

Week 12
건설산업 정보화

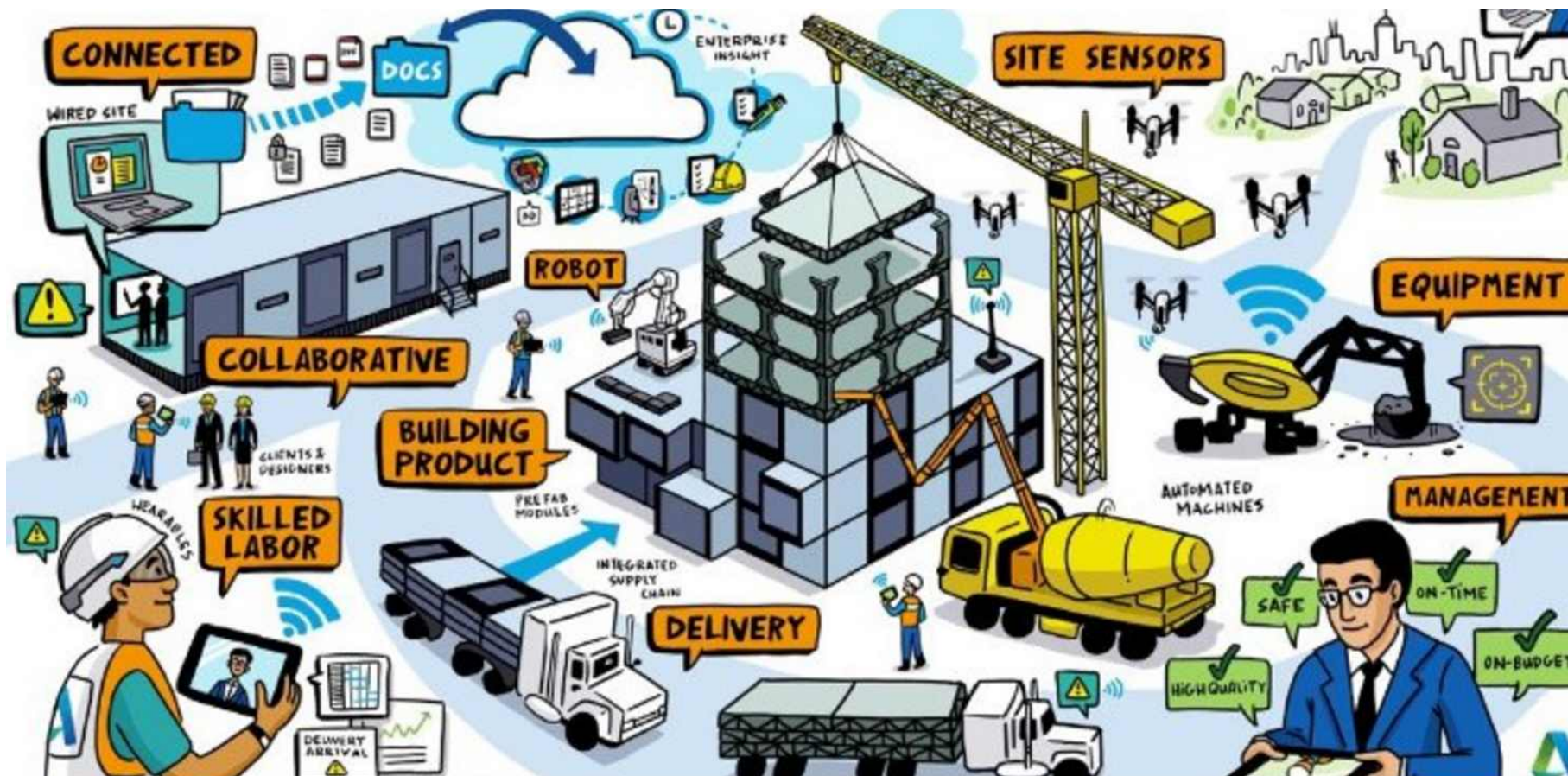
457.307 Construction Planning and Management
Department of Civil and Environmental Engineering
Seoul National University

Prof. Seokho Chi

shchi@snu.ac.kr

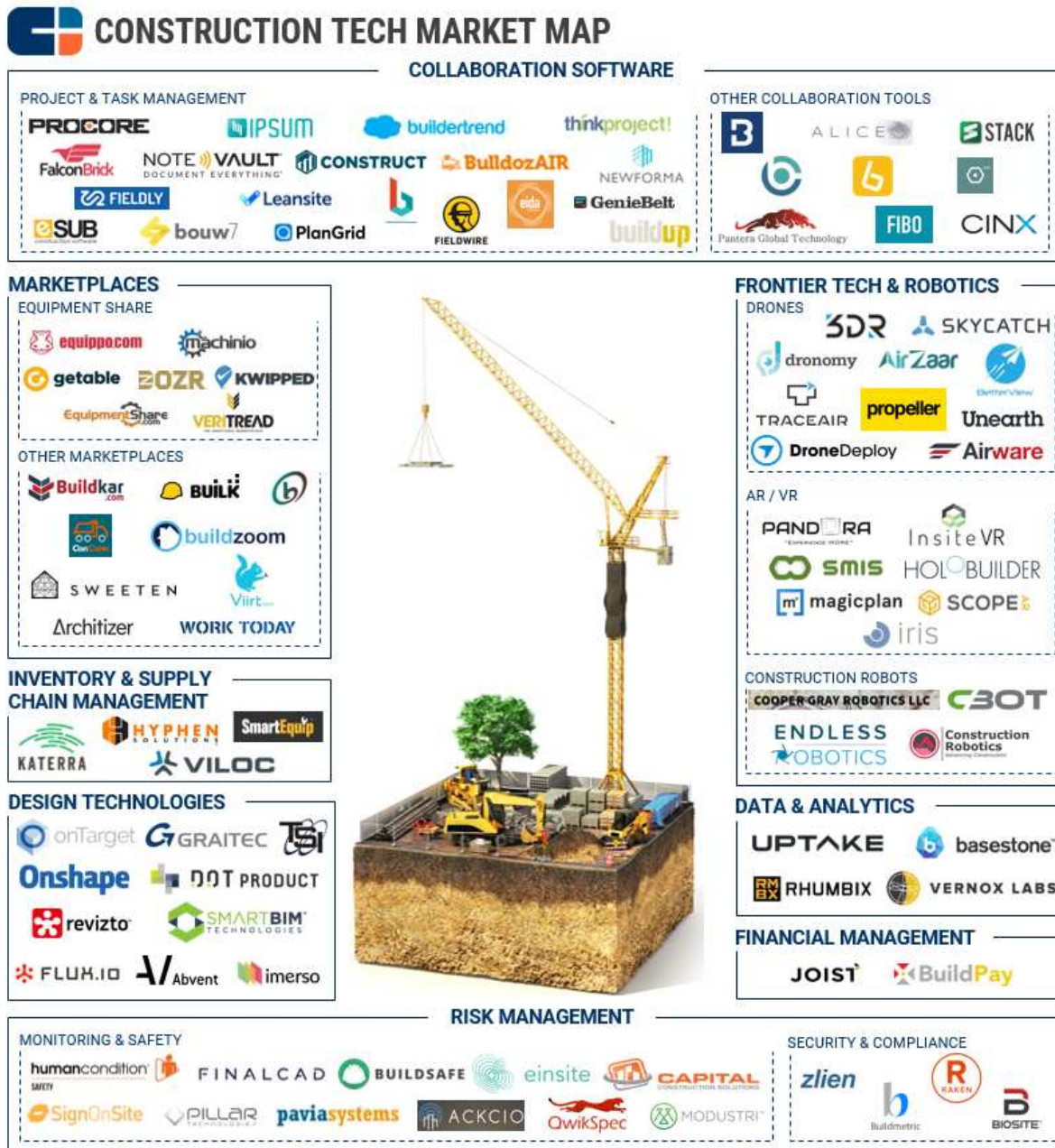
건설환경공학부 35동 304호

출처: Autodesk, 2016





미국 CB Insight 발표 글로벌 100대 건설 스타트업



Collaboration Software (28)

- Project & Task Management
- Other Collaboration Tools

Market Places (16)

- Equipment Share
- Other Market Places

Inventory & Supply Chain Management (4)

Design Technologies (10)

Risk Management (15)

- Monitoring & Safety
- Security & Compliance

Financial Management (2)

