Date of Presentation
ICRI 2023 Fall Convention

How Artificial Intelligence Can Assist in Concrete Building Repair and Maintenance

Sakshi Singh
Project Engineer
Thornton Tomasetti

Antonio De Luca
Senior Associate
Thornton Tomasetti

OUTLINE

- Introduction
- Background
- Definitions of artificial intelligence (AI) and machine learning (ML)
- Potential application of AI/ML for asset management
- Potential application of AI/ML for health monitoring
- Conclusions

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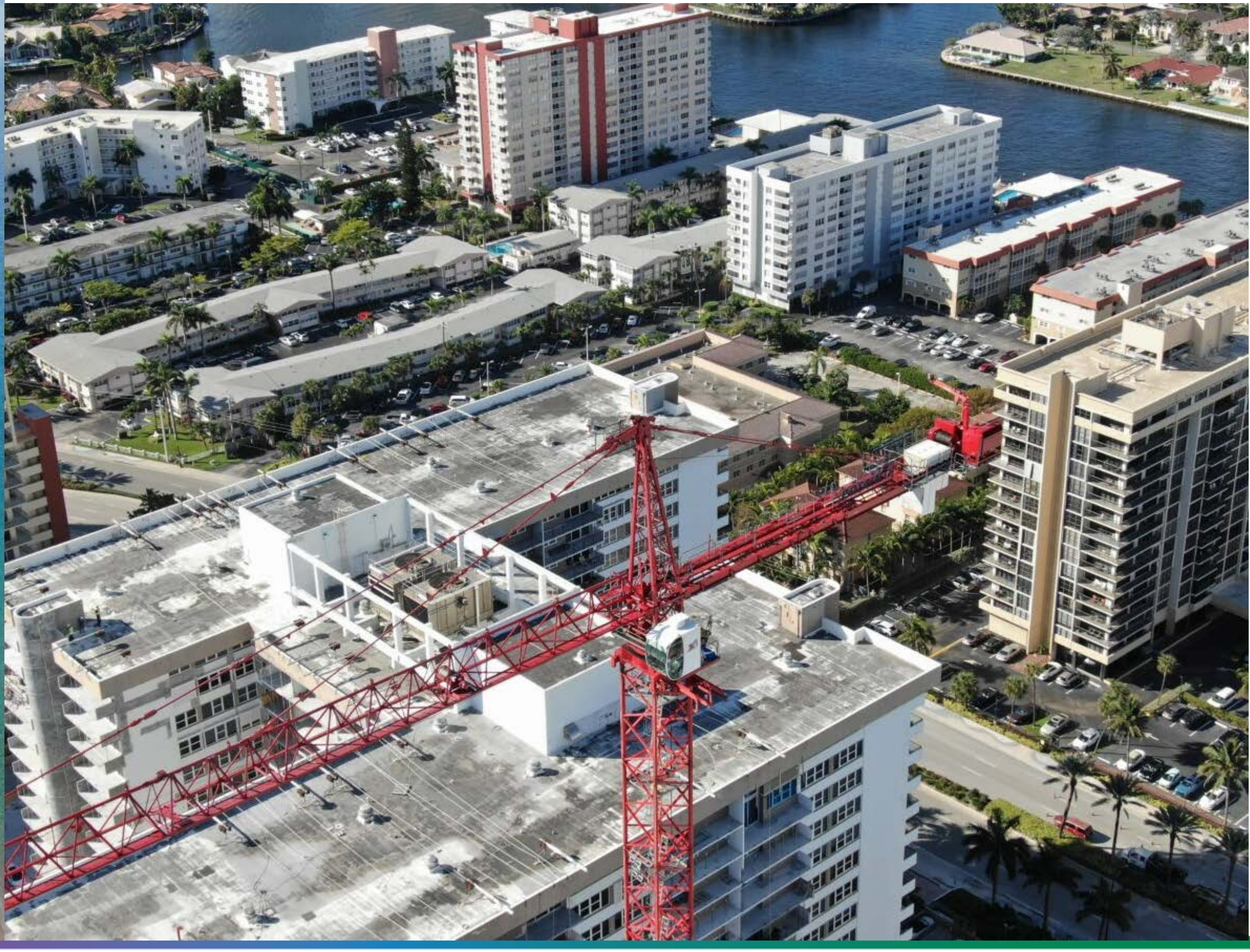

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35th YEAR ANNIVERSARY

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DAMAGE IN BULDINGS

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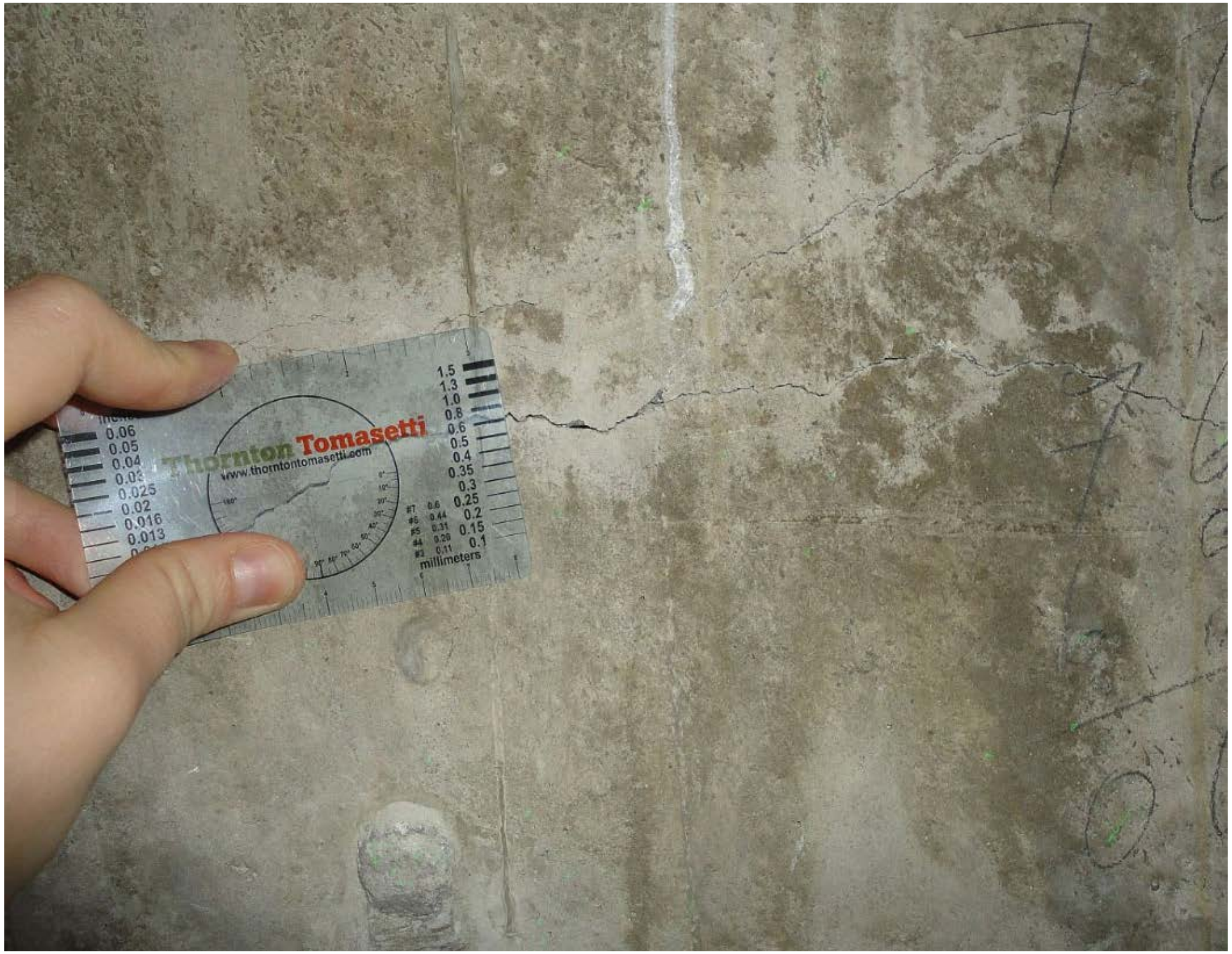

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BUILDINGS RIGGED WITH SCAFFOLDING

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UNFORESEEN NATURE OF CONCRETE REAPIR

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UNFORESEEN NATURE OF CONCRETE REAPIR

GENERAL CONTRACTOR

PCO #1000

Project: [redacted]

Prime Contract Potential Change Order #018: Overages on PT Quantities

TO:	[redacted]	FROM:	[redacted]
PCO NUMBER/REVISION:		CONTRACT:	
REQUEST RECEIVED FROM:		CREATED BY:	
STATUS:		CREATED DATE:	
REFERENCE:		PRIME CONTRACT CHANGE ORDER:	
FIELD CHANGE:			
LOCATION:		ACCOUNTING METHOD:	
SCHEDULE IMPACT:		PAID IN FULL:	
EXECUTED:		SIGNED CHANGE ORDE RECEIVED DATE:	
		TOTAL AMOUNT:	$10,000,000.00

POTENTIAL CHANGE ORDER TITLE: [redacted]

$10,000,000.00

CHANGE REASON: Existing Condition

POTENTIAL CHANGE ORDER DESCRIPTION: *(The Contract Is Changed As Follows)*

[redacted]

DELAYS!!

LACK OF FUNDS!

EXCEEDINGLY DETERIORATED STRUCTURES LEADS TO **HIGH REPAIR COSTS AND LOSS OF LIFE.**

THIS CAN BE PREVENTED BY REGULAR INSPECTION AND MAINTENANCE OF THE STRUCTURE.

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ARTIFICIAL INTELLIGENCE (AI)

ARTIFICIAL INTELLIGENCE
Programs that mimic human brain's ability to learn and reason

"What a typical person can do in a timely manner based on previous experience, AI can probably do it."

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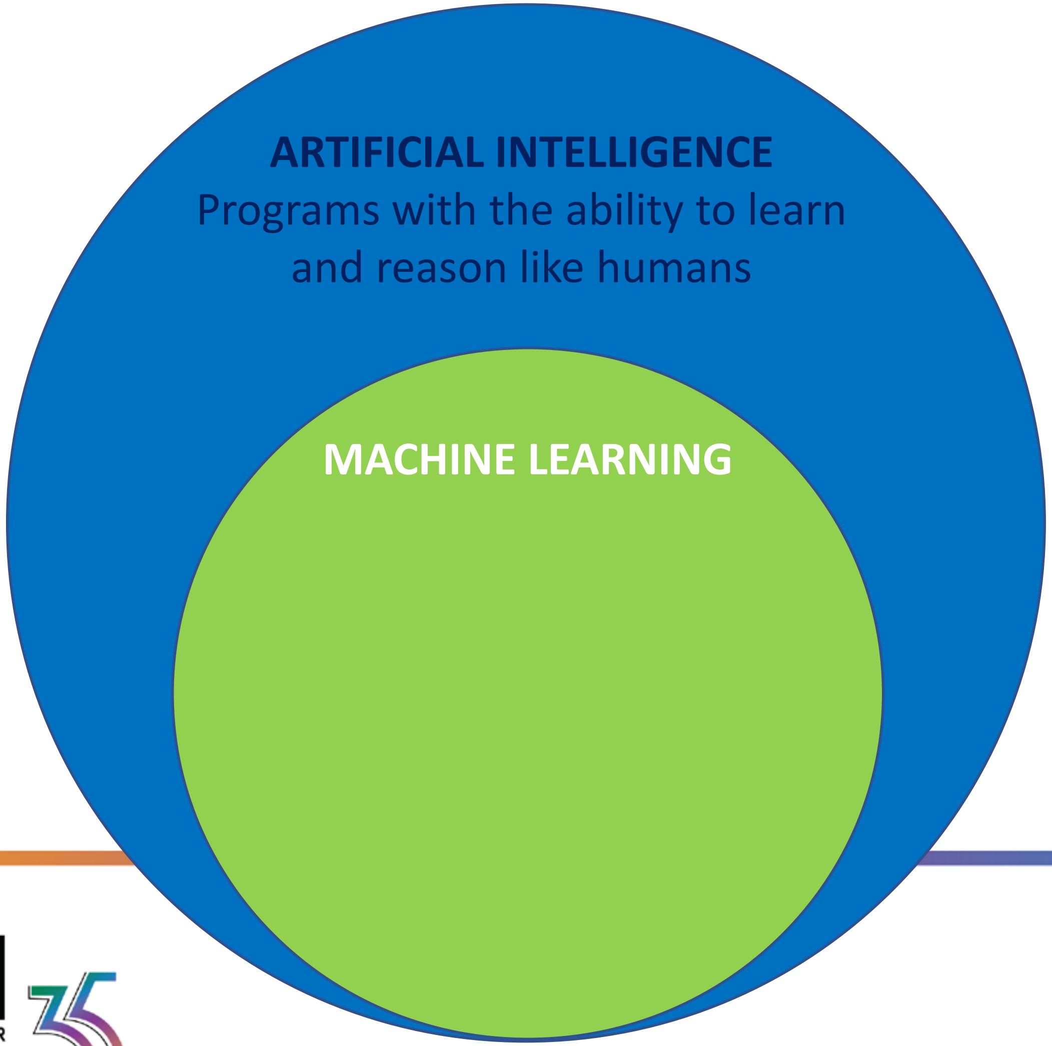
MACHINE LEARNING (ML)



"Machine learning is the field of study that gives computers the ability to learn **without being explicitly programmed**."

