San Francisco Bay meeting the horizon under a clear blue sky.

2017

construction 80 years later...

**circa 1930**



**automobiles**

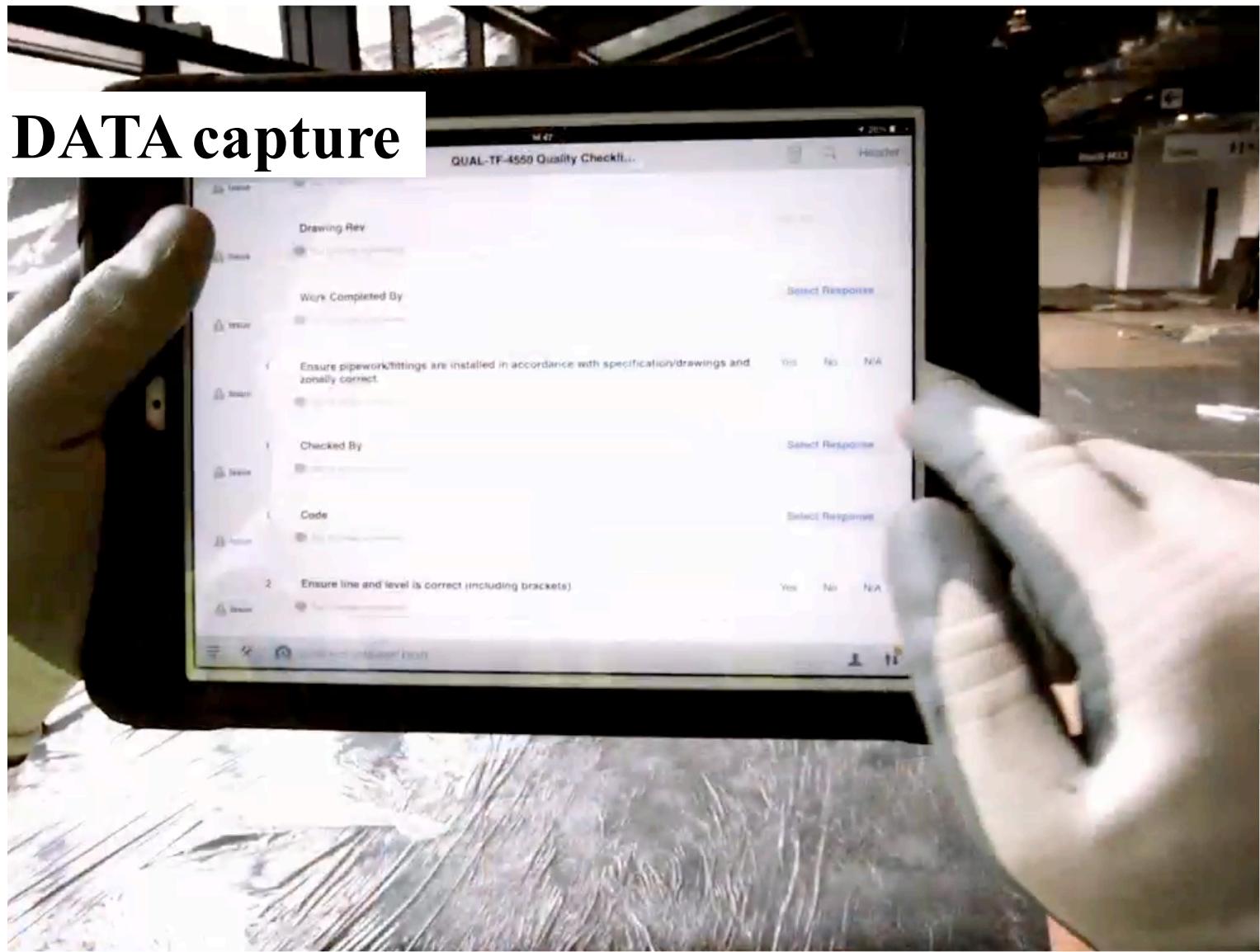
2017



self driving, smarter



# DATA capture



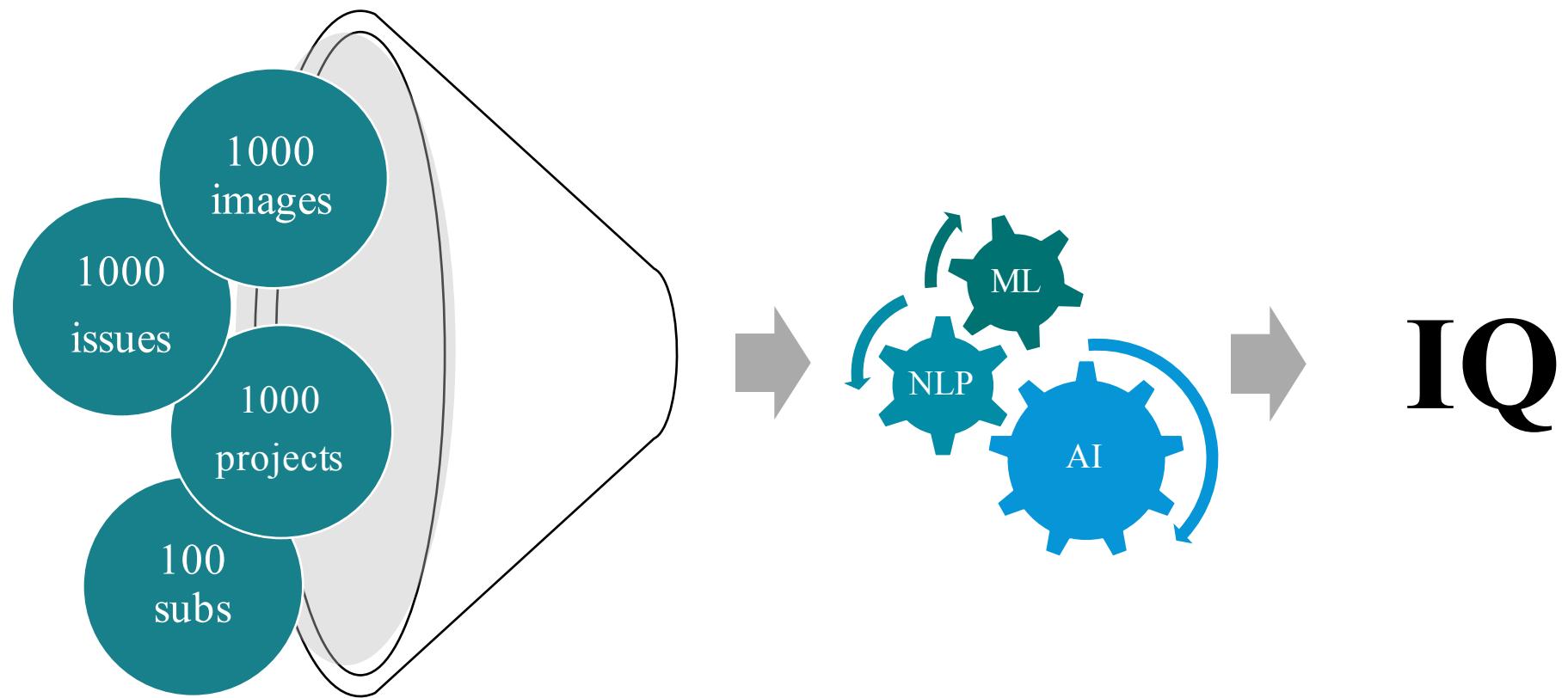
**Quality**

**Safety**

**Schedule**

**Cost**

**IQ**





# thousands of issues

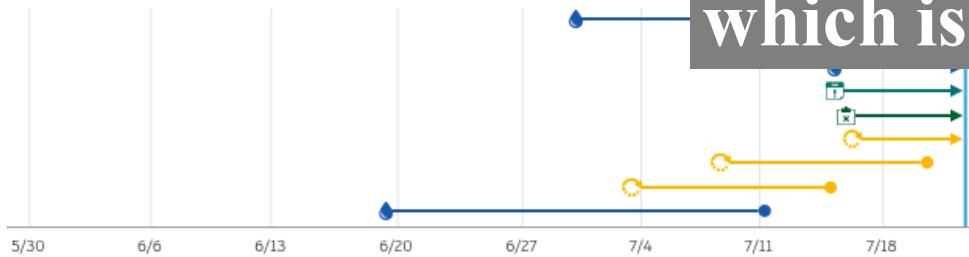
	ID	Description	Company	Location Path	Type	Status
<input type="checkbox"/>	000333	Verify surfaces to receive glass are dry, clean, and properly prepared.	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000368	Install light fixture	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000646	Chipping at end	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000337	Verify fixtures comply with specified fixtures and accessories are provided	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000482	Forms are not maintained nor snug against concrete surface. See attached	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000098	Forms need to be tightened and maintained snug against concrete surface	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000387	Missing light fixture see schedule for correct install	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000014	Chipping at end	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000237	Verify existing lines are coordinated to avoid congestion or interference.	Joe's Plumbing	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000251	Verify mounting height and location are as indicated.	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000239	Concrete, Concrete Block: New Concrete: Do not start surface preparat	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000010	Light fixture incomplete / missing on several floors and there is an inspec	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000087	Wood quality as specified	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000582	Missing exit sign, see attachments for correct installation	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000415	Verify surfaces to receive glass are dry, clean, and properly prepared.	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000258	Missing light fixture	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000009	Door handle is broken, see attached photo and schedule for correct insta	Steelers	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000270	Verify mounting height and location are as indicated.	CC Concrete	Building A>Floor 1	QA/QC	Work Comp