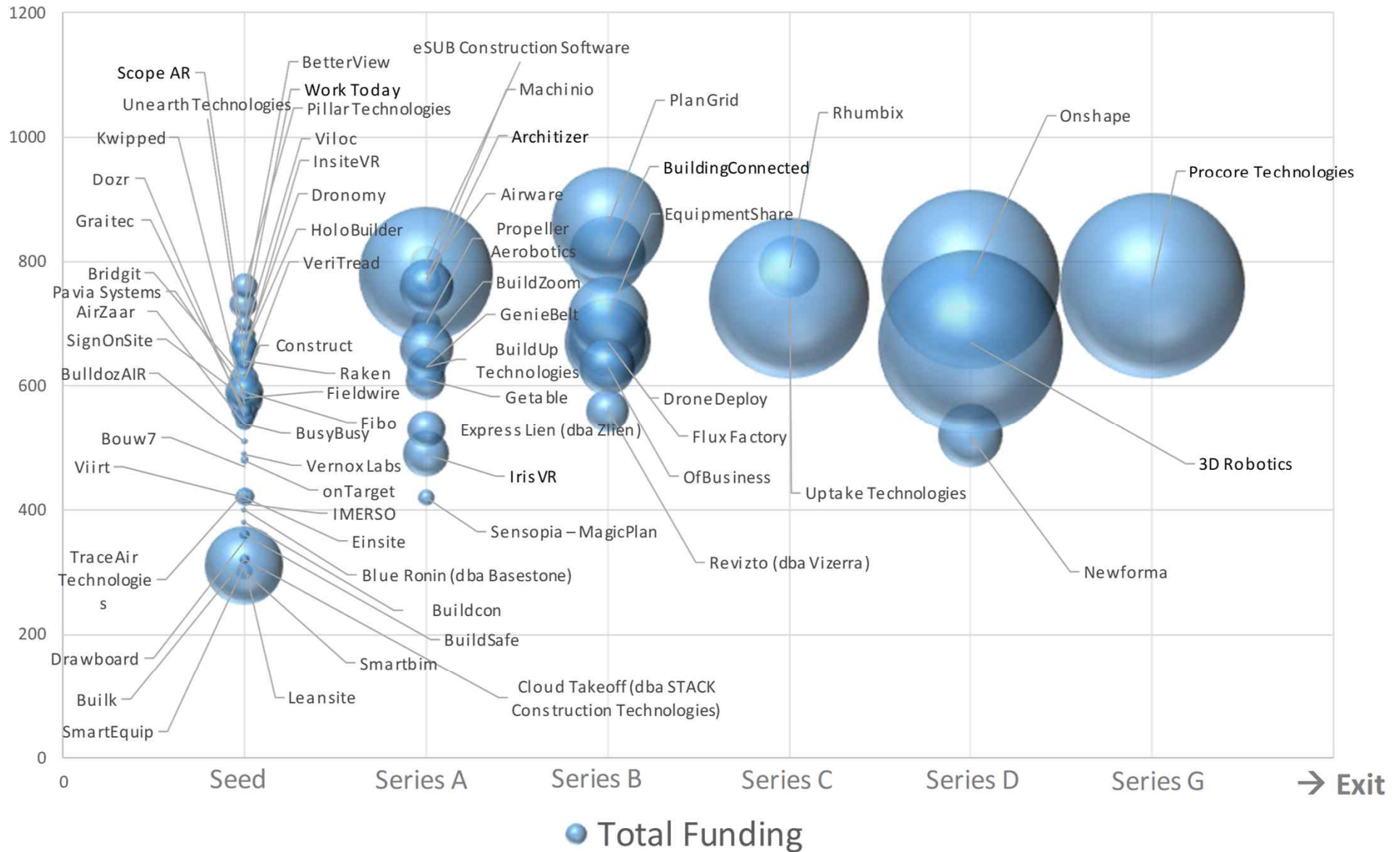
Data & Analytics (4)

Frontier Tech & Robotics (21)

- Drones
- AR/VR
- Construction Robots

Mosaic
(Overall Score)

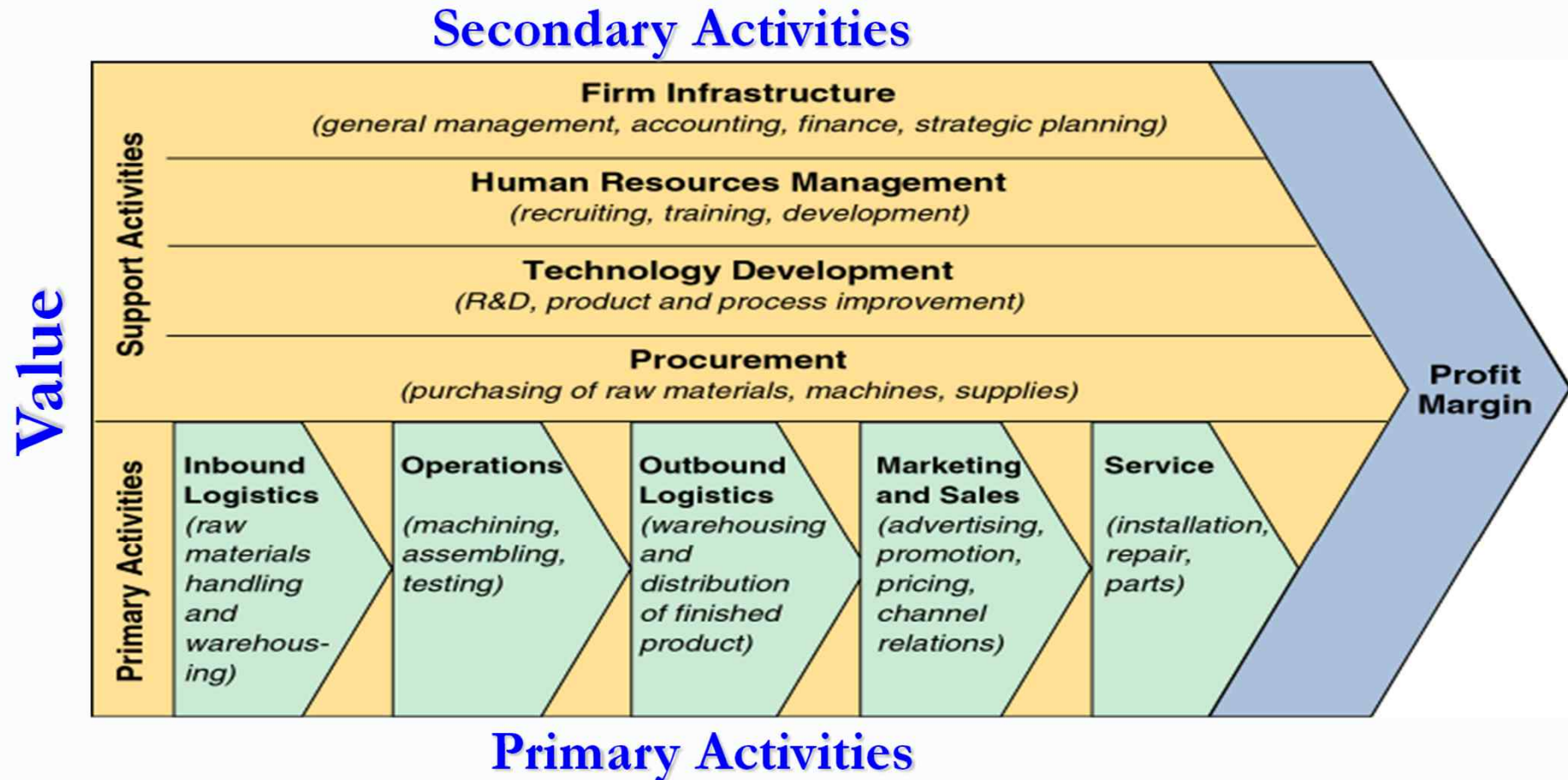
건설 스타트업들의 총 펀딩금액, 시드단계, 모자이크 점수



■ VR/AR: HOLO BUILDER



프로젝트 정보관리의 목적: Value Chain



Analyze the internal operations of a corporation to increase its *efficiency, effectiveness and competitiveness*.
A company analysis by systematically evaluating a company's key processes and core competencies.
Activity support using IT to adding value to the company and finally maximize the company's profit!