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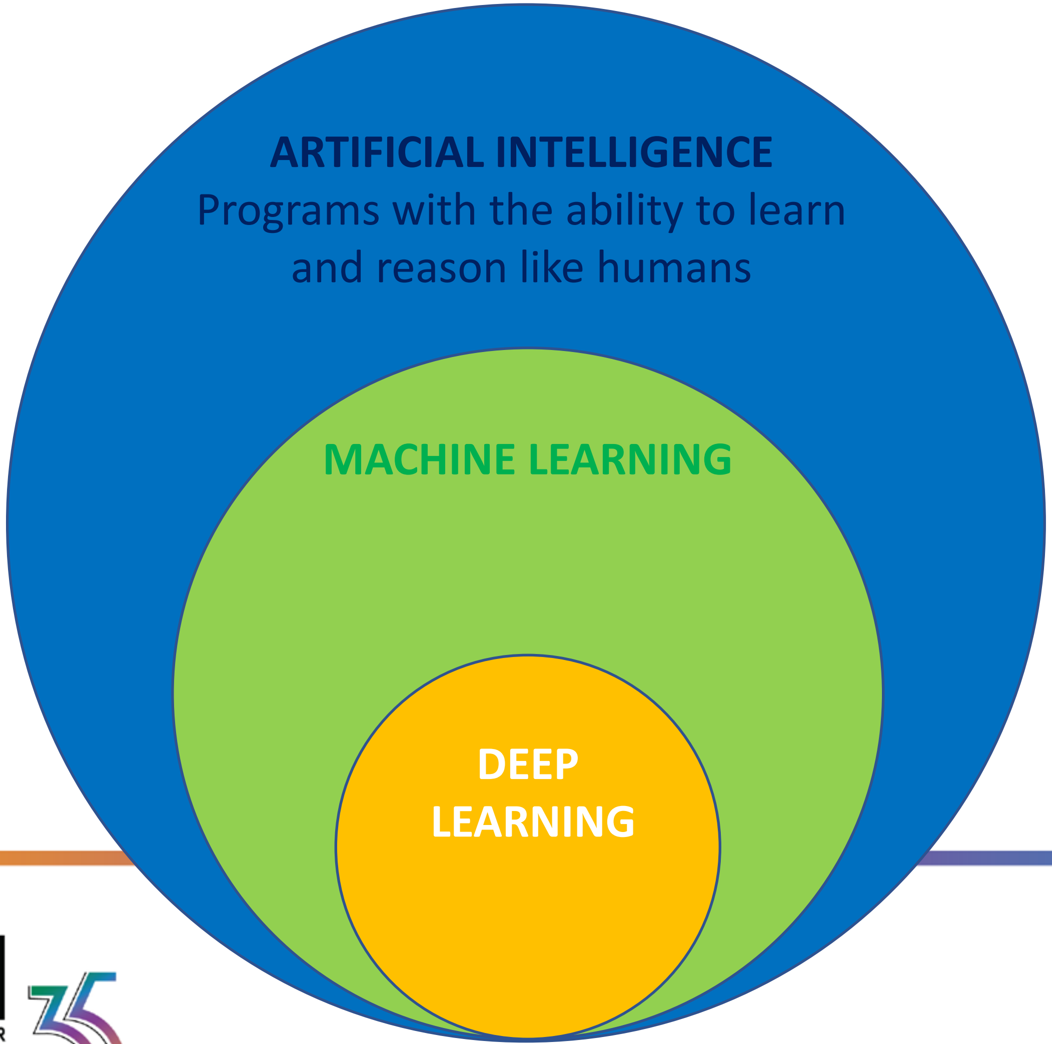
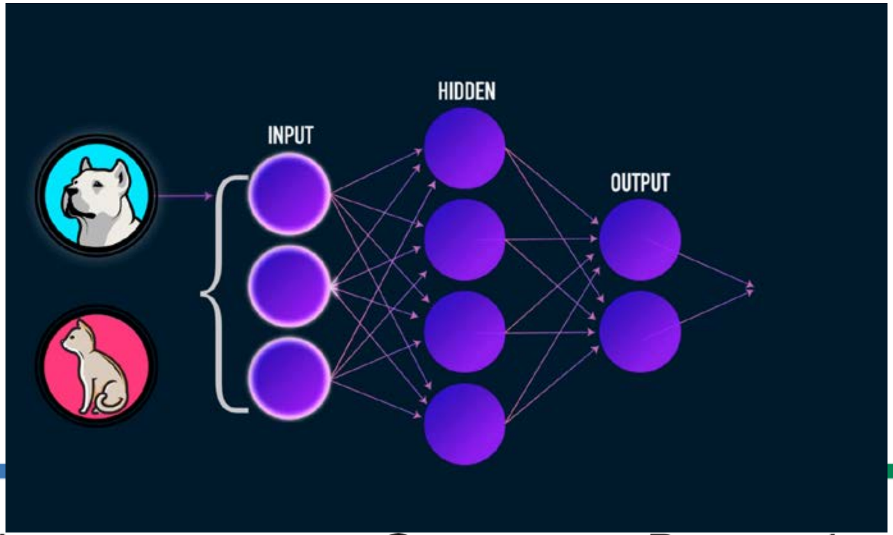
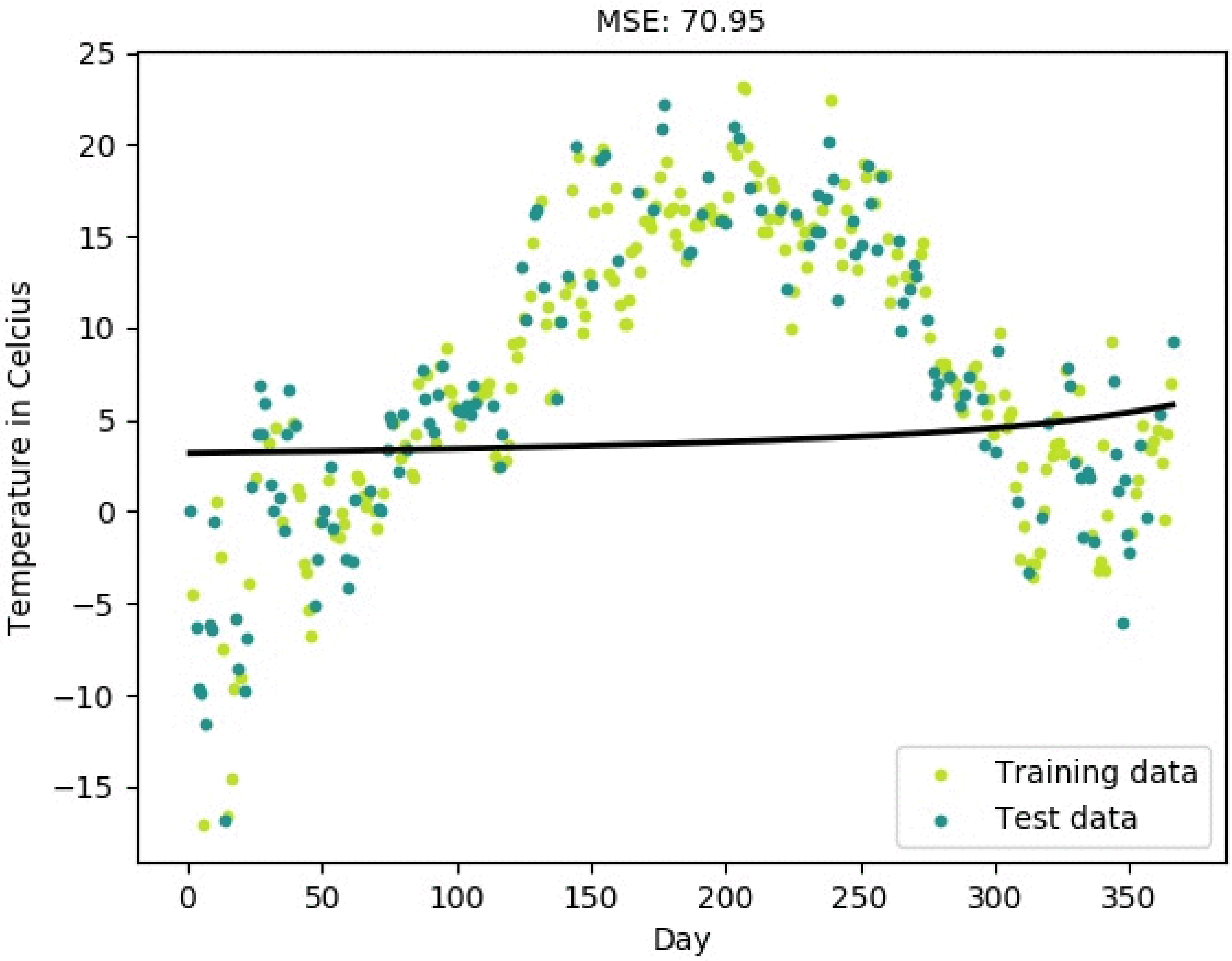
DEEP LEARNING



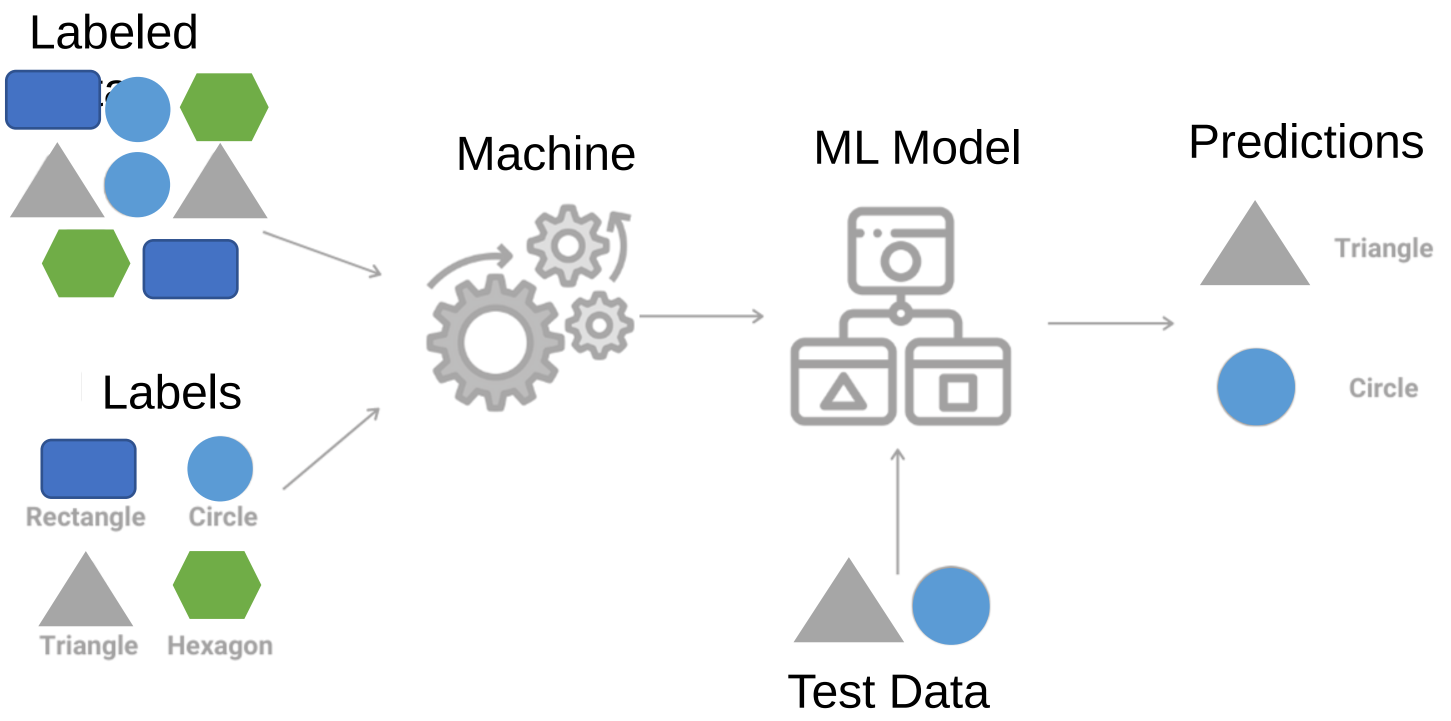
"Deep learning is a subset of ML in which artificial neural networks adapt and learn from large data."



Regression models

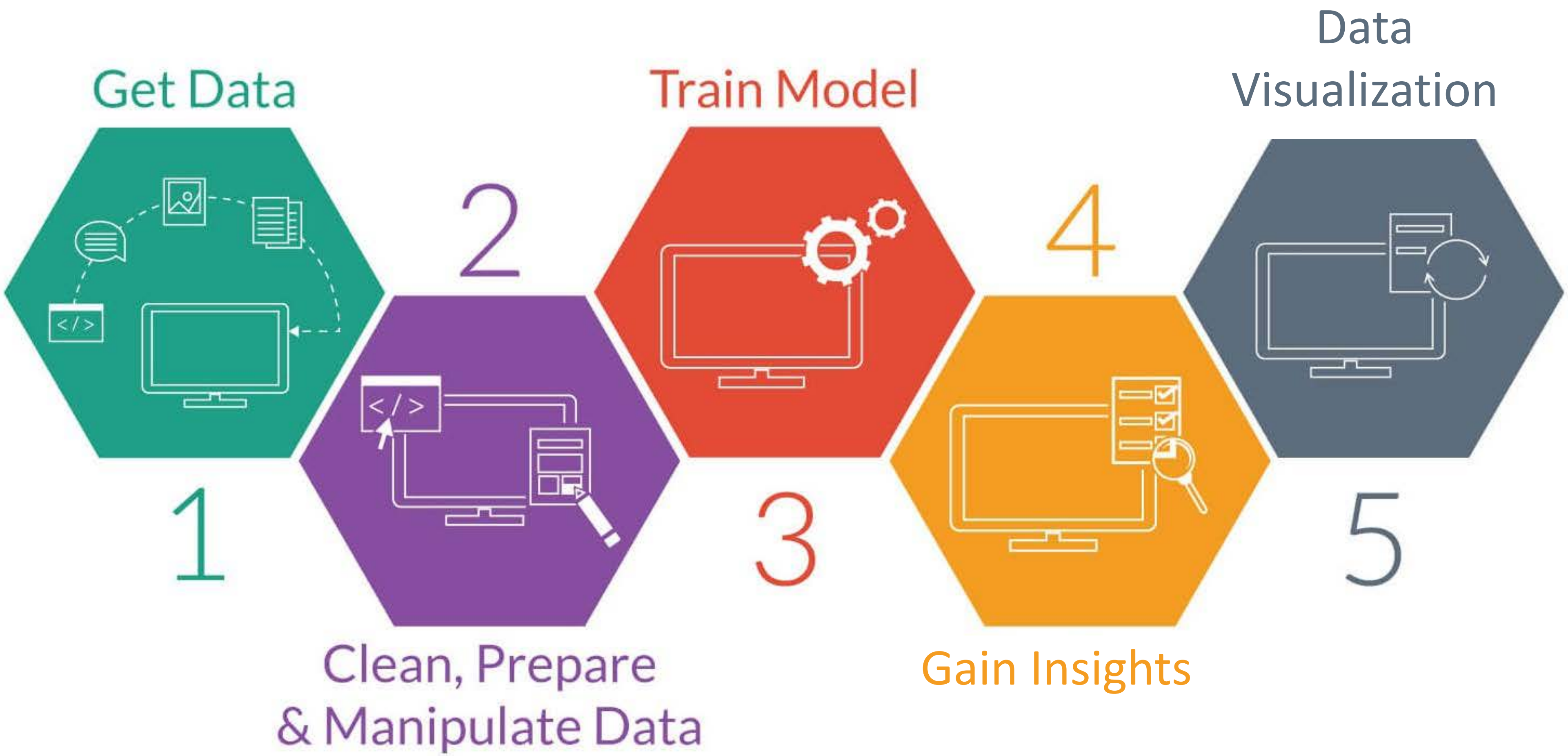


Classification models



Predicted Class		True Class: Positive	True Class: Negative
	Positive	TP	FP
	Negative	FN	TN