<input type="checkbox"/>	000261	Has the excavation soil density been checked?	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000343	Light fixture incomplete / missing.	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000314	Broken light fixture	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000605	Install light fixture, clean existing space	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000259	The EIFS installed is not per manufacturers documents. There is no flash	Xavier Rainscreens	Building A>Floor 1	QA/QC	In Dispute
<input type="checkbox"/>	000339	Missing light fixture, install per attached schedule	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000510	Excavate site to line and grade indicated.	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000419	Pour concrete slab	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000543	Device and/or trim plate is missing.	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000421	Missing light fixture, see attached schedule for installation	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000276	Device and/or trim plate is missing.	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000353	Repair concrete at base. There is damage and cracking already visible	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000110	Light fixture incomplete / missing.	Joe's Plumbing	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000327	Open penetrations in the concrete framing are not sealed and water is le	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000025	Air distribution damaged	Steelers	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000303	Light fixture incomplete / missing.	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000108	Install light fixture	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000115	Device is not flush with trim plate.	Stark MEP	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000643	Coat surfaces with wash primer.	CC Concrete	Building A>Floor 1	QA/QC	Open
<input type="checkbox"/>	000326	Cracked concrete slab	CC Concrete	Building A>Floor 1	QA/QC	Open

50 items Filter: All Unresolved Issues

Show: 50

## HIGH RISK ISSUES

Water Rework Key Activity Inspection Uncategorized



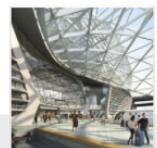
# which issues do I focus on first?