1965년에 그린 2000년대 미래상



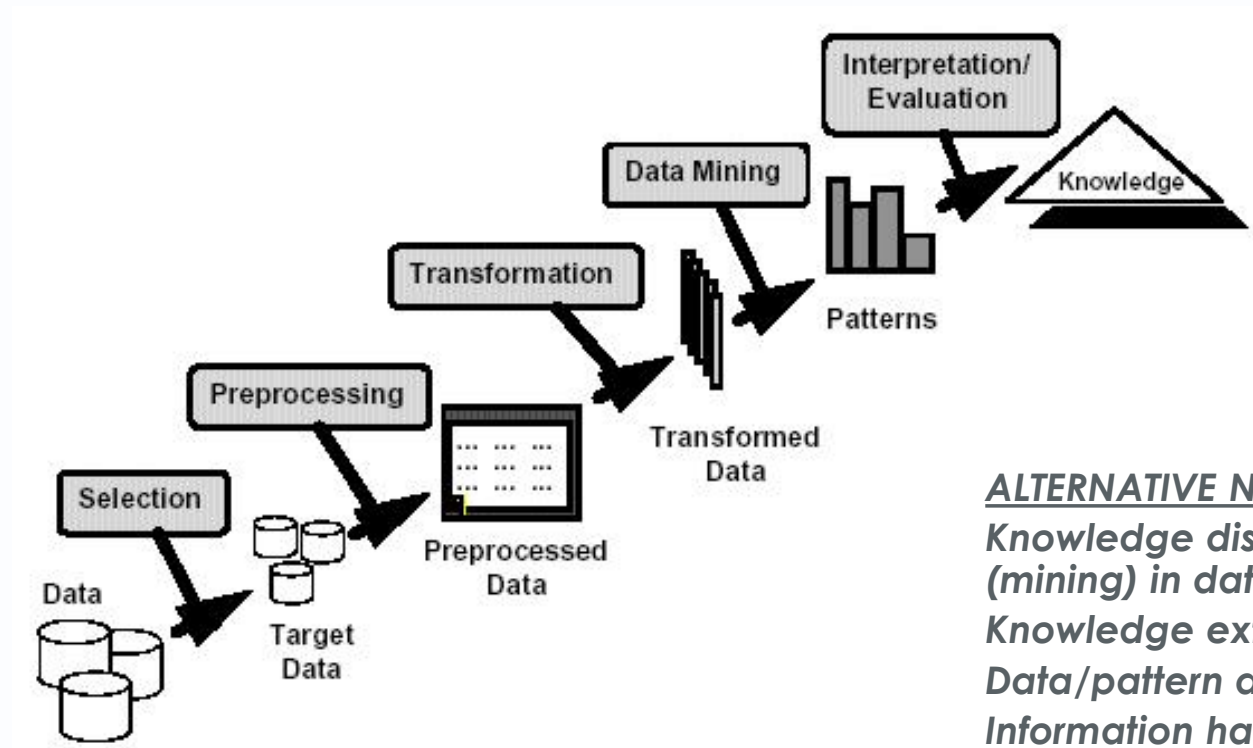
(이정문, 1965)



Data Mining VS Big Data

♦ Big Data ← Data Mining + 3 V (Volume, Velocity, Variety)

- Knowledge discovery from data
- Extraction of interesting patterns or knowledge from huge amount of data



빅데이터 분석의 목표: 데이터 → 정보 → 지식

◆ Data

- Raw description of things, events, activities and transactions that are recorded, but alone do not convey any specific meaning (e.g. 400,000)

◆ Information

- Data that have been organized so that they have meaning and value to the recipient (e.g. Current \$400,000 house price)

◆ Knowledge

- Information that has been organized and processed to convey understanding experience and expertise as they apply to a current problem or activity (e.g. The current \$400,000 house price is cheaper than the last year's price. The property market may be deflated.)

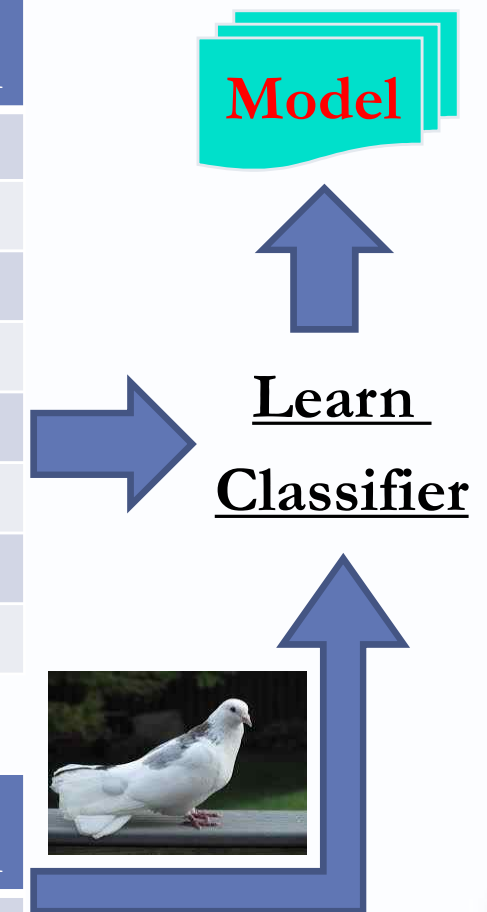
(1) Classification

TRAINING SET

Name	Body Temperature	Gives Birth	Four-legged	Hibernates	Class Label
Human	Warm-blooded	Y	N	N	Y
Elephant	Warm-blooded	Y	Y	N	Y
Leopard shark	Cold-blooded	Y	N	N	N
Turtle	Cold-blooded	N	Y	N	N
Penguin	Cold-blooded	N	N	N	N
Eel	Warm-blooded	N	N	N	N
Dolphin	Warm-blooded	Y	N	N	Y
Spiny anteater	Cold-blooded	N	Y	Y	Y

TESTING SET

Name	Body Temperature	Gives Birth	Four-legged	Hibernates	Class Label
Pigeon	Warm-blooded	N	N	N	?

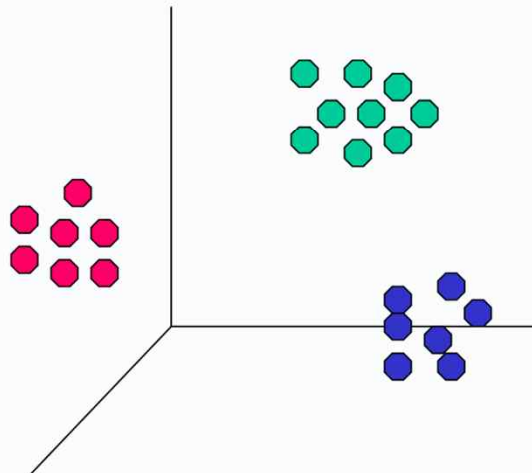


(2) Clustering

- Given a set of data points, each having a set of attributes and a similarity measure among them, find clusters such that
 - Data points in one cluster are more similar to one another
 - Data points in separate clusters are less similar to one another

Intracuster distances
are minimized

Intercluster distances
are maximized



(3) Association Rule Discovery

- Given a set of records each of which contain some number of items from a given collection
- Produce **dependency rules** which will predict occurrence of an item based on occurrences of other items

TID	Items
1	Bread, Coke, Milk
2	Beer, Bread
3	Beer, Coke, Diaper, Milk
4	Beer, Bread, Coke, Diaper, Milk
5	Beer, Diaper, Milk

Rules Discovered:

{Milk} → {Coke} X
{Diaper, Milk} → {Beer} O

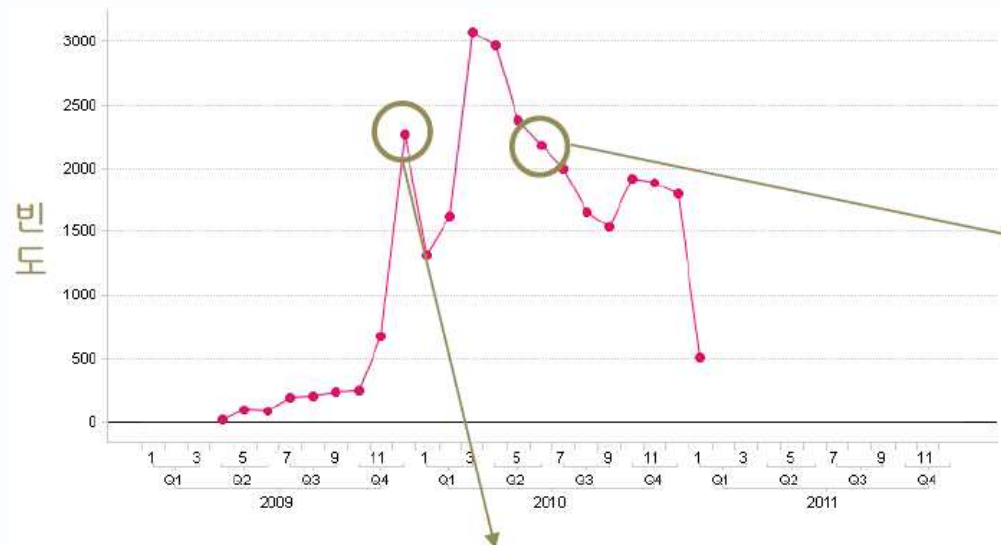
- *Marketing and sales promotion*
- *Supermarket shelf management*
- *Inventory management*