AI/ML Process



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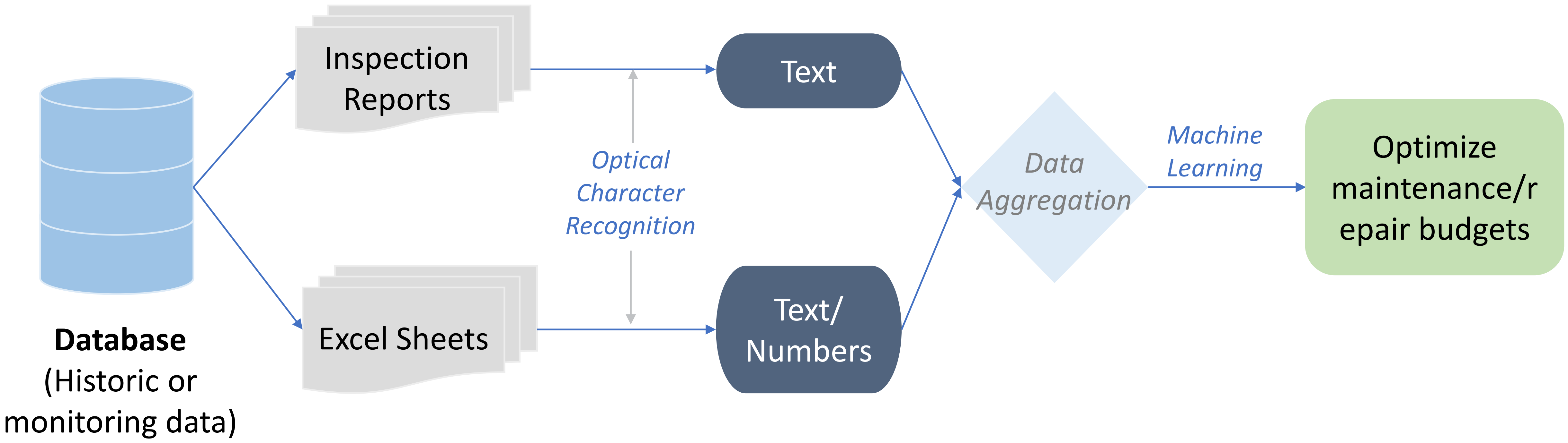
Inspection
Reports
Text
Optical
Character
Recognition
Data
Aggregation
Machine
Learning
Optimize
maintenance/r
epair budgets
Database
(Historic or
monitoring data)
Excel Sheets
Text/
Numbers

Example of Florida bridge inventory

Florida Bridge Information

DISTRICT	COUNTY	OWNER	BRIDGE	STRUCTURE NAME	ROADWAY	ADT	FACILITY CROSSED	YEAR BUILT	RECONSTRUCTED	LAST INSPECTION	SUFFICIENCY RATING	HEALTH INDEX	NBI RATING
Central Florida	Brevard	State Highway Agency	700002	SR-405 WB - FECRR	SR-405 WB	7,550	FECRR	1969		11/9/2021	80.3	98.26	
Central Florida	Brevard	State Highway Agency	700003	3-7x4x110 CBC	US-1	15,236	Kid Creek	1964		4/3/2020	69	58.85	
Central Florida	Brevard	State Highway Agency	700006	US-1 - Crane Cr. & City St	US-1	37,000	City St. & Crane Creek	1959	1990	10/22/2021	65	94.61	FO
Central Florida	Brevard	State Highway Agency	700007	US-1 over Elbow Creek	US-1	49,000	Elbow Creek	1961	1990	11/4/2021	92.3	93.96	
Central Florida	Brevard	State Highway Agency	700008	US-1- Eau Gallie River	US-1	54,000	Eau Gallie River	1961	1990	11/3/2021	85	95.22	
Central Florida	Brevard	State Highway Agency	700012	US-1 - FECRR	US-1	19,700	FECRR	1936	1961	9/13/2021	91.9	99.77	
Central Florida	Brevard	State Highway Agency	700013	SR-50 WB - St Johns River	SR-50 WB	6,100	St. Johns River	1971		12/15/2021	88.5	86.88	
Central Florida	Brevard	State Highway Agency	700014	SR-528 WB - US-1 & FECRR	SR-528 WB	20,000	US-1 & FECRR	1963	1970	10/27/2021	76.8	98.71	FO
Central Florida	Brevard	State Highway Agency	700015	SR-528 WB - CR-515	SR-528 WB	21,579	CR-515 & Indian River	1963	2001	10/28/2021	78.7	91.53	
Central Florida	Brevard	State Highway Agency	700017	SR-528 WB over SR-3	SR-528	15,250	SR-3	1971		3/22/2022	83.9	99.28	FO
Central Florida	Brevard	State Highway Agency	700018	US-192 EB - Sawgrass Creek	US-192 EB	5,150	Sawgrass Creek	1967	2004	2/1/2021	99.7	94.81	
Central Florida	Brevard	State Highway Agency	700023	US-192 WB - St Johns Relief	US-192 WB	5,150	St Johns River Relief	1966	2004	3/1/2021	99.7	90.42	
Central Florida	Brevard	State Highway Agency	700025	SR-528 WB - Sykes Creek	SR-528	15,250	Sykes Creek	1963	2002	3/22/2022	78	77.65	FO
Central Florida	Brevard	State Highway Agency	700026	SR-528 WB - Banana R. Dr.	SR-528 WB	13,000	Banana River Drive	1963		1/27/2022	76.2	90.42	FO
Central Florida	Brevard	State Highway Agency	700027	SR-528 WB-Banana R. Rel.	SR-528	13,000	Banana River Relief	1963		1/31/2022	74.2	92.97	
Central Florida	Brevard	State Highway Agency	700028	SR-528 WB - Banana R.	SR-528	13,000	Banana River	1963		7/27/2020	66.5	87.81	FO
Central Florida	Brevard	State Highway Agency	700029	SR-405 WB - US-1	SR-405 WB	7,550	US-1	1964		12/21/2021	82.3	98.39	
Central Florida	Brevard	State Highway Agency	700030	SR-401 SB - Barge Canal	SR-401 SB	5,750	Service Rd & Canal	1963	2011	9/29/2021	68.8	90.08	FO
Central Florida	Brevard	State Highway Agency	700031	SR-401 SB - Barge Canal	SR-401 SB	4,600	Service Rd & Canal	1963		9/29/2021	77	93.47	FO
Central Florida	Brevard	State Highway Agency	700033	4-12x12x142 CBC	US-192	35,500	Crane Creek	1974		12/21/2021	81.8	94.86	
Central Florida	Brevard	State Highway Agency	700034	I-95 SB - Tillman Canal	I-95 SB	31,250	Tillman Canal	1964	2010	1/7/2021	95.6	91.47	
Central Florida	Brevard	State Highway Agency	700043	I-95 SB -Lake Washington Road	I-95 SB	45,500	Lake Washington Road	1964	2009	1/20/2021	94.5	95.72	
Central Florida	Brevard	State Highway Agency	700046	3-8x4x184 CBC	I-95	91,000	Milner's Canal	1964	1994	1/28/2022	83	95.69	
Central Florida	Brevard	State Highway Agency	700050	2-12x10x187 CBC	I-95	76,435	Rockledge Creek	1965		3/23/2021	72	33.97	
Central Florida	Brevard	State Highway Agency	700052	I-95 SB - SR-520	I-95 SB	41,250	SR-520	1966	2004	1/20/2021	96	96.55	
Central Florida	Brevard	State Highway Agency	700054	I-95 SB - SR-524	I-95 SB	5,100	SR-524	1966	2009	2/21/2022	71	97.28	SD
Central Florida	Brevard	State Highway Agency	700055	3-9x11x157 CBC	I-95	44,500	Santiago Canal	1964		1/19/2021	83	34.18	
Central Florida	Brevard	State Highway Agency	700056	3-10x5x168 CBC	I-95	46,500	Ross Creek	1965	2014	12/16/2020	83	92.43	
Central Florida	Brevard	State Highway Agency	700058	I-95 SB - SR-50	I-95 SB	20,250	SR-50	1965	2013	8/25/2021	97	98.21	
Central Florida	Brevard	State Highway Agency	700059	I-95 SB over SR-406	I-95 SB	20,000	SR-406	1963	2013	8/25/2021	96	98.46	
Central Florida	Brevard	State Highway Agency	700061	Hubert H Humphrey Bridge	SR-520 WB	28,500	Indian River	1966		11/12/2020	71	97.18	FO
Central Florida	Brevard	State Highway Agency	700064	3-8x6x158 CBC	I-95	31,492	Outfall	1967		12/15/2020	83	66.91	
Central Florida	Brevard	State Highway Agency	700065	3-8x8x158 CBC	I-95	31,492	Outfall	1967		12/15/2020	83	66.85	
Central Florida	Brevard	State Highway Agency	700066	I-95 SB - Aurantia Rd.	I-95 SB	15,746	Aurantia Rd.	1967	2014	12/15/2020	94.6	98.42	
Central Florida	Brevard	State Highway Agency	700072	Christa McAuliffe Bridge	SR-3	14,000	Barge Canal	1961	1998	6/24/2021	62.9	97.12	FO
Central Florida	Brevard	State Highway Agency	700074	SR-528 WB - SR-401	SR-528 WB	13,000	SR-401	1971	2001	10/28/2021	90.3	99.52	
Central Florida	Brevard	State Highway Agency	700075	US-1 SB - SR-404	US-1 SB	19,500	SR-404	1971	1997	10/22/2021	96.5	98.60	
Central Florida	Brevard	State Highway Agency	700076	SR-404 WB - Indian River	SR-404 WB	26,250	Indian River West Relief	1971		10/22/2021	96	89.84	
Central Florida	Brevard	State Highway Agency	700077	SR-404 WB - Indian River	SR-404 WB	26,250	Indian River	1971		5/19/2020	84	95.70	
Central Florida	Brevard	State Highway Agency	700078	SR-404 WB-Indian River	SR-404 WB	26,250	Indian River Relief East	1971		11/3/2021	96	91.74	
Central Florida	Brevard	State Highway Agency	700079	SR-404 WB over CR-3	SR-404 WB	26,250	CR-3	1971		9/17/2021	98	99.44	
Central Florida	Brevard	State Highway Agency	700080	SR-404 WB-Banana River	SR-404 WB	26,500	Banana River Relief West	1971		11/2/2021	98	92.83	
Central Florida	Brevard	State Highway Agency	700081	SR-404 WB - Banana River	SR-404 WB	26,500	Banana River	1971		5/14/2020	93.9	97.18	
Central Florida	Brevard	State Highway Agency	700082	SR-404 WB-Banana River	SR-404 WB	26,500	Banana River Relief East	1971		11/1/2021	96	86.95	
Central Florida	Brevard	State Highway Agency	700083	Max K. Rodes	SR-404 WB	26,500	SR-513	1972		10/22/2021	98	97.73	
Central Florida	Brevard	Turnpike	700084	SR-528 WB-St Johns River	SR-528	23,050	St Johns River	1973		8/6/2020	96.9	90.30	
Central Florida	Brevard	Turnpike	700085	SR-407 NB over SR-528 WB	SR-407 NB	4,800	SR-528	1973	1998	8/5/2020	97.3	99.23	
Central Florida	Brevard	Turnpike	700086	4 - 10x10x167 CBC	SR-528	36,500	Ryan's Canal	1973		8/18/2020	70	66.00	
Central Florida	Brevard	Turnpike	700087	SR-528 WB over Pine St.	SR-528 WB	18,250	Pine Street	1973	1997	8/5/2020	96	99.37	
Central Florida	Brevard	Turnpike	700089	SR-528 WB over Clear Lk/Inds Rd	SR-528 WB	15,050	SR-524	1973		8/4/2020	95.2	98.87	
Central Florida	Brevard	Turnpike	700090	SR-407 over Kings Road	SR-407	6,747	Kings Road	1973	1998	8/18/2020	93.8	99.04	
Central Florida	Brevard	Turnpike	700091	SR-407 over I-95	SR-407	6,747	I-95 (SR-9)	1972	1998	8/18/2020	92.5	98.11	

Friday, April 1, 2022

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NBI=National Bridge Inventory
ADT=Average Daily Traffic
SD=Structurally Deficient
FO=Functionally Obsolete

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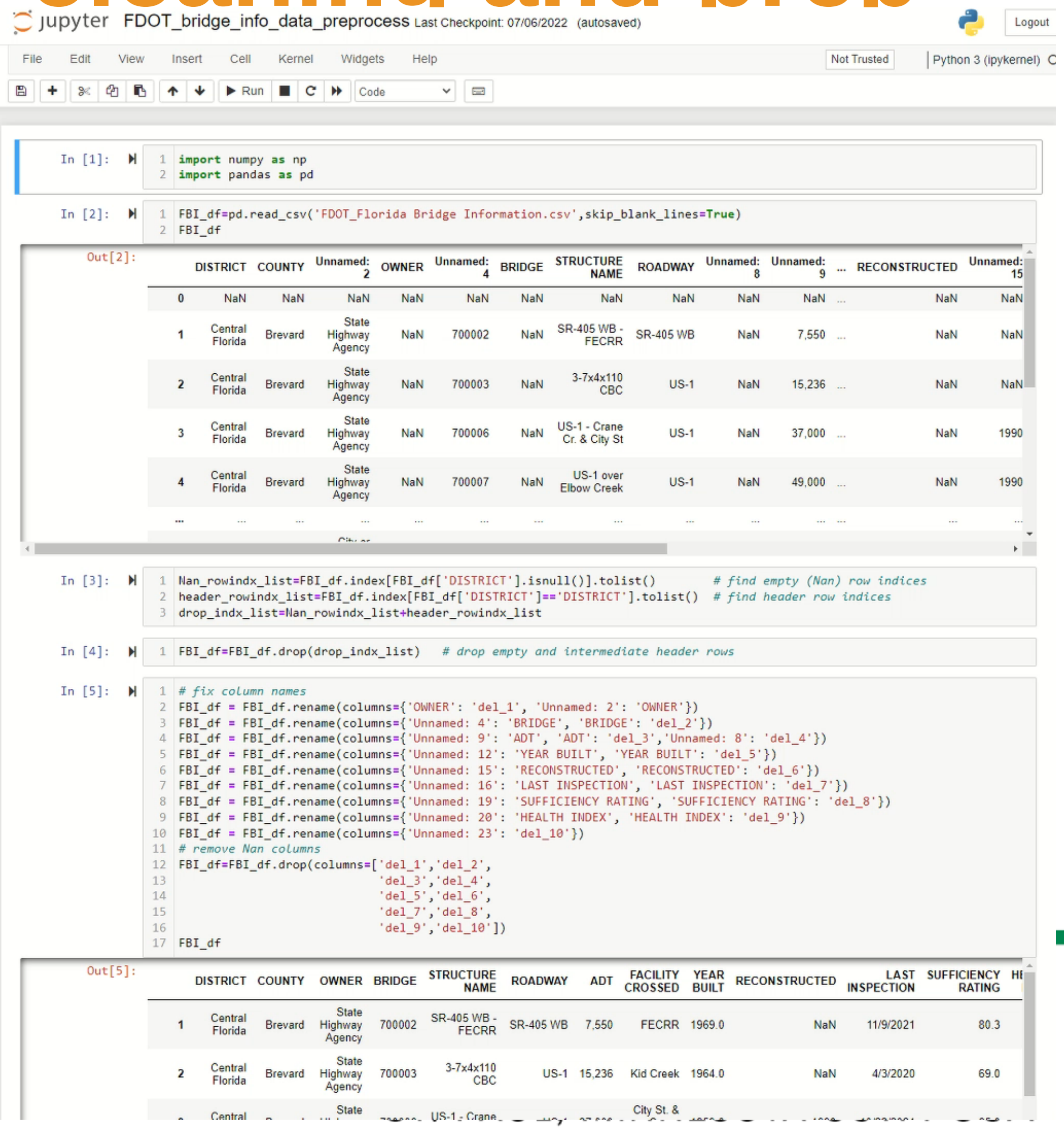
Data cleaning and prep