31 high risk issues detected

5 with water risk

**hundreds of subcontractors**





## United Construction Bayfront Arena

Project Dates: Fri Sep 30 2016 - Sat Oct

### SUBCONTRACTOR RISK

Today      Overall

CC Concrete	High	<div style="width: 100px;"></div>
Stark MEP	Medium	<div style="width: 50px;"></div>
Sunshine Weatherp...	Medium	<div style="width: 50px;"></div>
Drywall Inc.	Medium	<div style="width: 50px;"></div>
Joe's Plumbing	Medium	<div style="width: 50px;"></div>
Steelers	Medium	<div style="width: 50px;"></div>
Closet Closets	Medium	<div style="width: 50px;"></div>
Xavier Rainscreens	Medium	<div style="width: 50px;"></div>
United Construction	Medium	<div style="width: 50px;"></div>
Carolina Fire	Low	<div style="width: 10px;"></div>
Ceiling Experts	Low	<div style="width: 10px;"></div>
Click Electricals	Low	<div style="width: 10px;"></div>
Martha's Landscapi...	Low	<div style="width: 10px;"></div>
Rebar Co.	Low	<div style="width: 10px;"></div>
Rebar Masters	Low	<div style="width: 10px;"></div>
Silver Oaks Appliance...	Low	<div style="width: 10px;"></div>

# Who do I talk to first?

Risk Today: High

### Contributing Factors

- ! 3 High Risk Issues
- 💧 1 Water Risk Issues
- # +6 Weekly Issue Trend
- 📅 21 Days Open (avg.)
- ⌚ 6 Long-standing Issues

Daily risk is assessed nightly, based upon analysis of issue keywords and timing.

[>About Risk](#)

[Give us feedback](#)



**937 construction fatalities**

# How do we prevent them



BIM 360 IQ

# Superintendent

**RISK SCORE**

The risk score for this project is poor, and has been trending down for the past week.

[About Risk Scores](#)

**SUBCONTRACTOR RISK**

Subcontractor	Risk Level
CC Concrete	High
NextGen Panels	High
Majestic Steel	Medium
Joe's Plumbing	Medium
Rebar Masters	Low

**HIGH RISK ISSUES**

Water Rework Key Activity Inspection Uncategorized

5/30 6/6 6/13 6/20 6/27 7/4 7/11 7/18

- #22244 - Open penetrations in concrete... To: CC Concrete, Inc. Open 24 days
- #22116 - The waterproofing barrier... To: NextGen Panels Open 14 days
- #22105 - The EIFS installed... To: NextGen Panels Open 7 days
- #21984 - The concrete treads... To: CC Concrete, Inc. Open 7 days
- #21966 - Fireproofing incomplete at... To: Majestic Steel Open 6 days