(4) Sequential Pattern Discovery

- Given is a set of objects, with each object associated with its own timeline of events, find rules that predict strong sequential dependencies among different events.
- Association rule: Concurrent events
- Examples: Computer bookstore: Intro to C++ → MFC using C++
Shoes → Racket, Racketball → Sports Jacket

빅데이터 기술

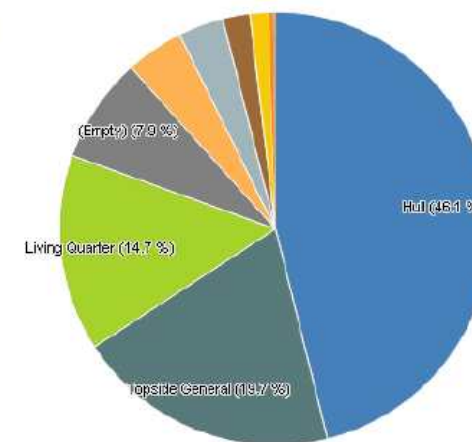
출처: 조성준 교수(서울대학교 산업공학과, 2013)



install	support	addition	gap	tray	con	ven	cov	nu	che	acc	insi	gui	tes
				fix	sid	sp	ve	op	hy	JB	mo	da	IS
			weld	modify	sh	su	ha	nu	se	su	co	d	is
				add	no	w	ty	q	re	p	pr	re	a
		cable		equip	con	co	ca	c					
	valve			ment	nect	ite	tu	dr					
		line		maint	ain	nee	cl	fa					
				plate	flange	att	ke	h					
	locate	joint				ID	pr	p					
		point		bolt	p...	per	F	br					
miss		pipe				rep	wi	d					
		page		DWG	c...	po	co	p					
tag													

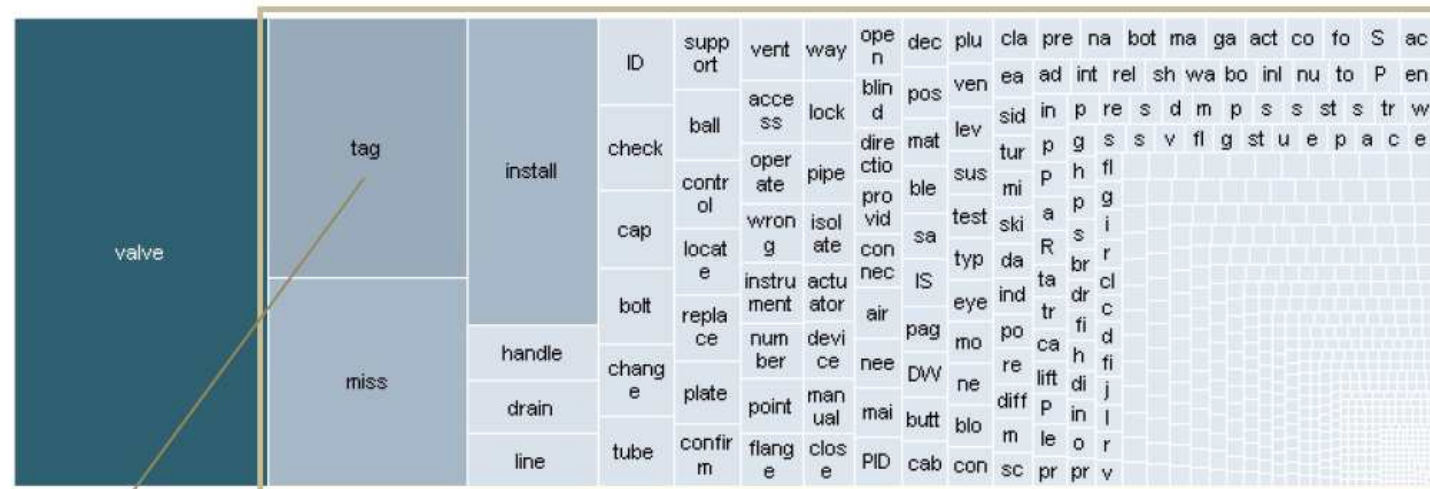
install	integrat	syste	plate	bolt	regula	con	flan	mo	ad	ca	too	us	de	cra	re	ca
	e	m		red	ear	m	ide	op	cir	re	m	ve	ca	int	m	co
	weld	point	chan	guide	th	re	ca	ja	oil	sh	wi	co	in	so	su	a
			ge	me	na	co	de	c	F	lis	st	st	s	te	b	in
support		DWG	provi	de	wa	inc	O	pr	in	a	i	o	p	s	t	r
	valve		AU	a...	typ	bo	pa	d	u	a	p	s	t	r	U	
		spool		e...	am	pa	sh	fix	st	bl	s	t	r	U		
miss	tag		num	ber	light	con	ce	gl	J	m	p	s	a	b		
		hydro	alar	m	dr...	ne	ch	s	d	e	l	a	b			
joint	NDE	cable	gap	ex...	con	m	dir	e	b							
test	comple	pipe	line	h...	sus	ca	dr	e	b							