- 12620 records
- Preprocess raw data
  - Check for outliers and anomalies

    Remove records with NBI rating of Functionally Obsolete (FO) or structural deficient (SD)
  - Handle issues with missing data

    Some records missing certain information (e.g., year built, sufficiency rating, etc.)
  - Fix formatting issues

    “St. Johns” vs “Saint Johns” county
- Data augmentation for enhanced data analytics
  - Humidity
  - Precipitation
  - Temperature
  - Population density and growth



jupyter FDOT_bridge_info_data_preprocess Last Checkpoint: 07/06/2022 (autosaved)

In [1]:
```python
import numpy as np
import pandas as pd
```

In [2]:
```python
FBI_df=pd.read_csv('FDOT_Florida Bridge Information.csv',skip_blank_lines=True)
FBI_df
```

Out[2]:

	DISTRICT	COUNTY	Unnamed: 2	OWNER	Unnamed: 4	BRIDGE	STRUCTURE NAME	ROADWAY	Unnamed: 8	Unnamed: 9	...	RECONSTRUCTED	Unnamed: 15
0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN
1	Central Florida	Brevard	State Highway Agency	NaN	700002	NaN	SR-405 WB - FECRR	SR-405 WB	NaN	7,550	...	NaN	NaN
2	Central Florida	Brevard	State Highway Agency	NaN	700003	NaN	3-7x4x110 CBC	US-1	NaN	15,236	...	NaN	NaN
3	Central Florida	Brevard	State Highway Agency	NaN	700006	NaN	US-1 - Crane Cr. & City St	US-1	NaN	37,000	...	NaN	1990
4	Central Florida	Brevard	State Highway Agency	NaN	700007	NaN	US-1 over Elbow Creek	US-1	NaN	49,000	...	NaN	1990
...	...	...	...	...	...	...	...	...	...	...	...	...	...

In [3]:
```python
Nan_rowindx_list=FBI_df.index[FBI_df['DISTRICT'].isnull()].tolist()       # find empty (Nan) row indices
header_rowindx_list=FBI_df.index[FBI_df['DISTRICT']=='DISTRICT'].tolist()  # find header row indices
drop_indx_list=Nan_rowindx_list+header_rowindx_list
```

In [4]:
```python
FBI_df=FBI_df.drop(drop_indx_list)   # drop empty and intermediate header rows
```

In [5]:
```python
# fix column names
FBI_df = FBI_df.rename(columns={'OWNER': 'del_1', 'Unnamed: 2': 'OWNER'})
FBI_df = FBI_df.rename(columns={'Unnamed: 4': 'BRIDGE', 'BRIDGE': 'del_2'})
FBI_df = FBI_df.rename(columns={'Unnamed: 9': 'ADT', 'ADT': 'del_3','Unnamed: 8': 'del_4'})
FBI_df = FBI_df.rename(columns={'Unnamed: 12': 'YEAR BUILT', 'YEAR BUILT': 'del_5'})
FBI_df = FBI_df.rename(columns={'Unnamed: 15': 'RECONSTRUCTED', 'RECONSTRUCTED': 'del_6'})
FBI_df = FBI_df.rename(columns={'Unnamed: 16': 'LAST INSPECTION', 'LAST INSPECTION': 'del_7'})
FBI_df = FBI_df.rename(columns={'Unnamed: 19': 'SUFFICIENCY RATING', 'SUFFICIENCY RATING': 'del_8'})
FBI_df = FBI_df.rename(columns={'Unnamed: 20': 'HEALTH INDEX', 'HEALTH INDEX': 'del_9'})
FBI_df = FBI_df.rename(columns={'Unnamed: 23': 'del_10'})
# remove Nan columns
FBI_df=FBI_df.drop(columns=['del_1','del_2',
                            'del_3','del_4',
                            'del_5','del_6',
                            'del_7','del_8',
                            'del_9','del_10'])
FBI_df
```

Out[5]:

	DISTRICT	COUNTY	OWNER	BRIDGE	STRUCTURE NAME	ROADWAY	ADT	FACILITY CROSSED	YEAR BUILT	RECONSTRUCTED	LAST INSPECTION	SUFFICIENCY RATING
1	Central Florida	Brevard	State Highway Agency	700002	SR-405 WB - FECRR	SR-405 WB	7,550	FECRR	1969.0	NaN	11/9/2021	80.3
2	Central Florida	Brevard	State Highway Agency	700003	3-7x4x110 CBC	US-1	15,236	Kid Creek	1964.0	NaN	4/3/2020	69.0

data mining

USA.COM

Local Data Search

Search State, County, City, Zip Code, or Area Code | Search

USA.com / Ranks / Florida Average Temperature County Rank

Florida Average Temperature County Rank

A total of 67 results found. Show Results on Map.

Rank	Average Temperature ▼	County / Population
1.	75.60°F	Miami-Dade, FL / 2,600,861
2.	75.00°F	Broward, FL / 1,815,269
3.	74.96°F	Monroe, FL / 75,208
4.	74.17°F	Palm Beach, FL / 1,359,074
5.	74.06°F	Lee, FL / 647,554
6.	73.95°F	Collier, FL / 334,474
7.	73.73°F	Hendry, FL / 38,360
8.	73.21°F	Martin, FL / 149,658
9.	73.08°F	Sarasota, FL / 386,944
10.	73.06°F	Saint Lucie, FL / 283,988
11.	72.98°F	Manatee, FL / 335,840
12.	72.96°F	Polk, FL / 617,323
13.	72.93°F	Charlotte, FL / 163,151
14.	72.85°F	Hillsborough, FL / 1,279,668
15.	72.85°F	Indian River, FL / 140,918
16.	72.70°F	De Soto, FL / 34,785
17.	72.69°F	Osceola, FL / 289,449
18.	72.66°F	Pinellas, FL / 925,030
19.	72.65°F	Glades, FL / 13,190
20.	72.61°F	Okeechobee, FL / 39,398
21.	72.58°F	Hardee, FL / 27,549
22.	72.53°F	Highlands, FL / 98,261
23.	72.24°F	Brevard, FL / 548,891
24.	71.84°F	Orange, FL / 1,200,241
25.	71.65°F	Hernando, FL / 173,792
26.	71.63°F	Pasco, FL / 472,745
27.	71.29°F	Seminole, FL / 432,135
28.	70.98°F	Sumter, FL / 103,708
29.	70.90°F	Lake, FL / 305,010
30.	70.52°F	Volusia, FL / 498,981
31.	70.35°F	Flagler, FL / 98,843
32.	70.19°F	Citrus, FL / 139,771

Population of Counties in Florida (2022)

There are **67** counties in Florida.

As of 2018, Florida's Miami-Dade County is the most populous county in the Sunshine State, with 2,751,796 residents, representing a population growth of 10.2% since the last census. Miami-Dade is followed by Broward County(1,935,878), Palm Beach County (1,471,150), Hillsborough County (1,381,627), and Orange County (1,323,598) as the only other counties in the state with populations in excess of one million. Of these, Orange County has seen the highest population growth at an impressive 17.7%.

Florida Counties with Fewer Residents

The least populous Floridian counties are Liberty County, with 8,242 residents, closely followed by Lafayette County, with its population of 8,451. Both of these counties have seen their populations decline in recent years, with reductions of 1.5% and 4.7%, respectively. However, other counties with small populations, such as Franklin County (11,727) and Glades County (13,754), have had population increases (1.5% for Franklin County and 6.8% for Glades County).

Florida Counties with Rapid Growth

Sumter County boasts the highest growth rate in the state, with a substantial increase of 34% according to statistics for 2018, taking its total population to 125,165. Osceola County and St. Johns County also show impressive population growth, with increases of 31.1% and 28.3%, respectively. Bradford County, with its 2010 population of 28,520, has the biggest reduction in numbers – its population has reduced to 26,728, representing a negative growth of -5.2% in the last few years.

⤓ CSV ⤓ JSON

Name	2022 Population ▼	Growth Since 2010	Density (mi²)
Miami-Dade County	2,723,200	8.63%	1,434.33
Broward County	1,972,790	12.55%	1,634.42
Palm Beach County	1,538,450	16.23%	780.99
Hillsborough County	1,532,120	24.21%	1,501.62
Orange County	1,429,190	24.43%	1,582.16
Duval County	985,064	13.80%	1,291.66
Pinellas County	980,810	7.03%	3,582.30
Lee County	818,898	31.98%	1,044.05
Polk County	779,317	29.22%	433.77
Brevard County	622,159	14.37%	612.70

jupyter FDOT_bridge_info_data_pre

File Edit View Insert Cell Kernel Widgets Help | Not Trusted | Python 3 (ipykernel) | Logout

Run | Code

In [1]:

```python
import numpy as np
import pandas as pd
```

In [2]:

```python
FBI_df=pd.read_csv('FDOT_Florida Bridge Information.csv',skip_blank_lines=True)
FBI_df
```

Out[2]:

	DISTRICT	COUNTY	Unnamed: 2	OWNER	Unnamed: 4	BRIDGE	STRUCTURE NAME	ROADWAY	Unnamed: 8	Unnamed: 9	...	RECONSTRUCTED	Unnamed: 15
0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	...	NaN	NaN
1	Central Florida	Brevard	State Highway Agency	NaN	700002	NaN	SR-405 WB - FECRR	SR-405 WB	NaN	7,550	...	NaN	NaN
2	Central Florida	Brevard	State Highway Agency	NaN	700003	NaN	3-7x4x110 CBC	US-1	NaN	15,236	...	NaN	NaN
3	Central Florida	Brevard	State Highway Agency	NaN	700006	NaN	US-1 - Crane Cr. & City St	US-1	NaN	37,000	...	NaN	1990
4	Central Florida	Brevard	State Highway Agency	NaN	700007	NaN	US-1 over Elbow Creek	US-1	NaN	49,000	...	NaN	1990
...	...	...	...	...	...	...	...	...	...	...	...	...	...

In [3]:

```python
Nan_rowindx_list=FBI_df.index[FBI_df['DISTRICT'].isnull()].tolist()        # find empty (Nan) row indices
header_rowindx_list=FBI_df.index[FBI_df['DISTRICT']=='DISTRICT'].tolist()  # find header row indices
drop_indx_list=Nan_rowindx_list+header_rowindx_list
```

In [4]:

```python
FBI_df=FBI_df.drop(drop_indx_list)   # drop empty and intermediate header rows
```

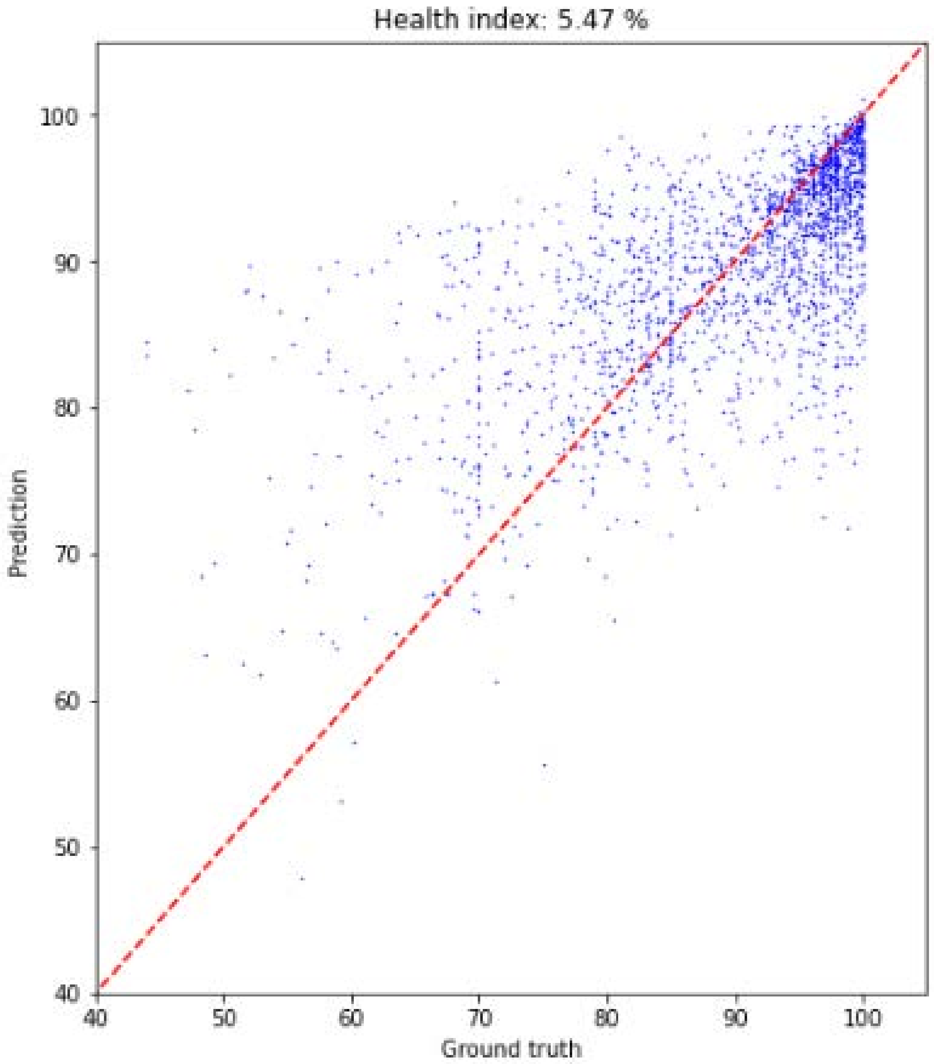
In [5]:

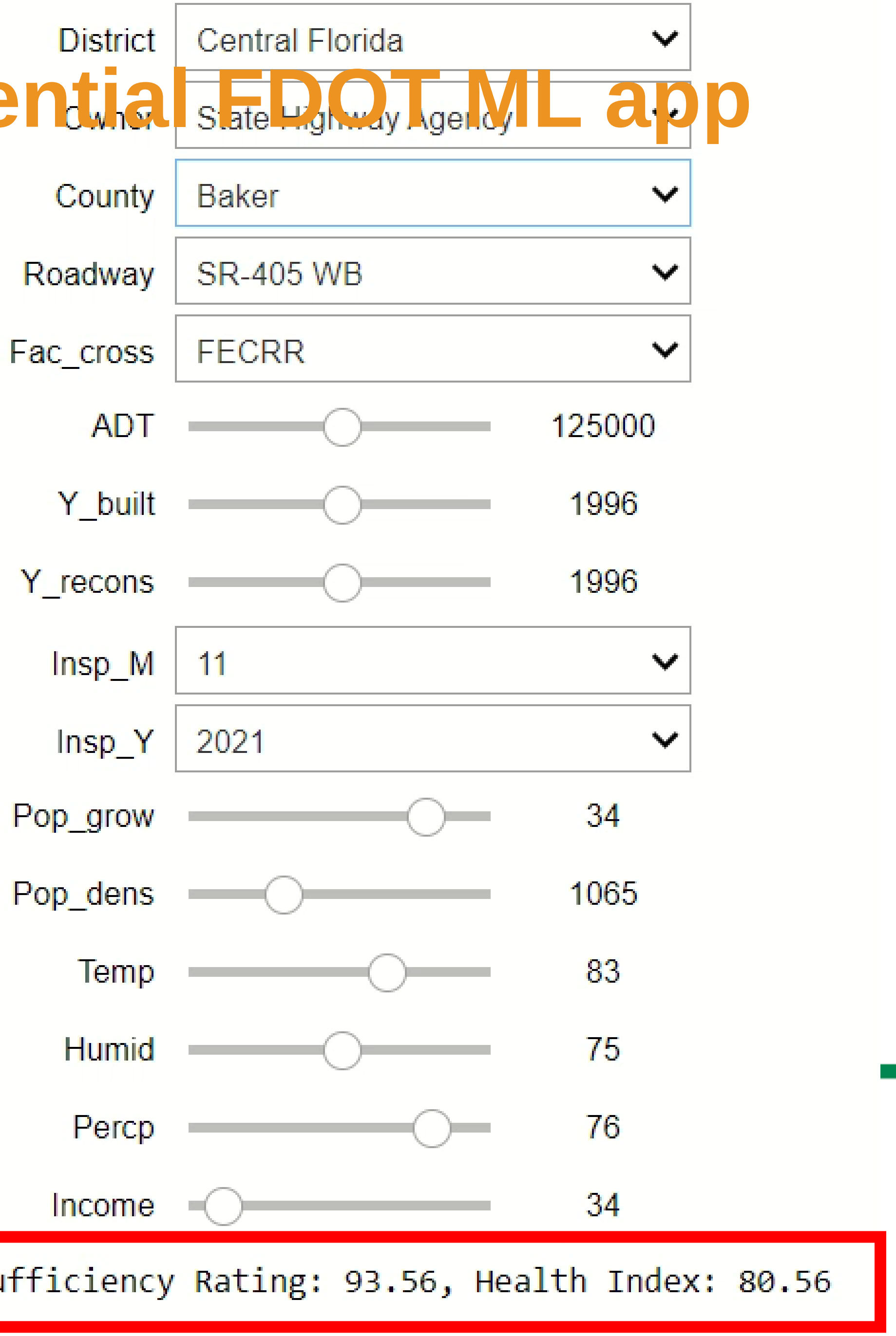
```python
# fix column names
FBI_df = FBI_df.rename(columns={'OWNER': 'del_1', 'Unnamed: 2': 'OWNER'})
FBI_df = FBI_df.rename(columns={'Unnamed: 4': 'BRIDGE', 'BRIDGE': 'del_2'})
FBI_df = FBI_df.rename(columns={'Unnamed: 9': 'ADT', 'ADT': 'del_3','Unnamed: 8': 'del_4'})
FBI_df = FBI_df.rename(columns={'Unnamed: 12': 'YEAR BUILT', 'YEAR BUILT': 'del_5'})
FBI_df = FBI_df.rename(columns={'Unnamed: 15': 'RECONSTRUCTED', 'RECONSTRUCTED': 'del_6'})
FBI_df = FBI_df.rename(columns={'Unnamed: 16': 'LAST INSPECTION', 'LAST INSPECTION': 'del_7'})
FBI_df = FBI_df.rename(columns={'Unnamed: 19': 'SUFFICIENCY RATING', 'SUFFICIENCY RATING': 'del_8'})
FBI_df = FBI_df.rename(columns={'Unnamed: 20': 'HEALTH INDEX', 'HEALTH INDEX': 'del_9'})
FBI_df = FBI_df.rename(columns={'Unnamed: 23': 'del_10'})
# remove Nan columns
FBI_df=FBI_df.drop(columns=['del_1','del_2',
                            'del_3','del_4',
                            'del_5','del_6',
                            'del_7','del_8',
                            'del_9','del_10'])
FBI_df
```

Out[5]:

	DISTRICT	COUNTY	OWNER	BRIDGE	STRUCTURE NAME	ROADWAY	ADT	FACILITY CROSSED	YEAR BUILT	RECONSTRUCTED	LAST INSPECTION	SUFFICIENCY RATING
1	Central Florida	Brevard	State Highway Agency	700002	SR-405 WB - FECRR	SR-405 WB	7,550	FECRR	1969.0	NaN	11/9/2021	80.3
2	Central Florida	Brevard	State Highway Agency	700003	3-7x4x110 CBC	US-1	15,236	Kid Creek	1964.0	NaN	4/3/2020	69.0

Potential FDOT ML app

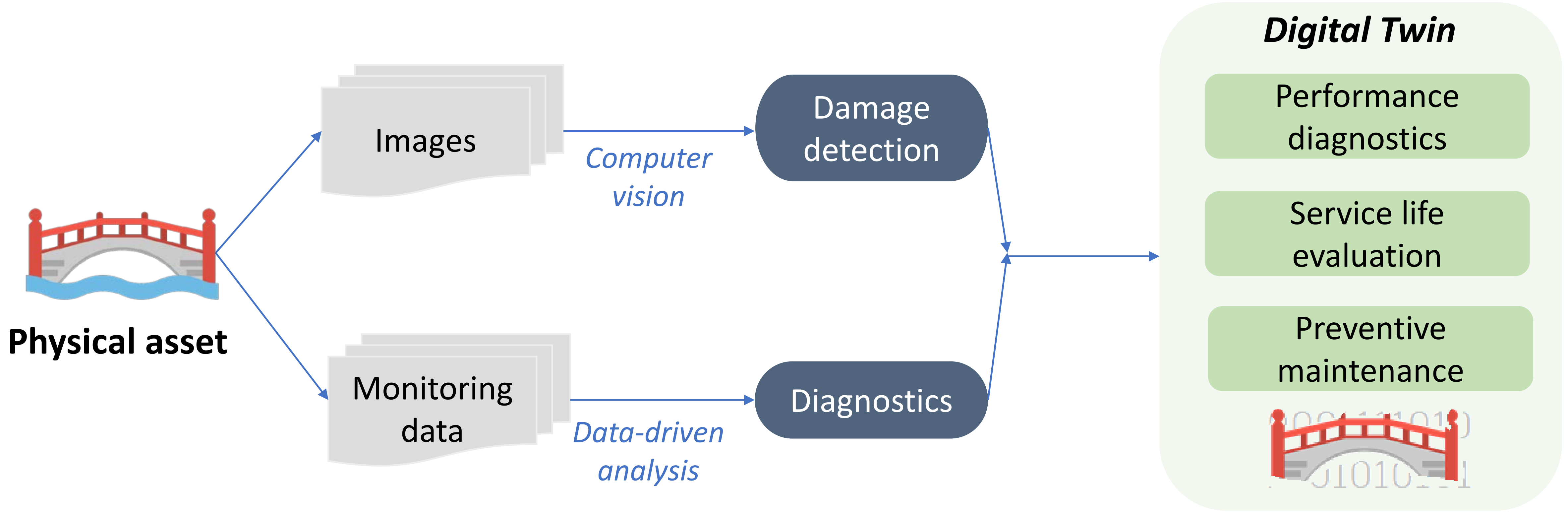


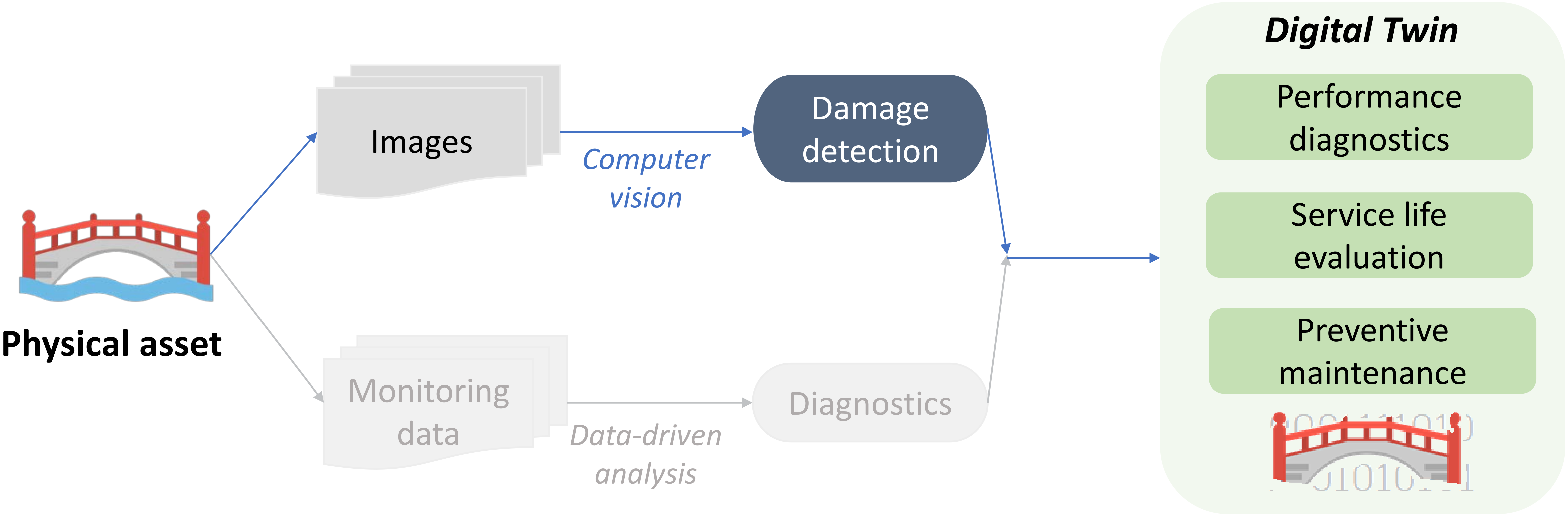


OUTLINE

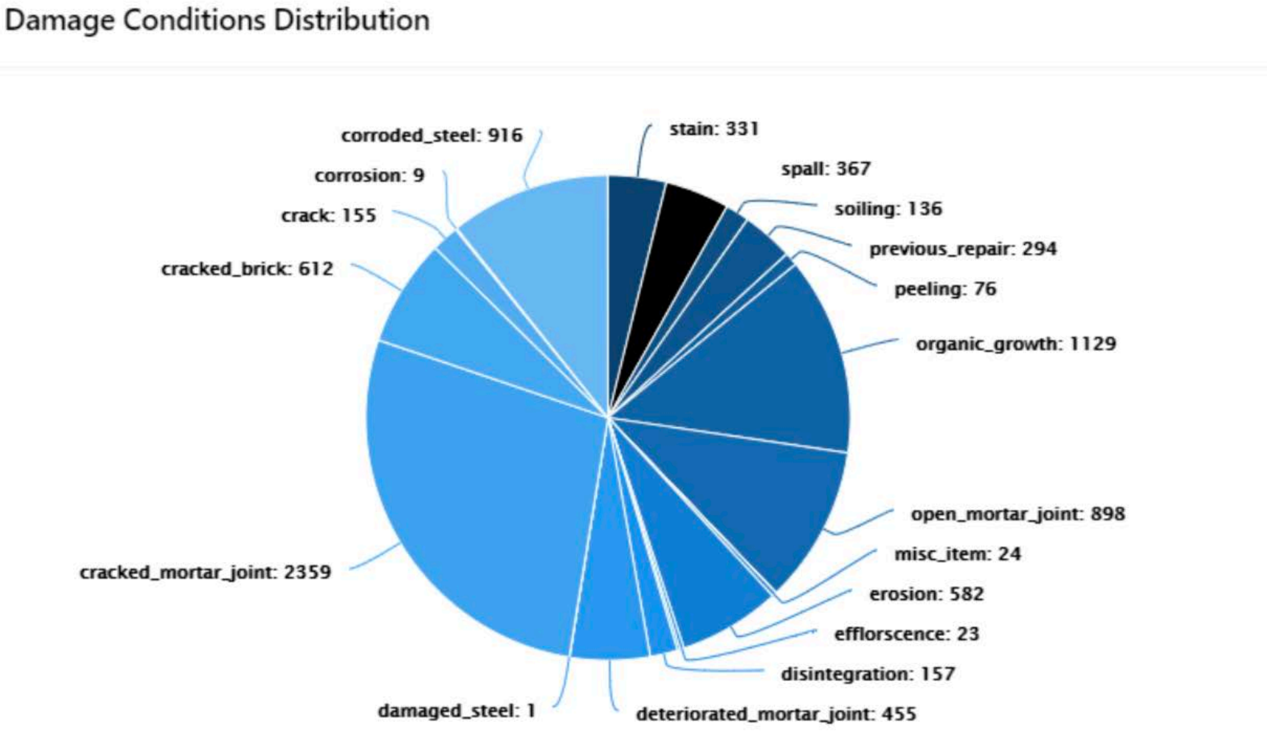
- Introduction
- Background
- Definitions of artificial intelligence (AI) and machine learning (ML)
- Potential application of AI/ML for asset management
- Potential application of AI/ML for health monitoring
- Conclusions

Possible future of health monitoring




Physical asset
Images
Computer vision
Damage detection
Monitoring data
Data-driven analysis
Diagnostics
Digital Twin
Performance diagnostics
Service life evaluation
Preventive maintenance

Detect.
Classify.
Analyze.
Estimate.
Monitor.