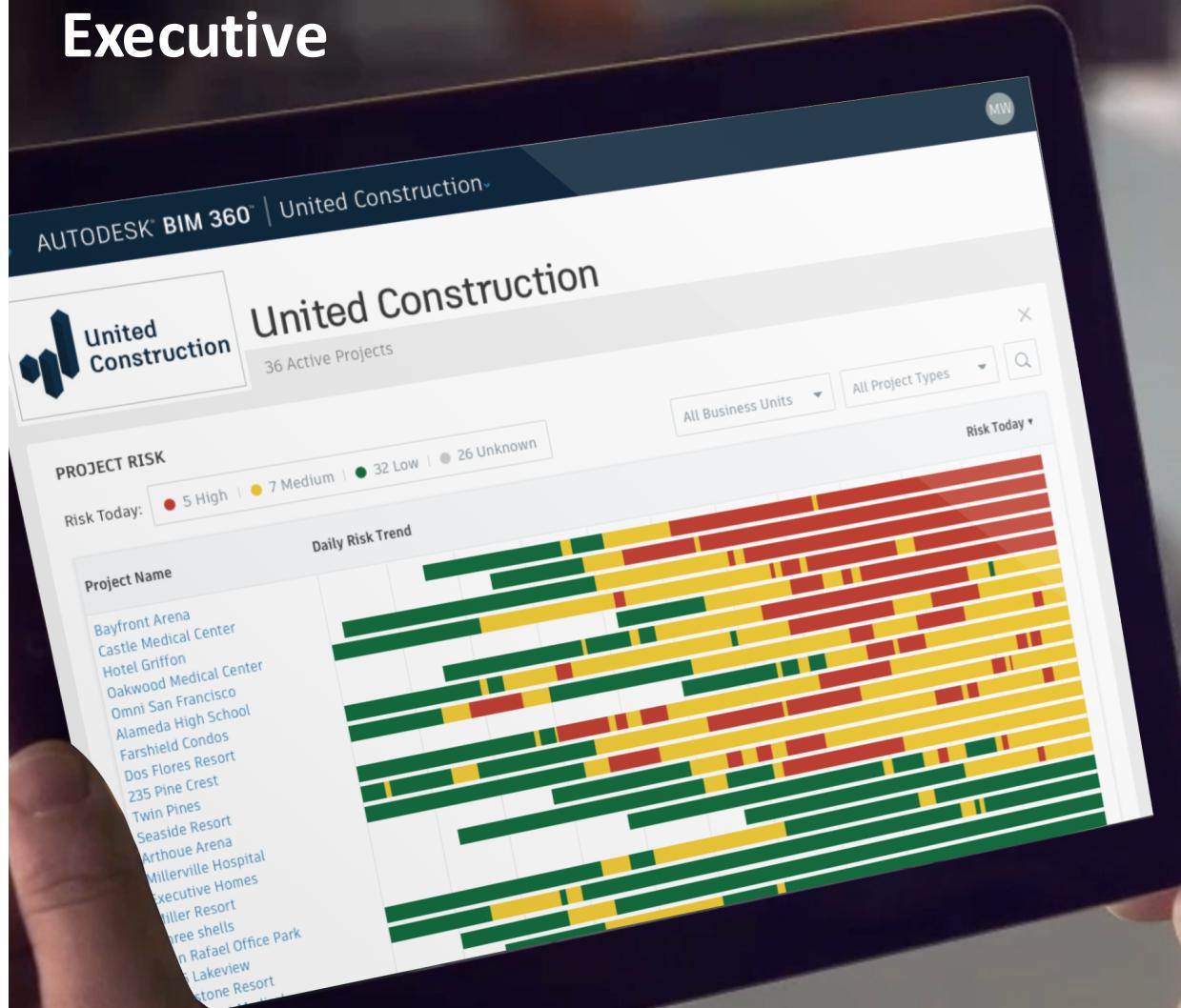


AUTODESK.

Autodesk Confidential – NDA Applicable – NDA Applies

BIM 360 IQ

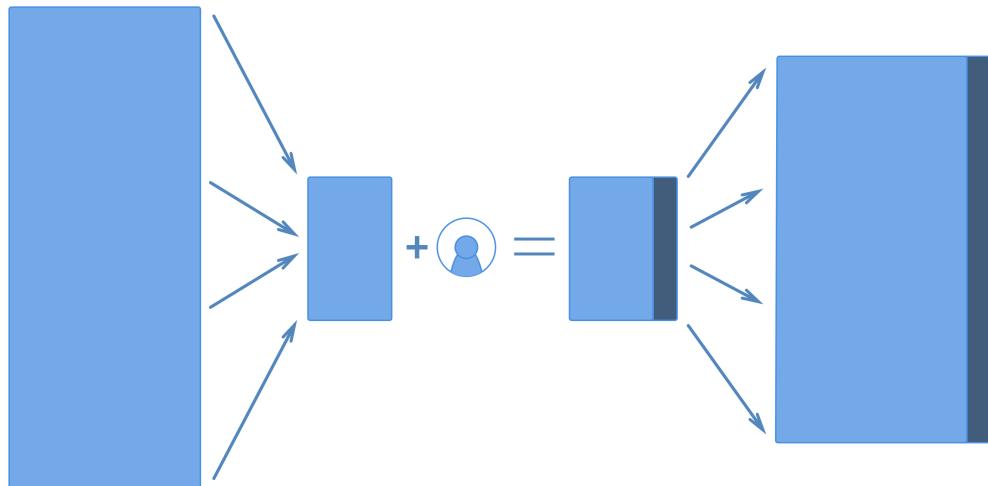
# Executive



# No Labels

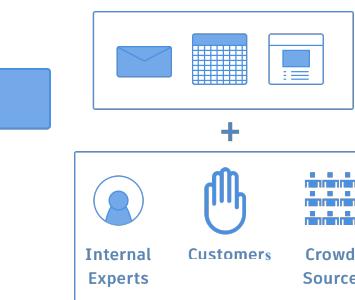
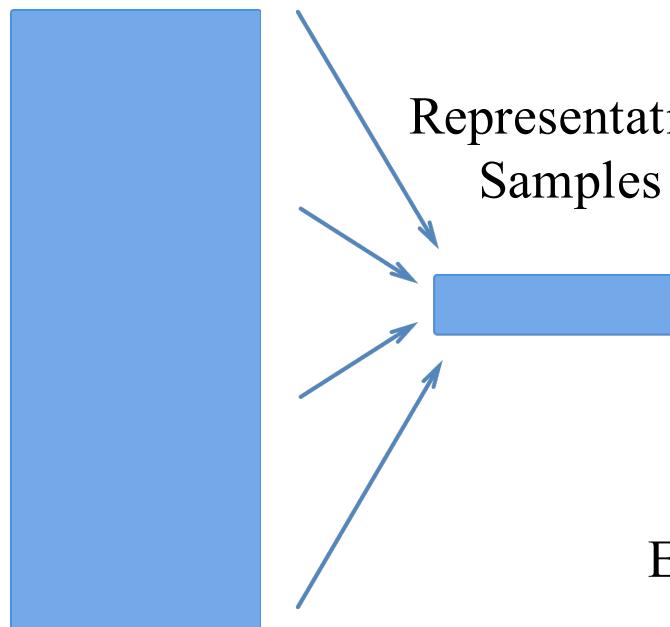