등장하는 단어



발생하는 장소

“valve”와 함께 등장하는 단어



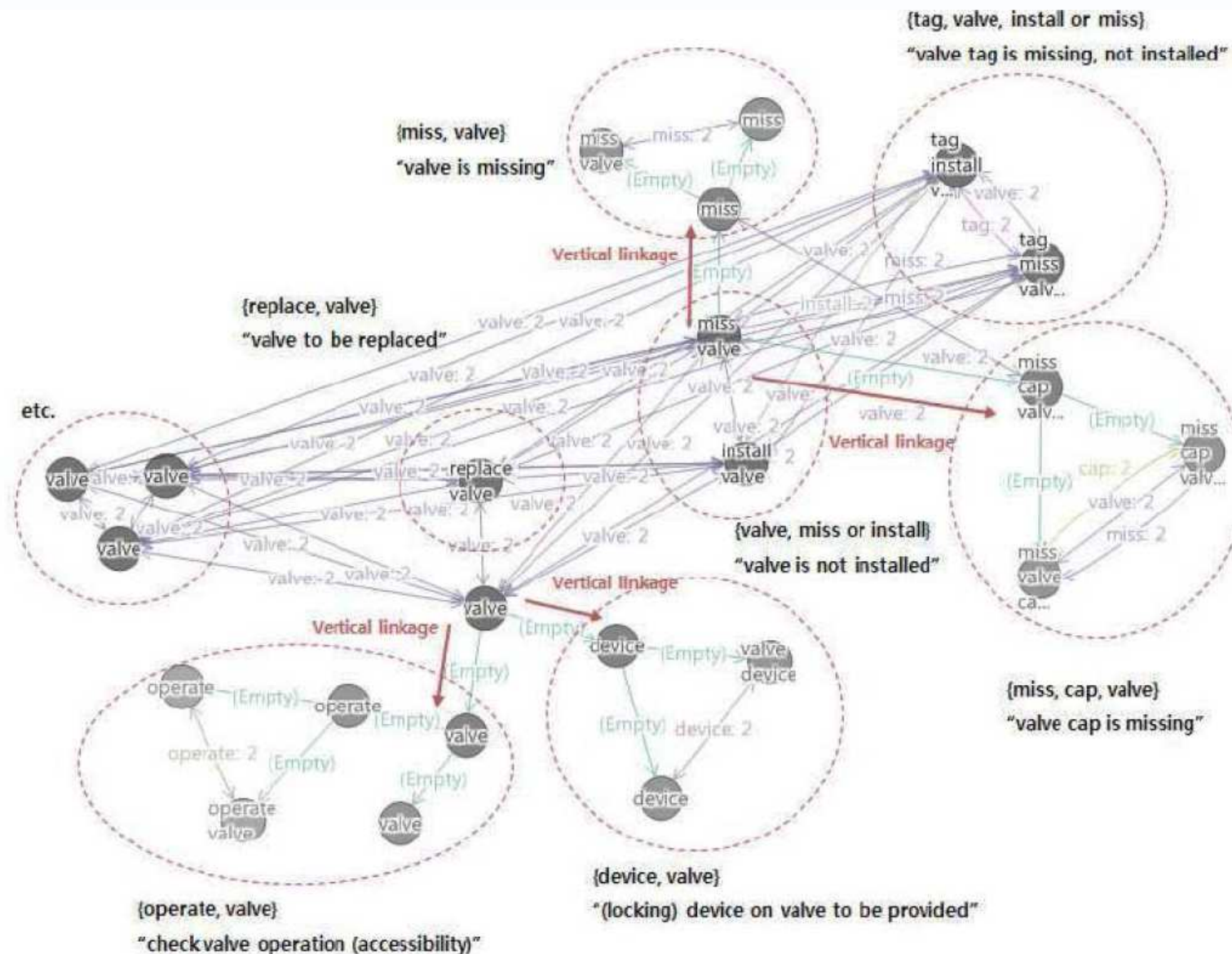
notc_detl_desc

Valve tags missing-4EA (HV-05026B/C,27329,27362)
 Valve (HV-73008A) tag is missing.Handle touched other valve's body.
 "Valve (HV-07527, HV-07530, HV-07528) tag is missing "
 Valve(HV-27207) tag is missing (밸브 tag 설치 요망)
 Valve(HV-27207) tag is missing (밸브 tag 설치 요망)
 All valve tag is missing (PKG에 포함된 전 밸브 tag 설치 요망- 6 ea)
 All valve tag is missing (5 points - PKG 내 전 밸브 tag 미설치)
 Vave (HV-27217A, 27217B) tag is missing (밸브 tag 미설치 - 2 points)
 Vave (HV-27221A, 27221B) tag is missing (밸브 tag 미설치 - 2 points)
 Vave (HV-27204A, 27204B) tag is missing (밸브 tag 미설치 - 2 points)
 Vave (ROV 27241, 27243) tag is missing (밸브 tag 미설치 - 2 points)

“valve”와 “tag”가 함께 나오는 검사문서

→ “valve tag가 누락(miss)되어 설치(install)가 필요하다”





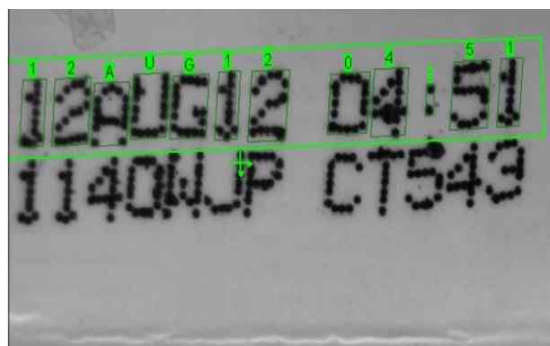
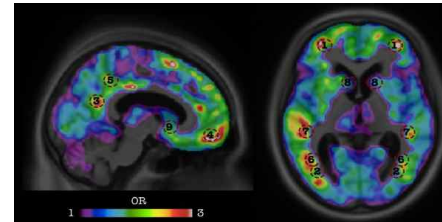
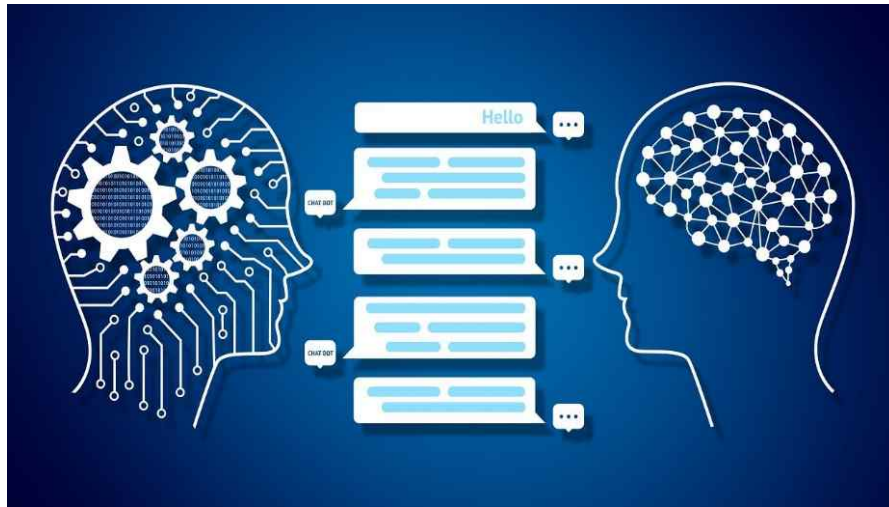
“valve” 관련한 문제 유형들은 뭐가 있는가?

- Valve tag, valve cap, locking device 미 설치 문제, Valve 교체 문제, Valve 오작동 문제가 있음

What's Deep Learning

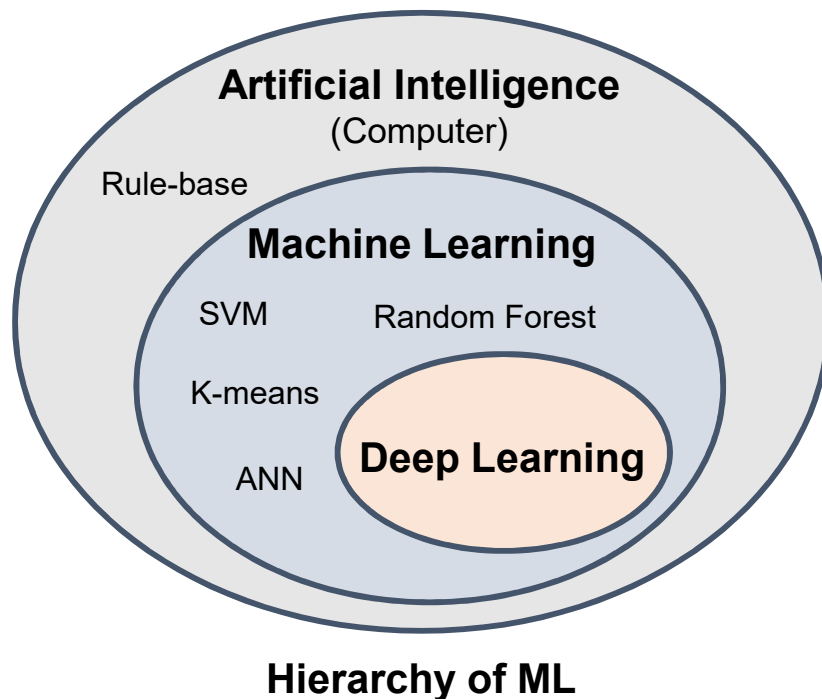


Artificial Intelligence

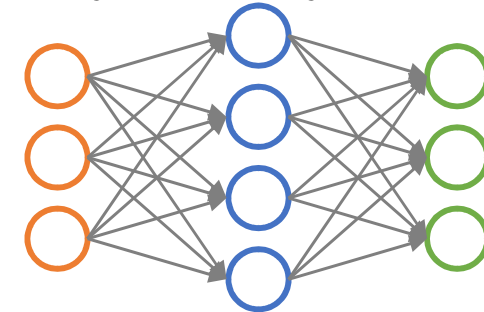


■ Deep Learning

- One of Machine Learning(ML) models based on the Artificial Neural Network(ANN)
- Hidden layers of ANN became **DEEP** by using
 - [1] Rich data
 - [2] Cheap and powerful computing