Max Cost
$ 15000
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$ 7500
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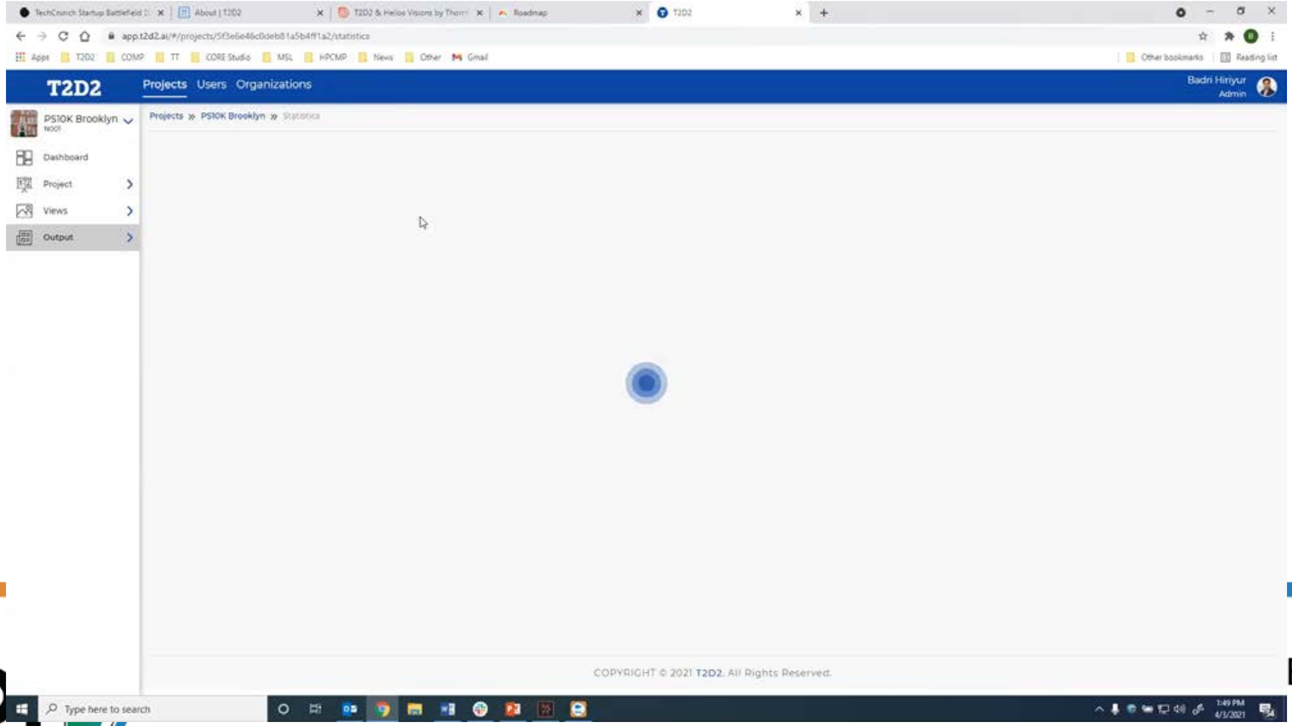
$ 30,000

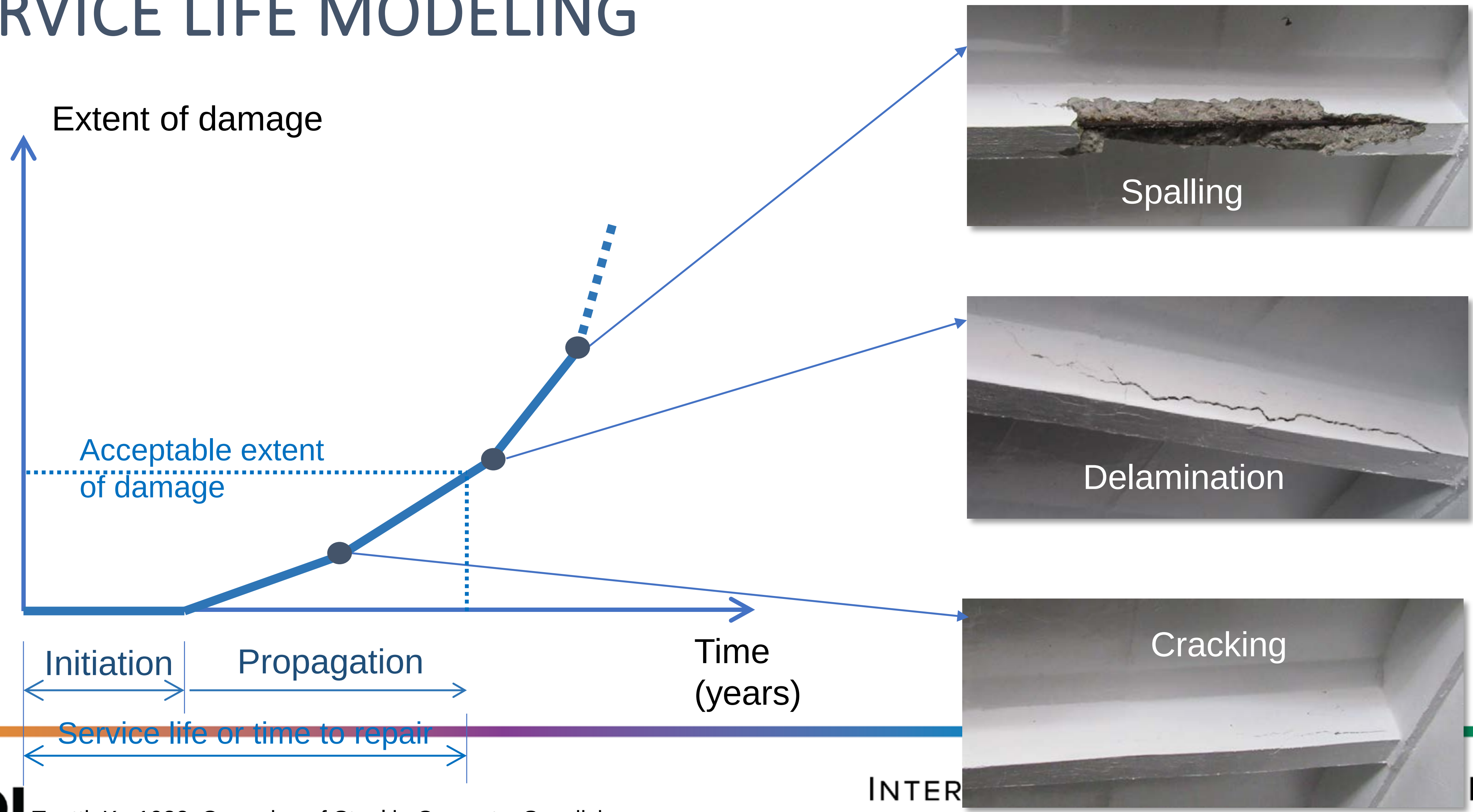
"The system flags many defects that even our team of trained engineers would have easily missed"

"This technology saves us a phenomenal amount of time and effort"

"T2D2 is the future of structural inspections. This should be the way all structures are inspected"



SERVICE LIFE MODELING



Tuutti, K., 1982, Corrosion of Steel in Concrete, Swedish Cement and Concrete Research Institute, Stockholm, Sweden

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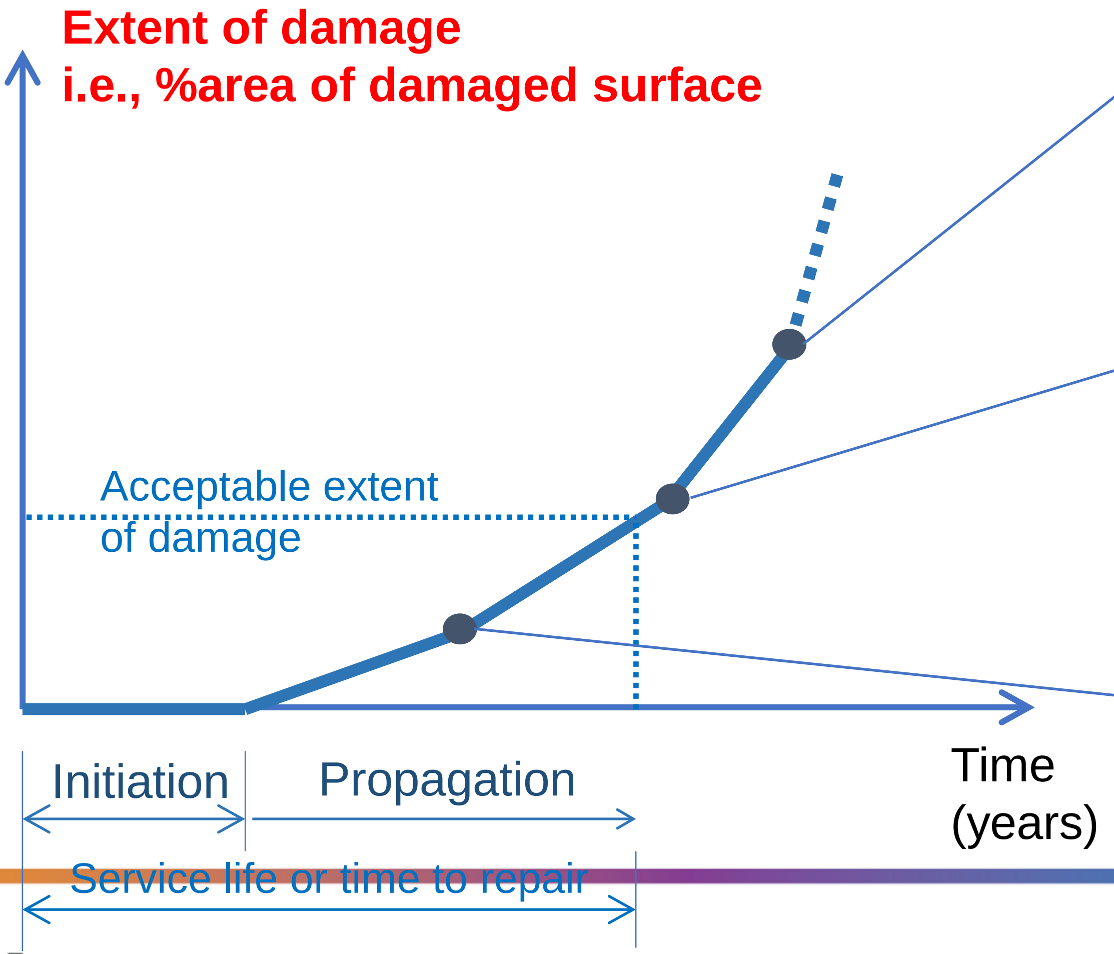
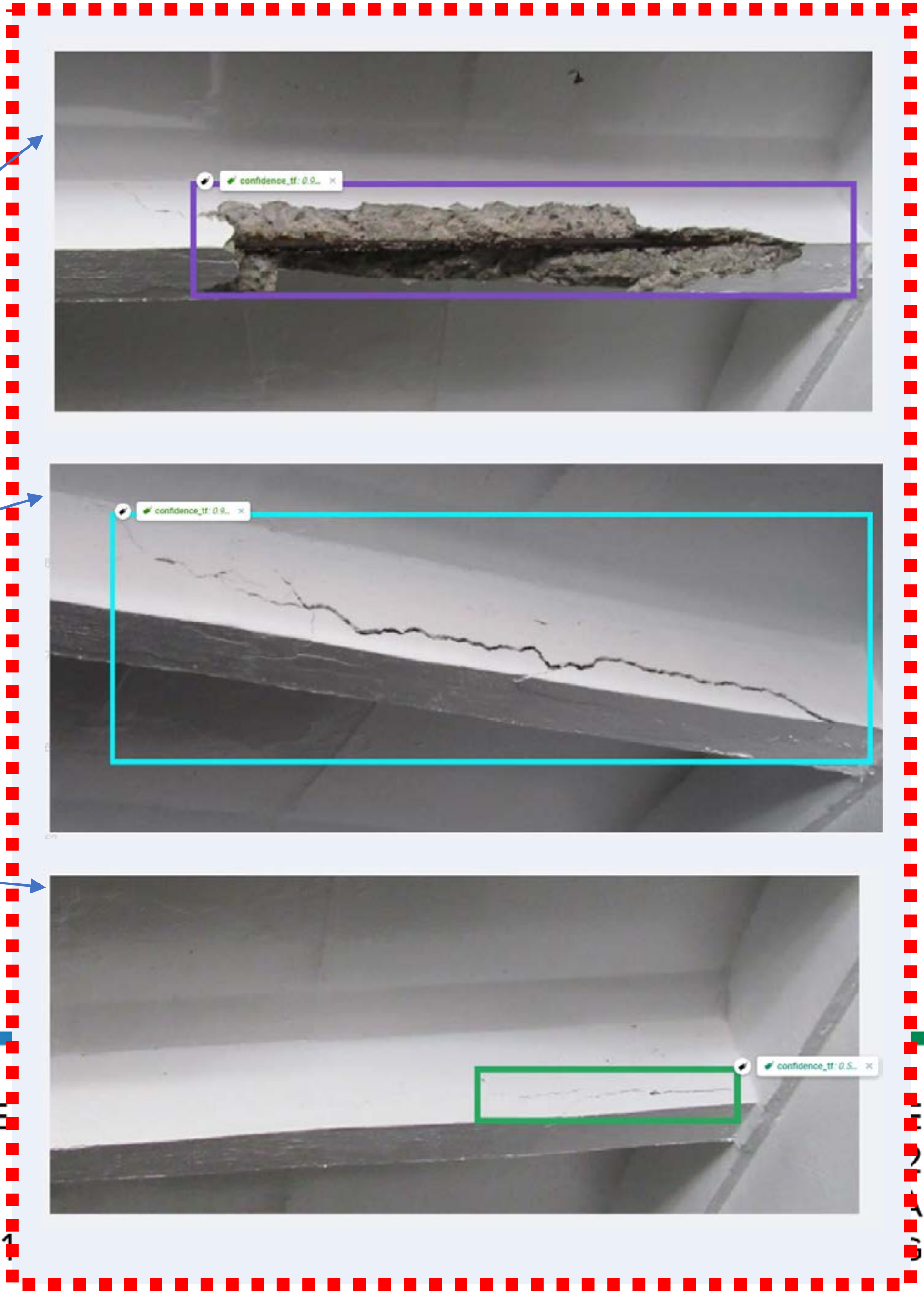
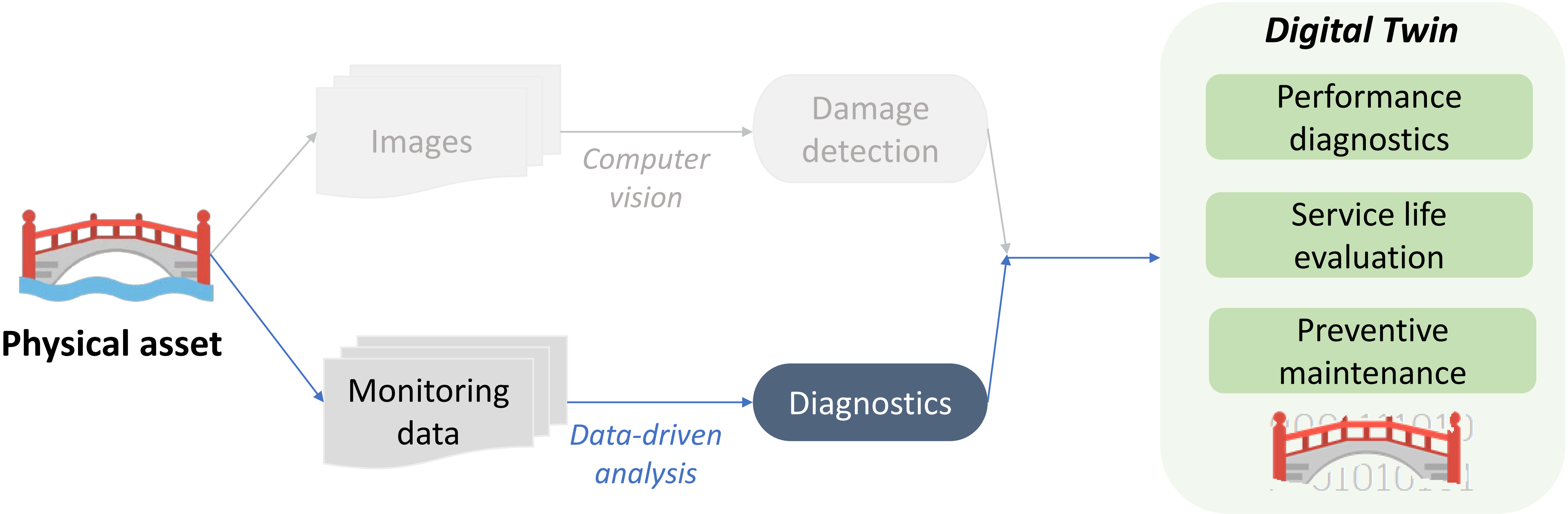
SERVICE LIFE MODELING