# LUSI - Labelling Large Datasets Using Human Scale Input



# LUSI Methodology

Original Data Set

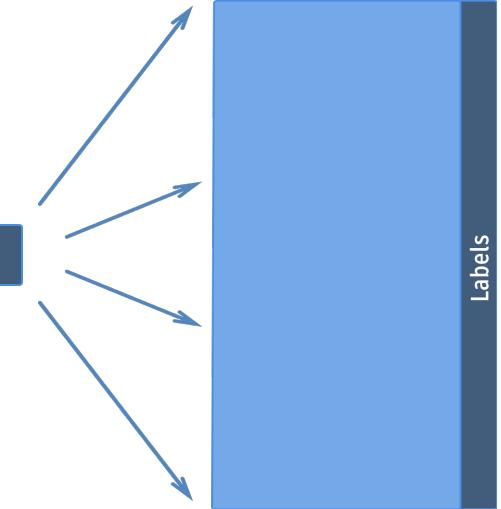


Expert Contributors

Cluster

Training Dataset

Labelled Dataset



Propagate Labels

# Feedback loop

(Forward Looking)

Advantage:

- Easy model performance tracking
- Collect labels for new categories

About Issue Risk

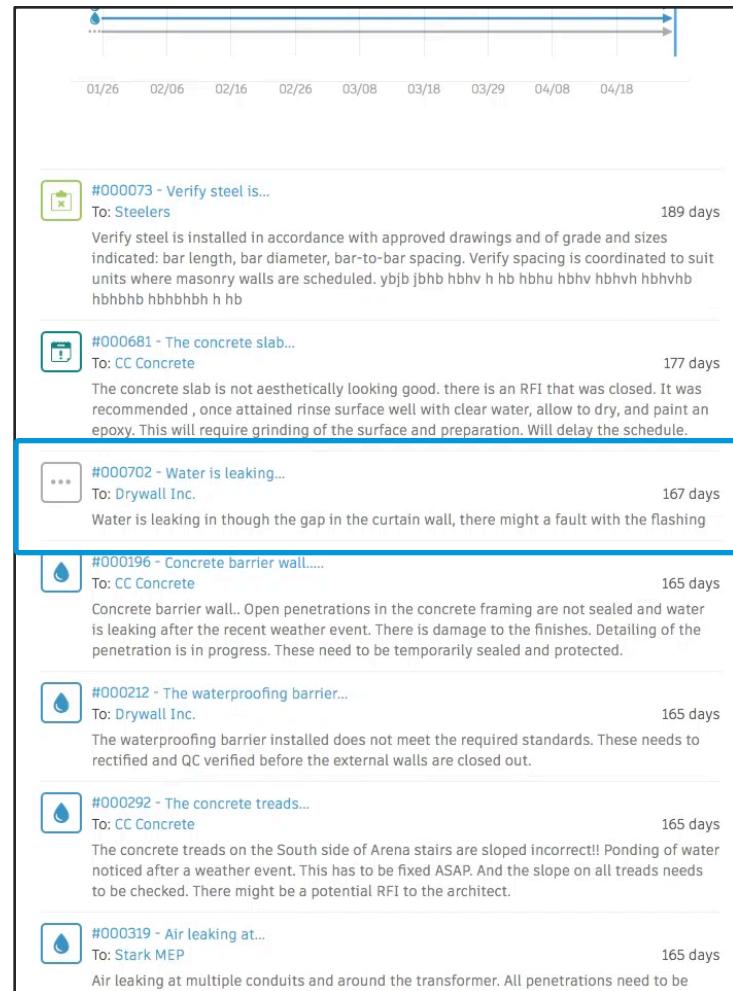
**HIGH RISK ISSUES**  
The construction assistant automatically reviews all quality issues and predicts which ones create high risk for one or more key project outcomes, such as on-time delivery, margin, or customer satisfaction. Surface high risk issues helps ensure that something important doesn't get overlooked. It helps you to focus on the most important things each day and take action early before a risk turns into a liability.

 On Time     On Budget     High Quality

Don't Agree? If you don't agree with an issue risk level, you can change it. Changes immediately update the issue list and issue details. A history of changes appear at the bottom of the project issue list.

**KEY RISK CATEGORIES**  
The construction assistant automatically tags issues into risk categories to help you understand and manage key risk areas.

 Water Water penetration or a water event.	 Key Activity May impact a key activity or milestone.	 Rework May cause time consuming and costly rework.	 Inspection May fail a planned inspection or test.
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# Assistive Predictive Modeling in Construction

**AUTODESK® BIM 360® | Bayfront Arena**

United Construction  
**Bayfront Arena**  
Project Dates: Aug 16, 2016 – Jun 12, 2018

**RISK SCORE**

The risk score for this project is poor, and has been trending down for the past week.