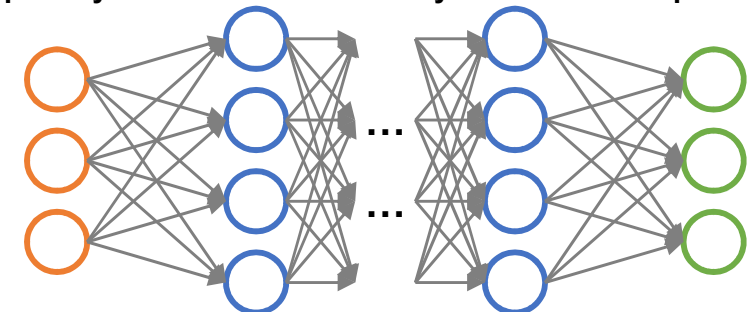
Input Layer Hidden Layer Output Layer



Artificial Neural Network

Data ↓ **Computing Power**

Input Layer Hidden Layer Output Layer

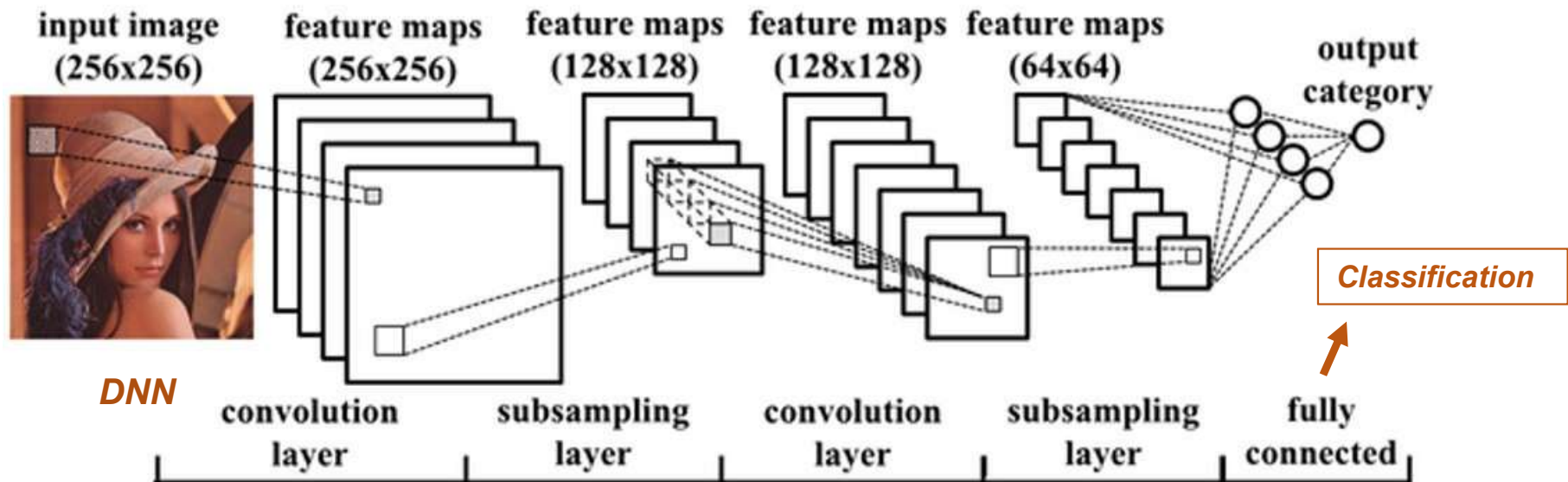


Deep Neural Network

■ Convolutional Neural Network (CNN)

Split input data into **small units** and extract various features of each unit for classification (e.g., image recognition)

< CNN Architecture >



1	1	1	0	0
0	1	1	1	0
0	0	1	1	1
0	0	1	1	0
0	1	1	0	0

Image

4		

Convolved Feature

1	1	1	0	0
0	1	1	1	0
0	0	1	1	1
0	0	1	1	0
0	1	1	0	0

Image

4	3	4
2	4	3

Convolved Feature

12	20	30	0
8	12	2	0
34	70	37	7
112	100	22	12

Activation Map

Max Pooling

20	30
112	37

Average Pooling

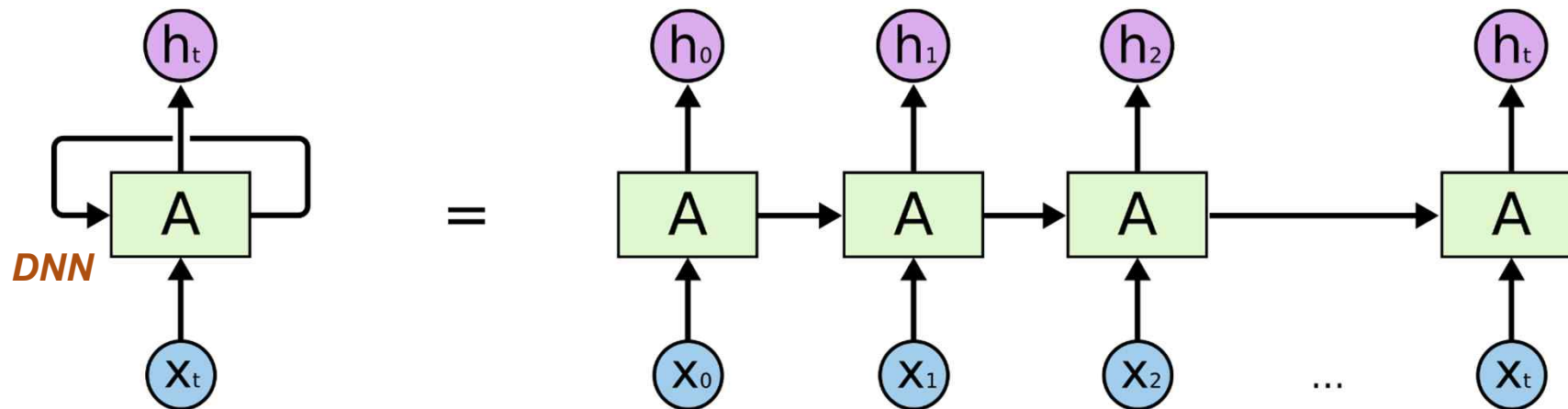
13	8
79	18

■ Recurrent Neural Network (RNN)

- x : input
- A : Neural Network
- h : Output

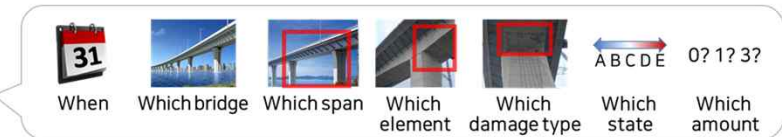
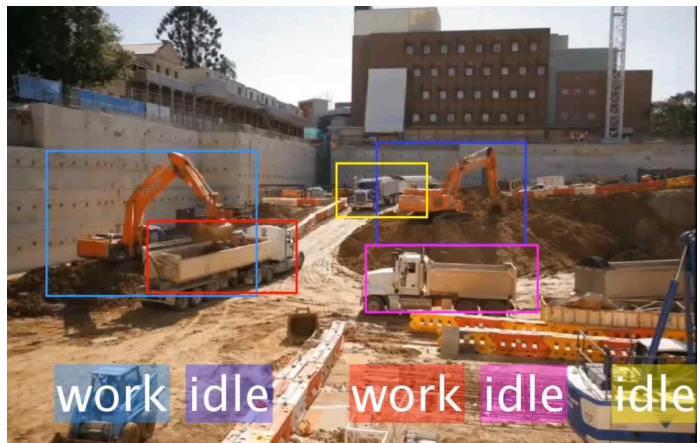
Take into account the **patterns** of the input data, the information of the old network is used in the following network's learning
(e.g., natural language processing, time-series)

"Cannot consider the sequence with only one network!"



RNN Architecture

Deep Learning Research @ C!LAB



Actual inspection



[4] Standard Comparison

Construction Element	Qatar	Arkansas	DIFF
Distillation Test Residue	MIN 55%	MIN 68%	DIFF
Liquid Asphalt	ASTM D2027 AASHTO M82	AASHTO M82	SAME
...	...	...	...

[1] Selection of Reference Specification

Country	Region	Reliability	Reference
U.S.A.	Arkansas	0.88	✓
U.K.	-	0.67	
CANADA		0.65	

OCS 2014	Section 06: Roadworks	Page 3
Part	05: Asphalt Works	
5 ASPHALT WORKS		
5.2.7 Prime Coat		
1	Liquid asphalt for use as prime coat shall be MC-70 medium curing cutback asphalt in accordance with ASTM D2027 or AASHTO M82.	
2	The prime coat shall be a cutback consisting of a 60/70 penetration grade bitumen and kerosene. The residue from the distillation test, carried out to 360 °C in accordance with ASTM D4443, shall be a minimum of 55% by volume, as determined by the difference method. Sampling shall be in accordance with ASTM D140. One sample shall be tested every 5 tons.	
5.2.8 Tack Coat		
1	Emulsified asphalt for use as tack coat in asphalt works may be CSS 1h or CRS-2 cationic emulsified asphalt in accordance with AASHTO M 208 or SS 1h anionic emulsified asphalt in accordance with ASTM D977 or AASHTO M140 unless otherwise designated.	