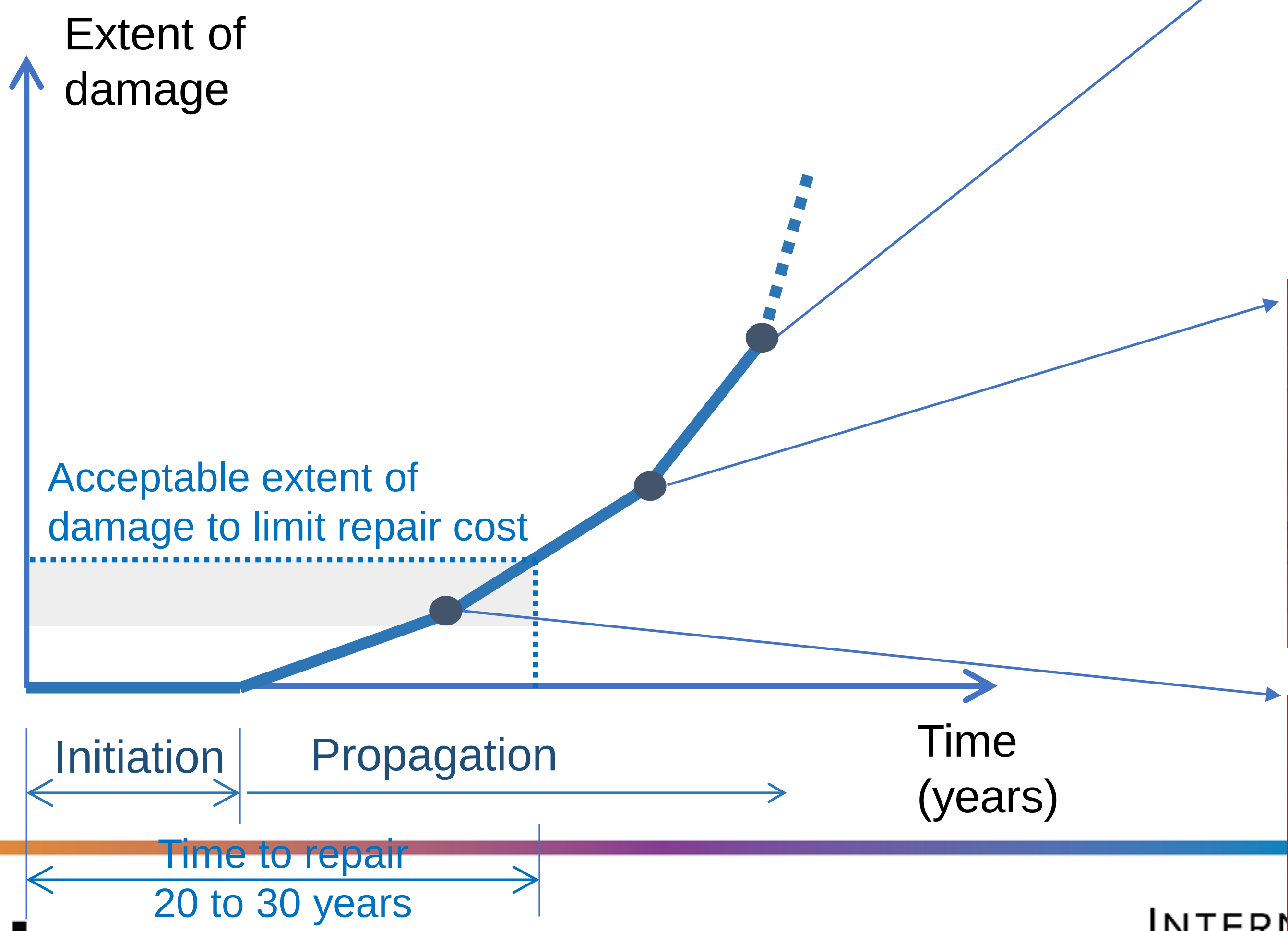




Computer vision / T2D2


Digital Twin
Performance diagnostics
Service life evaluation
Preventive maintenance
Images
Computer vision
Damage detection
Physical asset
Monitoring data
Data-driven analysis
Diagnostics

PT DECK SERVICE LIFE



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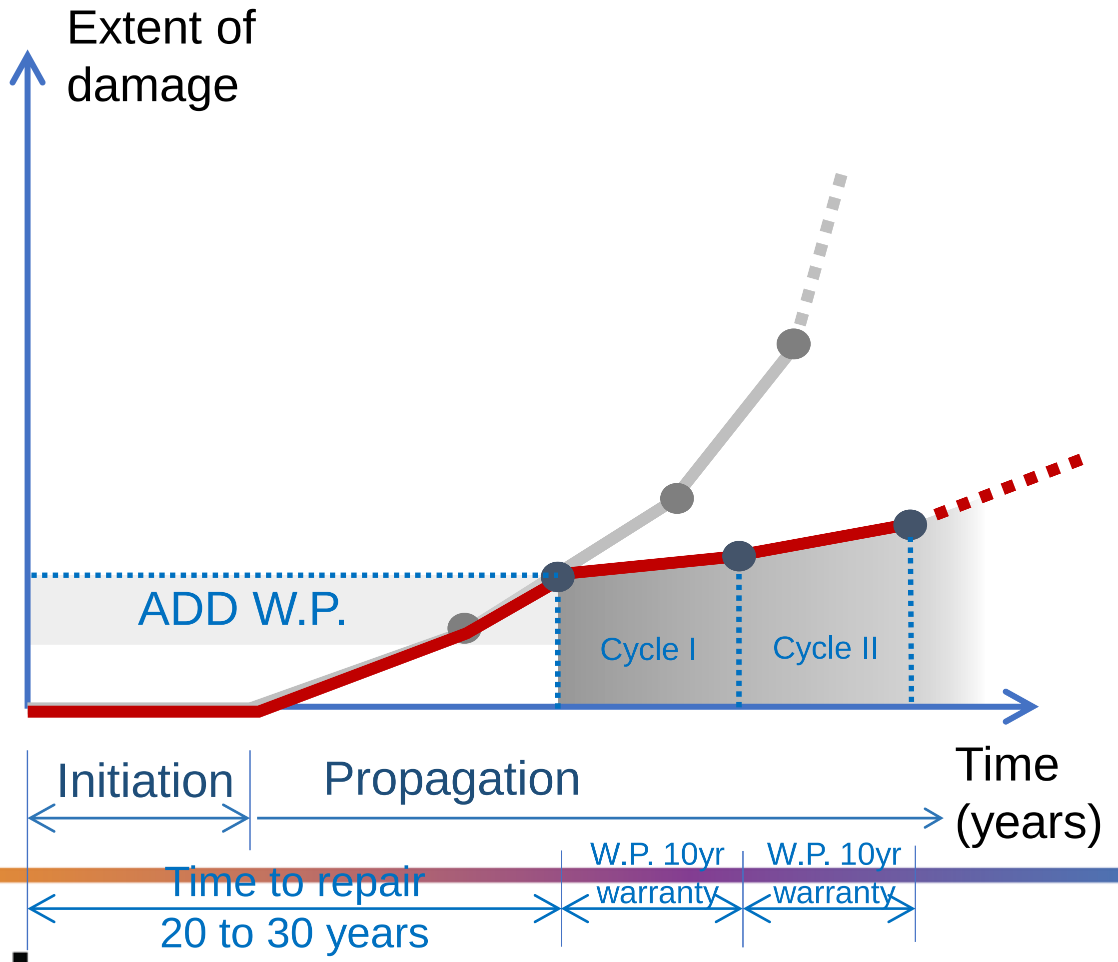
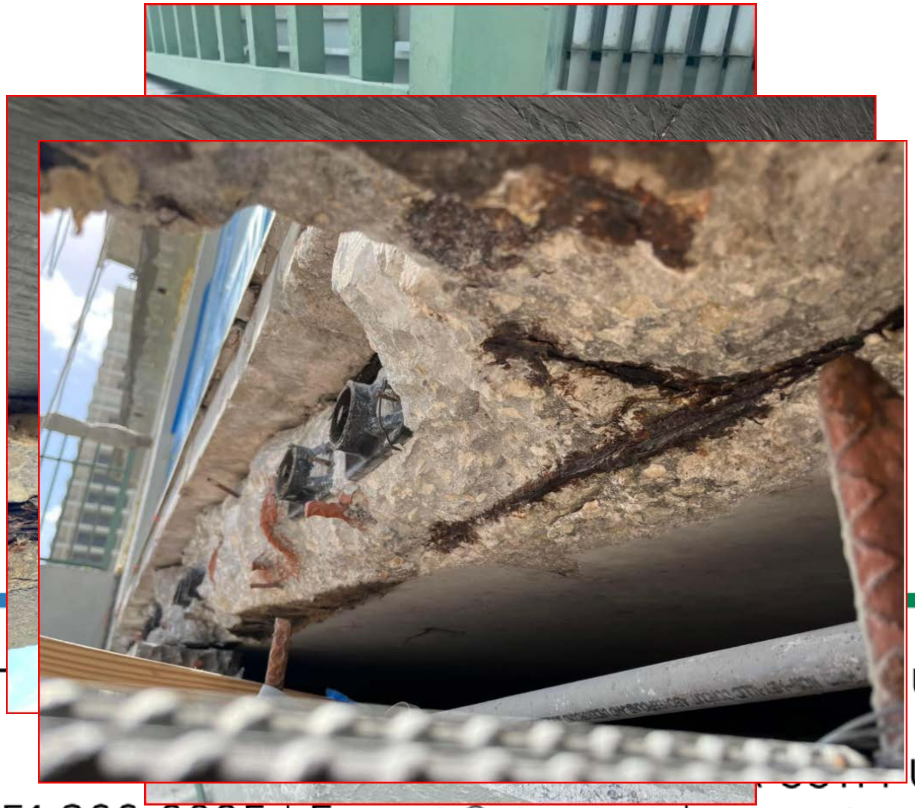
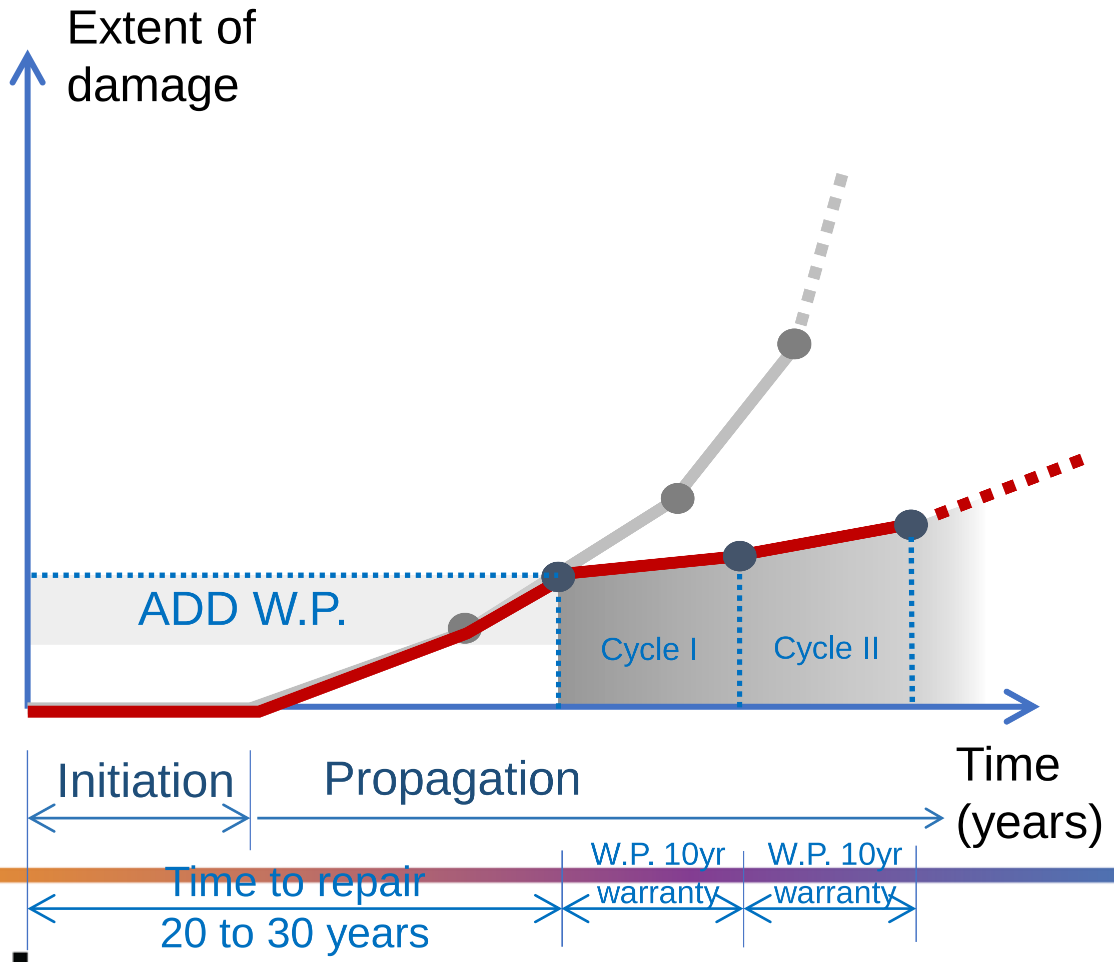
PT DECK SERVICE LIFE