[About Risk Scores](#)

**SUBCONTRACTOR RISK**

Subcontractor	Today	Score
CC Concrete	High	Red
NextGen Panels	High	Red
Majestic Steel	Medium	Yellow
Joe's Plumbing	Medium	Yellow
Rebar Masters	Low	Green
Rebar Co.	Low	Green
Ceiling Experts	Low	Green
Star Elevators	Low	Green
Dry Wall Inc	Low	Green

**HIGH RISK ISSUES**

**Risk Today: High**

**Contributing Factors**

- 3 High Risk Issues
- 1 Water Risk Issues
- +6 Weekly Issue Trend
- 21 Days Open (avg.)
- 6 Long-standing Issues

Daily risk is assessed nightly, based upon analysis of issue keywords and timing.

[About Risk](#) [Give us feedback](#)

**Modified Risk Level**

#22244 - Open penetrations in concrete damage to the finishes. Detailing of the external walls are closed out.

#22116 - The waterproofing barrier installed on the South side of the building is not complete.

#22105 - The EIFS installed is not per manufacturer's specifications. The whole enclosure needs to be replaced.

#21984 - The concrete treads on the South side of the building are not finished. This needs to be fixed ASAP. And architect.

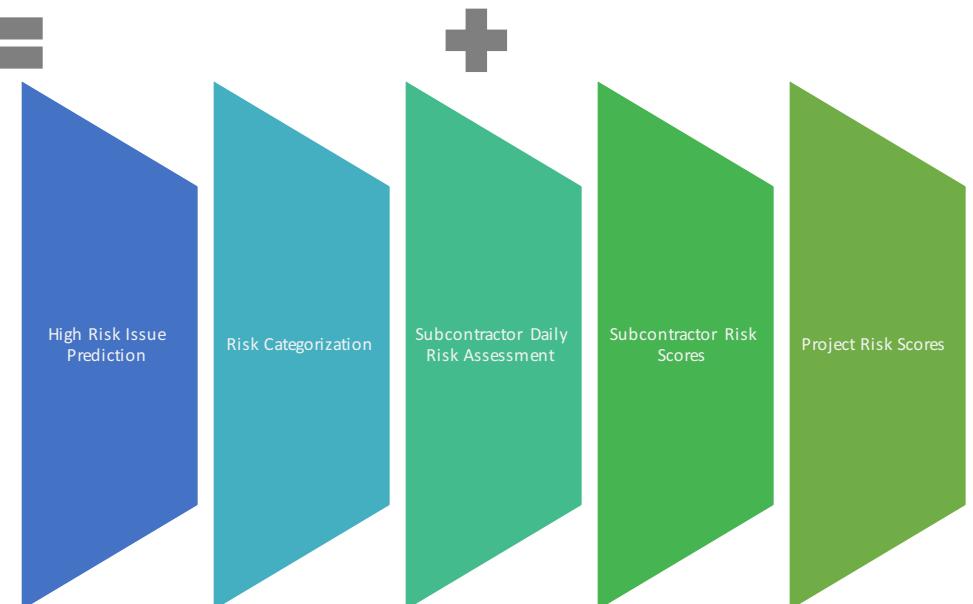
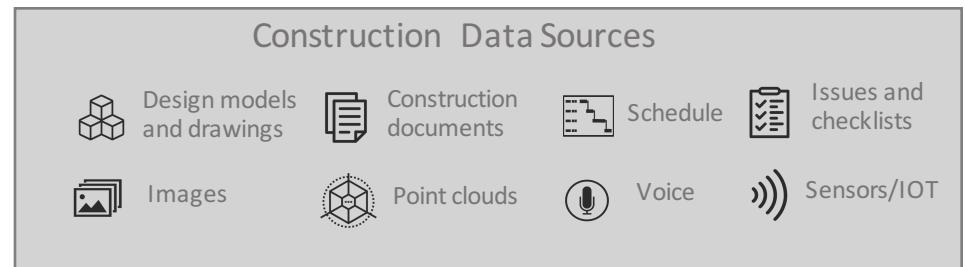
#21966 - Fireproofing incomplete at steel members.

#21898 - Repair concrete at base. There is damage within the permissible limits and if it continues, it will affect the structural integrity of the building.