[2] Category Matching

SECTION 402 ASPHALT SURFACE TREATMENT
402.03 Asphalt Materials. Asphalt materials shall include cutback asphalt, emulsified asphalt, and asphalt binder. Samples of asphalt material will be tested according to applicable AASHTO or ASTM methods.
402.04 Cationic Emulsified Asphalt. Cationic Emulsified Asphalt shall conform to the requirements of AASHTO M 208. In addition, CRS-2 shall have 1) A minimum Asphalt Fatty Viscosity at 122 °F (50 °C) at the point of manufacture and/or origin of 200 seconds, fails to comply at 122 °F (50 °C) test temperature, the test shall be repeated at 140 °F (70 °C) and shall be within the limits of 90-200 seconds, and 2) the minimum residue from distillation by weight shall be 60%.

[3] Named Entity Recognition

Sentence: The residue from the distillation test shall be a minimum of 55% ...
 Label: Construction Element Action Standard

SYSTEM DATA

국토부에서 추진중인 건설사업정보화(CALS) 현황

- 건설사업정보시스템 개발 및 운영
 - 건설사업의 전(全)과정에서 발생하는 건설정보를 상호 교환 및 공유하기 위해 총 5종의 건설사업정보 단위시스템이 개발되어 운영 중이며 현재 도로, 하천분야에 적용 중임



시설물 안전등급 정보공개



시설물의 안전관리에 관한 특별법에 따른 **국가 주요시설물(1,2종)**의 안전관리 현황 정보 중 같은법 시행령 제16조의2와 시설물정보관리종합시스템 운영규정에 따라 **공공 시설물**(공동주택 제외)의 안전등급 및 최종점검일자 등 안전관리 현황 정보를 공개하는 화면입니다.

검색하고자 하는 **시설물의 위치** 또는 **시설물명**을 입력하세요.

시설물위치 : 시도선택 나머지주소 :

시설물종류 : 전체 전체 종별 : 전체 등급 : 전체

시설물명칭 : 차기점검일 ~

- ▶ 시설물별 안전등급은 점검진단일 기준의 등급으로 A(우수), B(양호), C(보통), D(미흡), E(불량)를 의미합니다. ?
- ▶ 준공 이후, 정밀점검 또는 정밀안전진단을 한번도 실시하지 않은 시설물은 정기점검 결과(양호/보통/불량)를 표시합니다.
- ▶ **시설물명을 클릭**해서 해당 시설물의 추가정보를 조회할 수 있습니다. (* 차기점검진단일 범례 : ■ 정밀안전진단 ■ 정밀점검 ■ 정기점검)

No	시설물명	시설물구분	시설물종류	종별	최근 점검진단일	차기 점검진단일	등급	위치
----	------	-------	-------	----	----------	----------	----	----

데이터조회

교통

- 교통량
 - 영업소별 이용차량
 - 권역별 이용차량
 - 영업소간 이용차량
 - 구간교통량(VDS)

- 속도
- 통행시간
- 교통지표
- 교통분석

휴게소

- 고속도로 휴게소 현황
- 휴게소 편의시설 정보
- 노선별 주유소 정보

영업소별 이용차량



건설사고DB Accident DB

시설물 안전확보를 통한 **국민행복기반 마련**,
한국시설안전공단의 소명입니다.

사고사례검색

사고유형	전체	공사종류	전체	전체
사고원인	전체	사고일자		

사고명을 클릭하면 사고사례 상세정보를 검색할 수 있습니다.

No	사고명	사고일시	현장
1	창녕군 대지면 황산리 8번지 외 00모텔 진입로 공사	2017-03-27 오후 04:00	창녕군 대지면 용
2	두산캠퍼스 신관 증축공사 두산캠퍼스 신관 증	2017-03-17	두산캠퍼스 신관

QUICK MENU

시설물안전등급정보공개

안전진단전문기관현황

유지관리업체현황

시설물사고사례

유지관리기술정보

시설물
점검진단시스템

소규모취약시설
안전관리시스템

IREMS
점검진단평가시스템

KLMS
시설안전교육센터



Police Are Using Big Data To Predict Future Crime Rates

Some police are starting to use big data to predict crime circumstances, and when and where illegal acts could happen. Here's what to know about it.



Andrej Kovacevic
November 7, 2018

~ 44 Shares 👁 5,370 Views



Share on Facebook

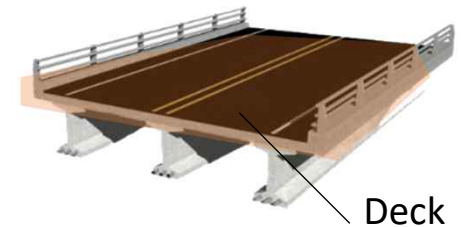


Tweet on Twitter



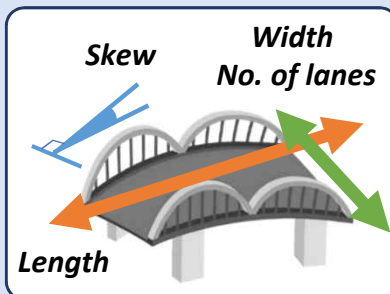
Data Characteristics

- Korean Bridge Management System Data
- Scope: Pre-stressed Concrete I-type (PSCI) bridges, Deck damage
- 2,388 bridges, 10,187 inspection records, 142,439 data
- 61 Variables (52 numerical, 9 categorical) → 59 dependent variables, 2 independent variables

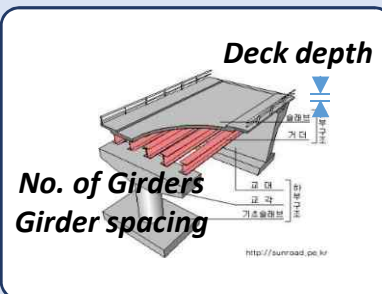


From Bridge Management System (BMS), Korea Transport Database (KTDB), and Korean Meteorological Administration (KMA)

Identification factors (22)



Structural factors (17)



Environmental factors (18)



Types of Damage (7)



Cracking



Map Cracking



Scaling



Breakage



Leakage



Efflorescence



Corrosion of exposed rebar

Inspection factors (2)

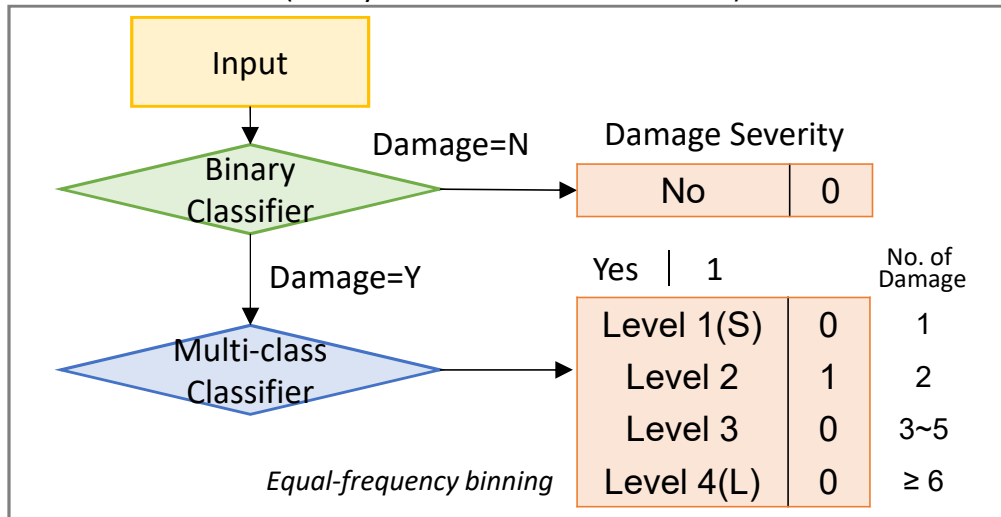
Bridge No.	Location (Span#)	Inspection Date	Construction Date	Age
000078	1	20070919	19870101	21
033054	5	20151218	19991230	16
072235	3	20131015	20101229	3

Inspection factors (2)