Avoid/postpone conditions that lead to major structural repairs

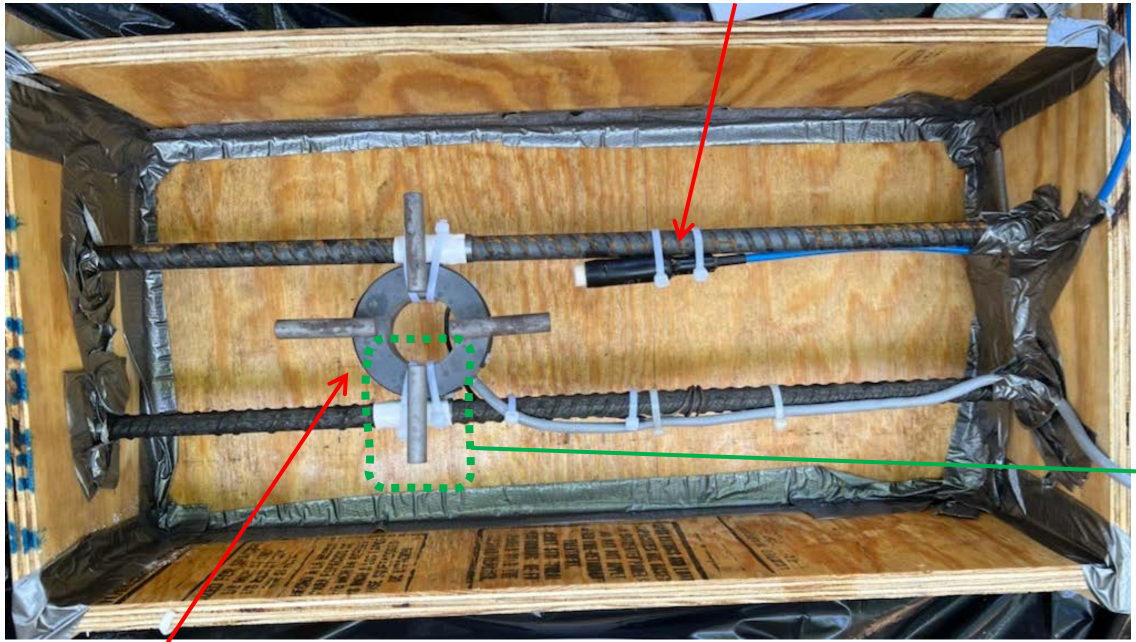


PT DECK SERVICE LIFE

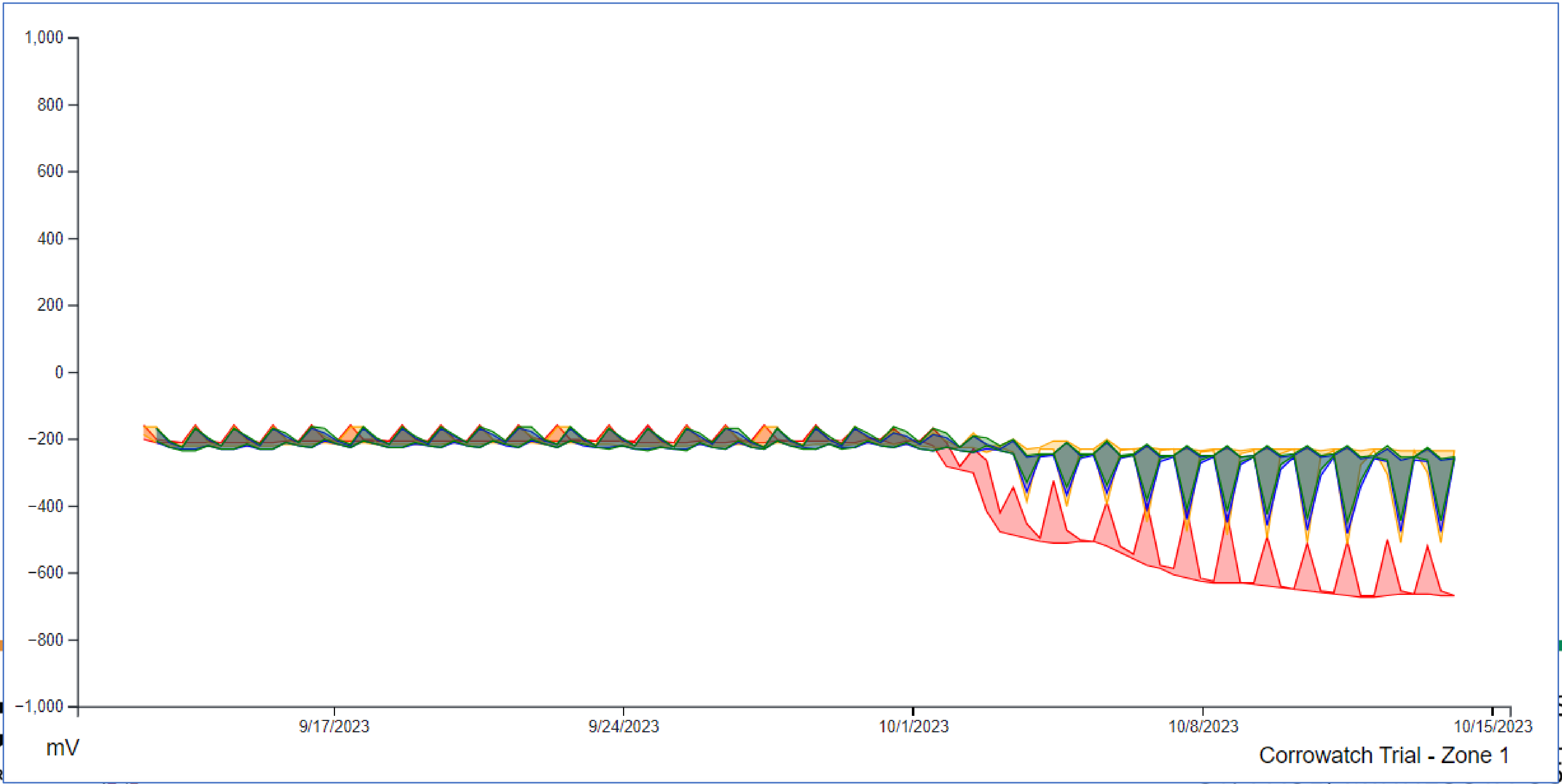


Major structural repairs to avoid/postpone

Half-cell reference electrode embedded into concrete



Multi-probe device consisting of four black steel bars acting as anodes and a noble metal as the cathode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10/8/2023
10/15/2023
mV
Corrowatch Trial - Zone 1

OUTLINE

- Introduction
- Background
- Definitions and examples of artificial intelligence and machine learning
- Potential application of machine learning for asset management
- Discussion on how innovation may impact future of bridge monitoring
- **Conclusions**

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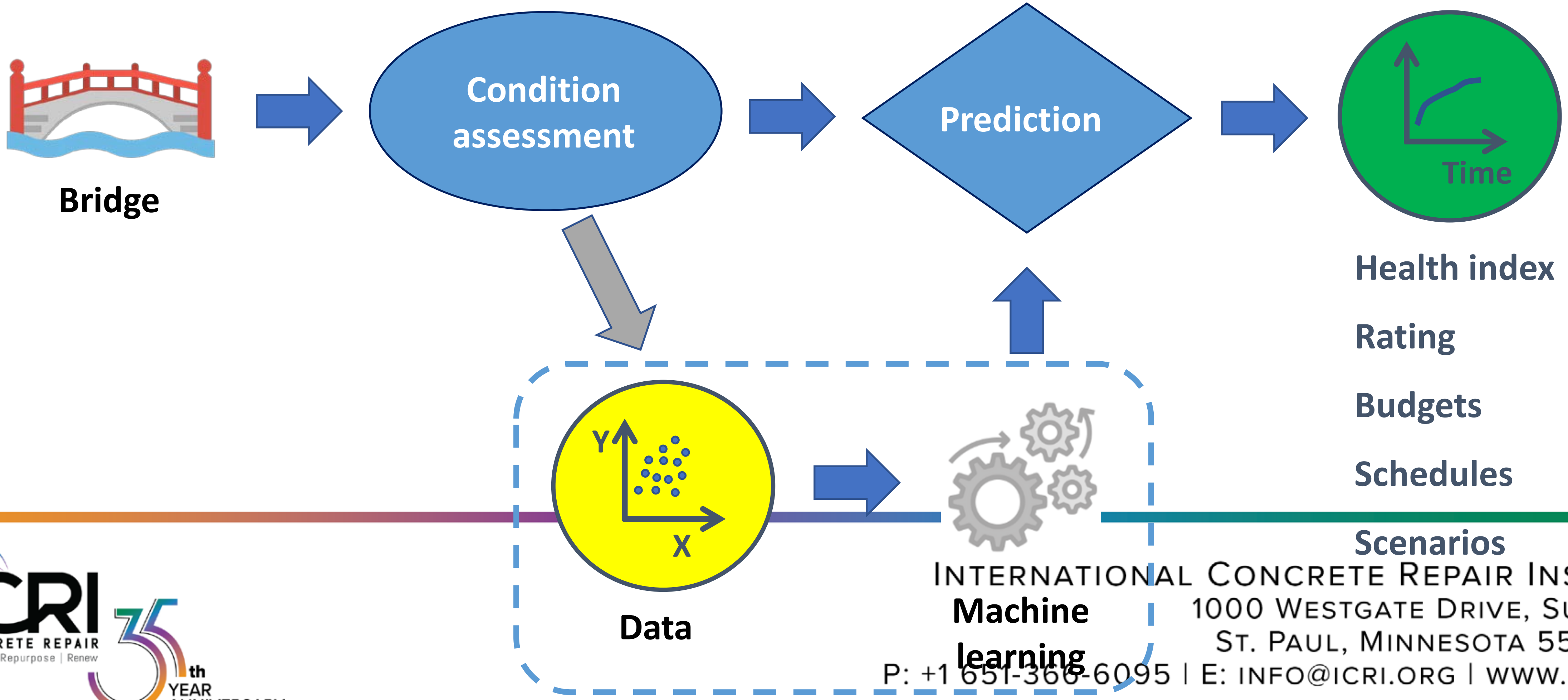
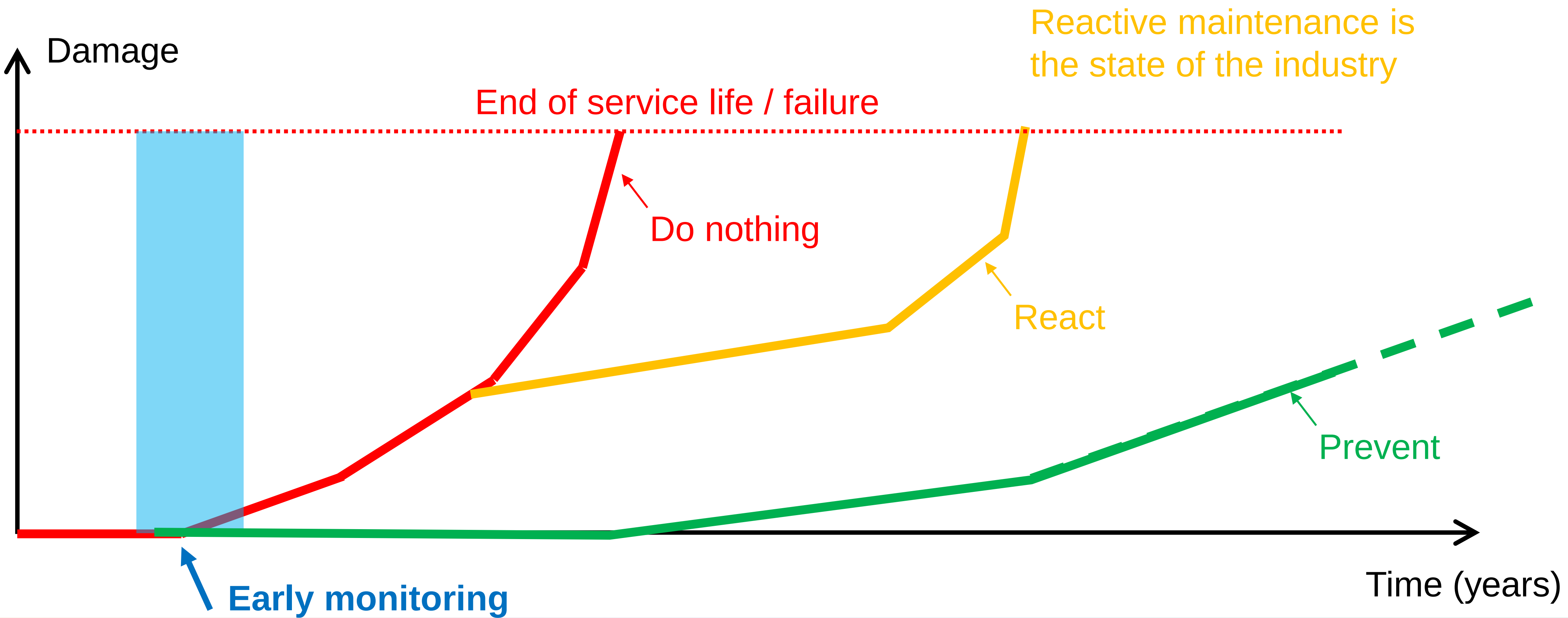
DATA-DRIVEN PREVENTIVE MAINTENANCE



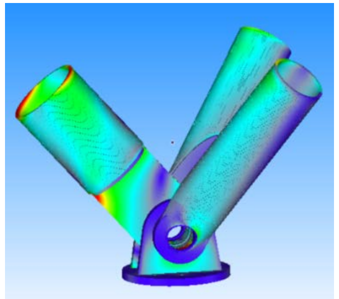
PREVENT RATHER THAN REACT



Will Bridge DIGITAL TWINS be the future?

"Digital representation of a physical object that ages with the physical object."

DIAGNOSIS



MONITORING

PROGNOSIS

PREVENTIVE MAINTENANCE & EARLY TREATMENT

Questions?

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