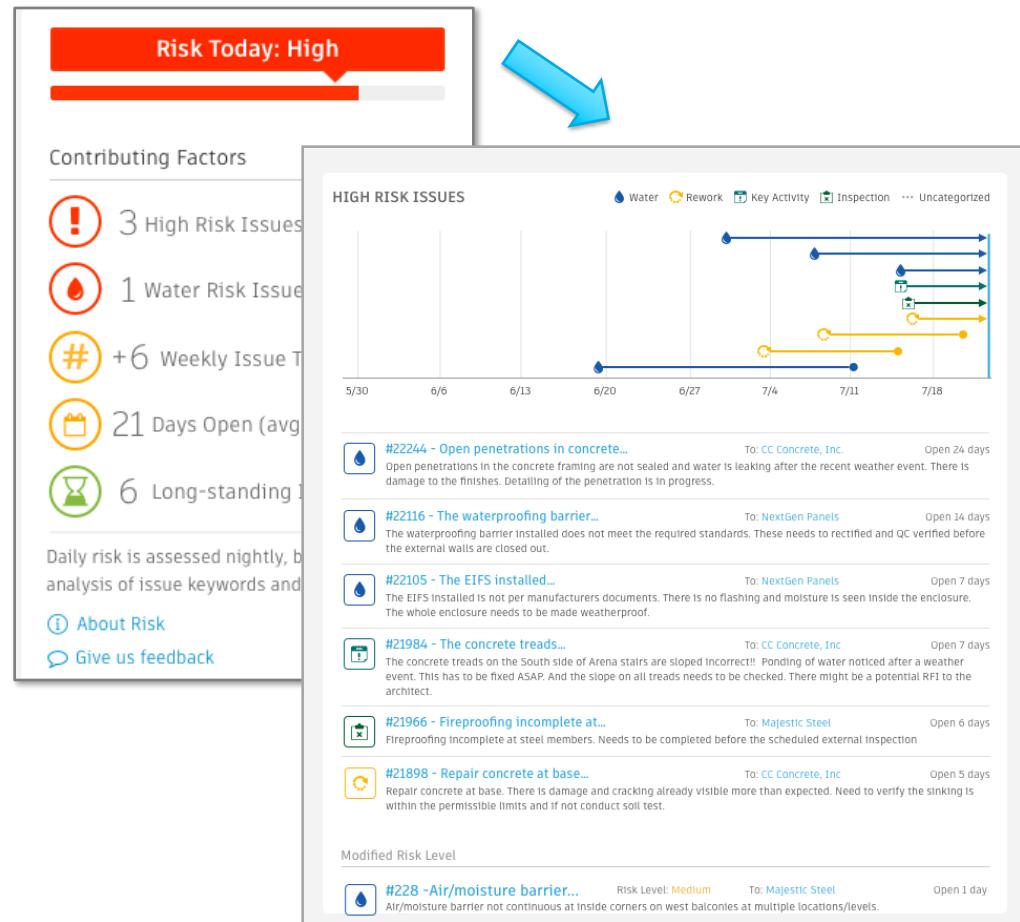
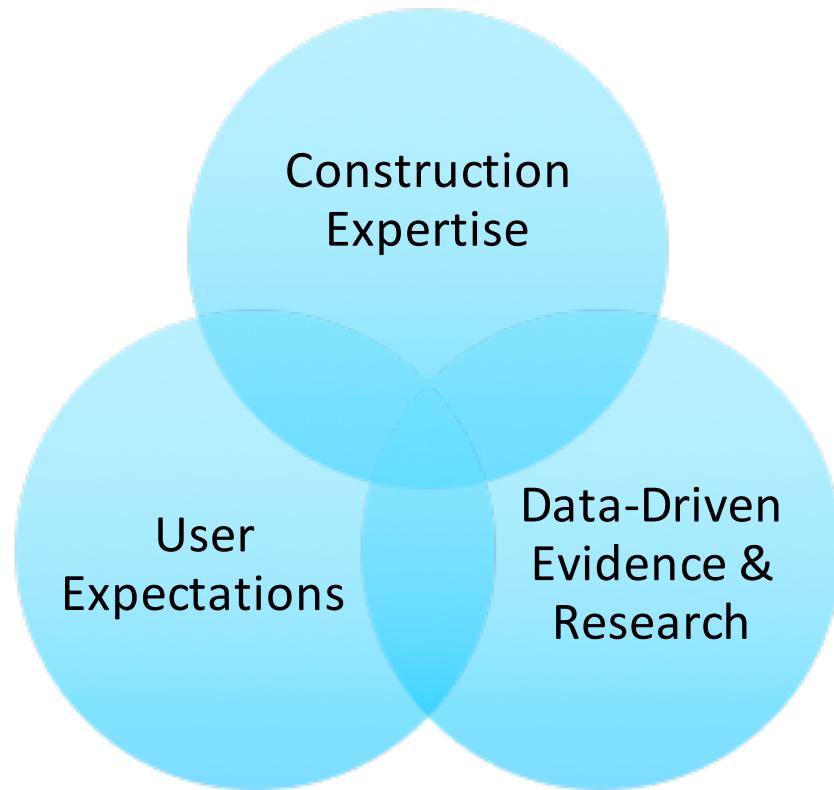
#228 - Air/moisture barrier... Air/moisture barrier not continuous at inside corners on west balconies at multiple locations/levels.

Risk Level: Medium To: Majestic Steel Open 1 day

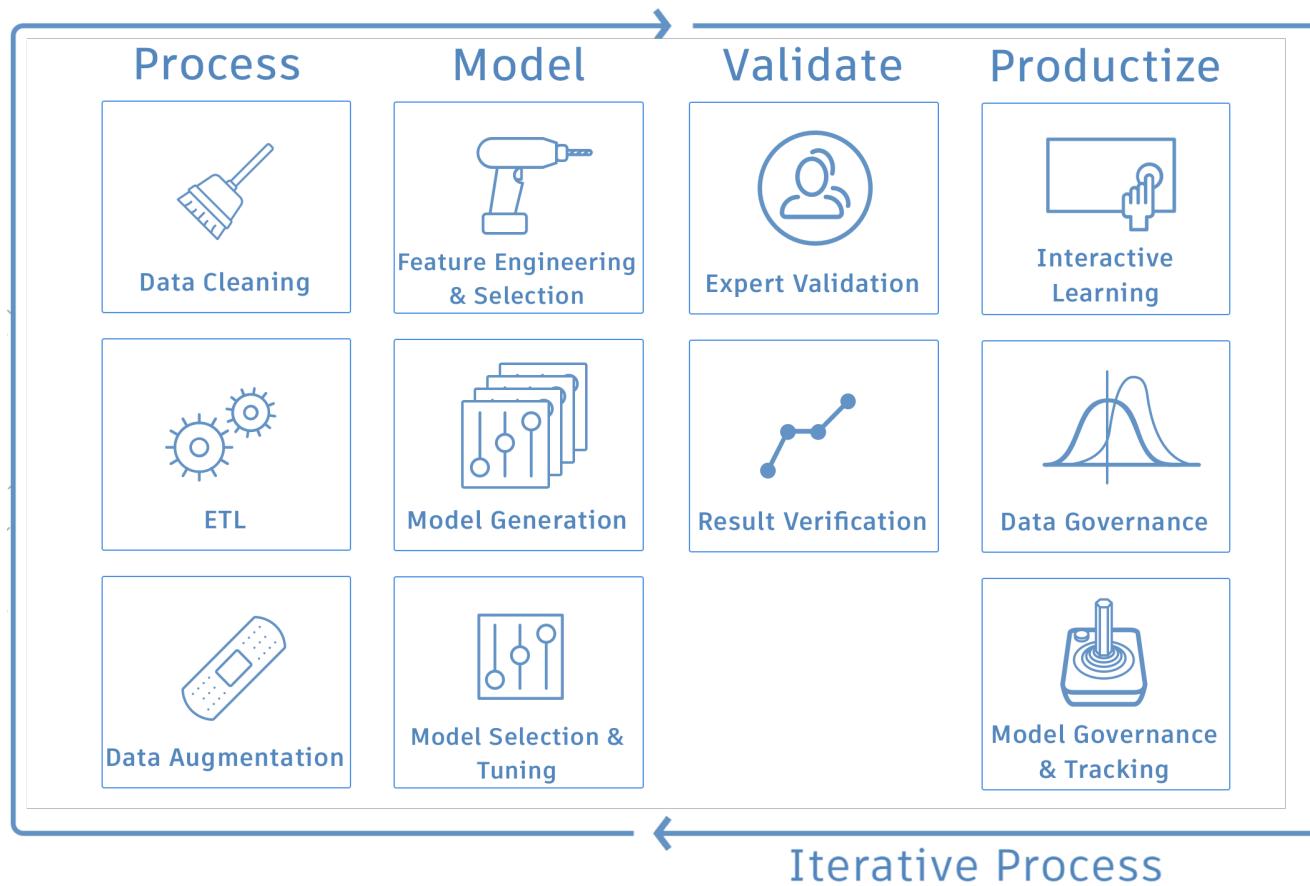
Construction Risk Assistant

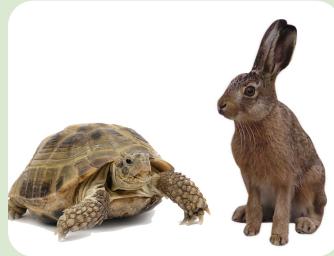


# Evidence-Based Practices & Modeling



# BIM 360 Data Science Methodology





Scalable  
computation  
close to the  
data

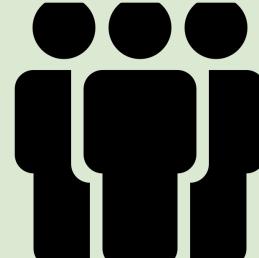
Ingestion of  
heterogeneous  
data

Support both  
batch and  
streaming  
workflows

Effective data  
science  
workflow

Smoother  
transition to  
production





Cluster  
Management  
Auto scaling

Workflows  
in notebooks

Visualization  
Support

Real-time  
collaboration  
books  
(SQL,  
Python, R)

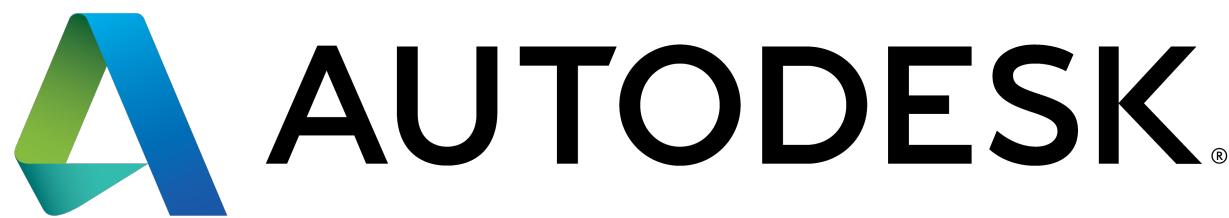
One-Click  
Job  
Scheduling



A photograph of a woman in a hard hat, safety glasses, and an orange safety vest, standing in a factory or industrial setting. She is holding a tablet labeled "GoPad" and gesturing with her hands. A large black circular arrow graphic is overlaid on the left side of the image, containing the word "DATA".

DATA

- classify
- verify
- utilize
- trust



Make anything.

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# Thank You.

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