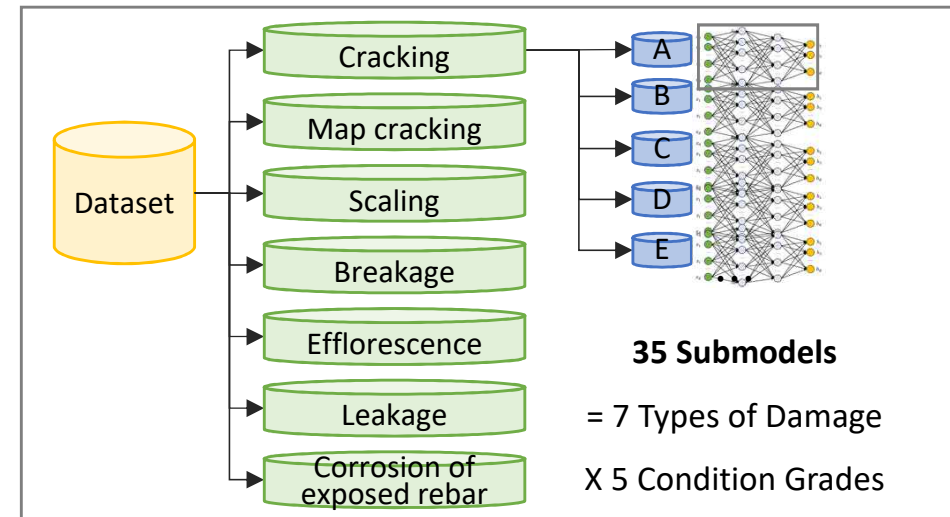
Element	Damage	Condition
Deck	Cracking	C
Deck	Corrosion	B
Deck	Breakage	B

Model Design

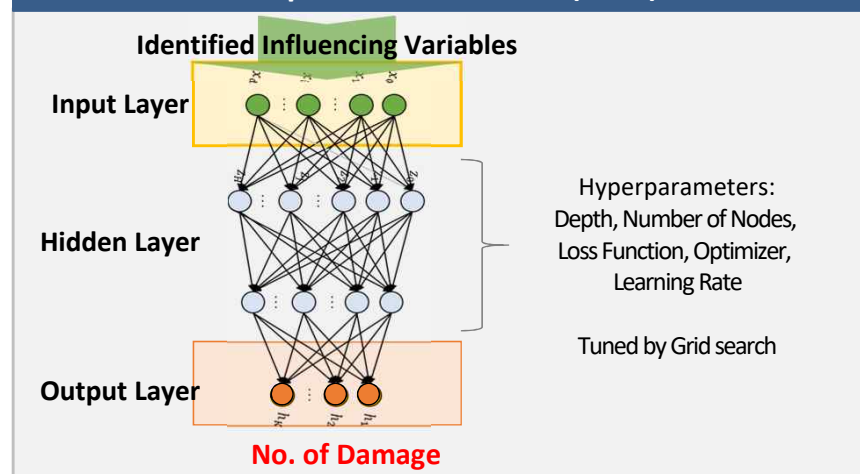
Two-Stage Submodel Design
(Binary & Multi-class Classification)



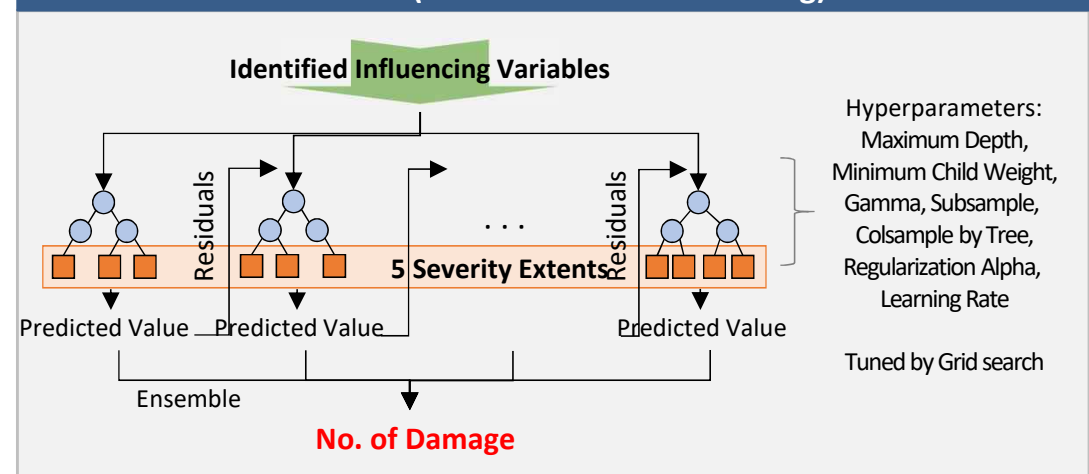
Model Composition



Deep Neural Networks (DNN)



XGBoost (Extreme Gradient Boosting)



Prediction Results Example



Damage = No

L1

Severity Level 1~4

Damage Type	Bridge No.	Inspection Date	Age	Location	Predict					Actual					Total Difference
					A	B	C	D	E	A	B	C	D	E	
Cracking	030039	2015-06-24	19	Middle Left		L4	L3				L4	L3			0
	032058	2014-08-30	15	Right					L1					L1	0
	028151	2012-07-15	9	Middle Right				L4					L3		1
	033150	2004-06-15	2	Middle Right	L2	L1				L1	L2				2
Efflorescence	001342	2015-06-09	12	Left				L4					L4		0
	028191	2016-06-21	12	Middle Right			L3					L2			1
	032005	2006-06-26	10	Right		L1									1
	002545	2007-10-23	21	Middle Left		L1	L1				L3	L2			2

Prediction Accuracy by Damage Types

Model	Cracking	Honeycombing	Scaling	Breakage	Efflorescence	Leakage	Corrosion of Exposed Rebar	Average
DNN	68.1	74.7	77.3	71.2	71.7	62.9	69.0	73.6
XGBoost	89.56	93.60	95.23	91.45	89.83	91.53	93.97	94.48%

(1) Imbalanced data: "No Damage" is predominant → XGBoost weights more for misclassified samples

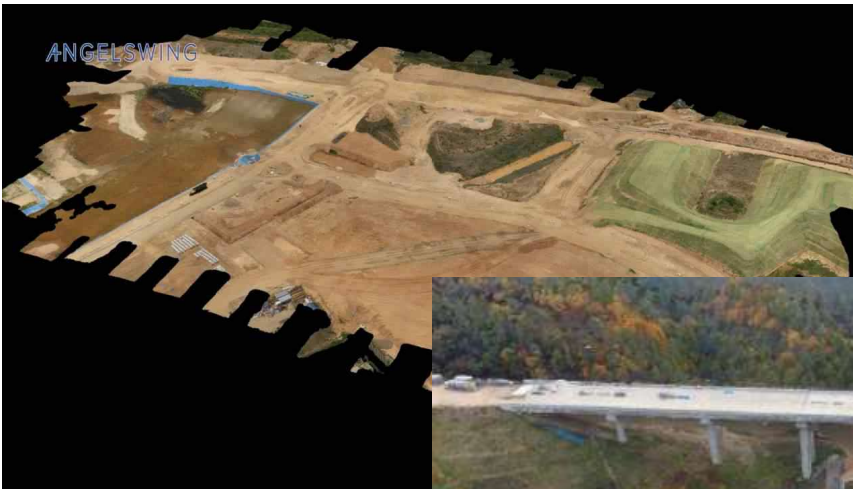
(2) Lack of enough data for every 35 submodels → Difficult to train DNN fully

Example: Portfolio Generation for Each Bridge

- Expected Inspection: 2019 2nd Half
- Bridge Number: 000495
- Region: Gangwon-Do
- Superstructure: Pre-Stressed Concrete I type
- Age: 28

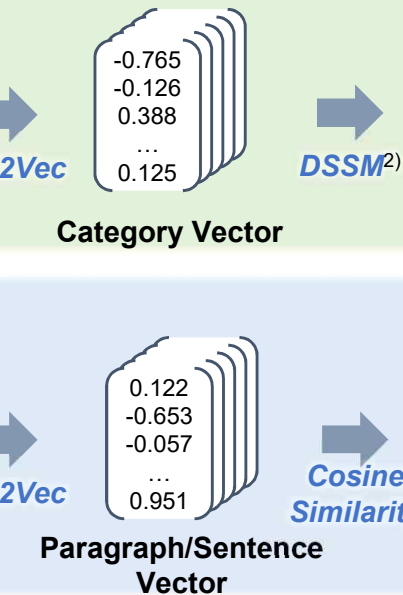
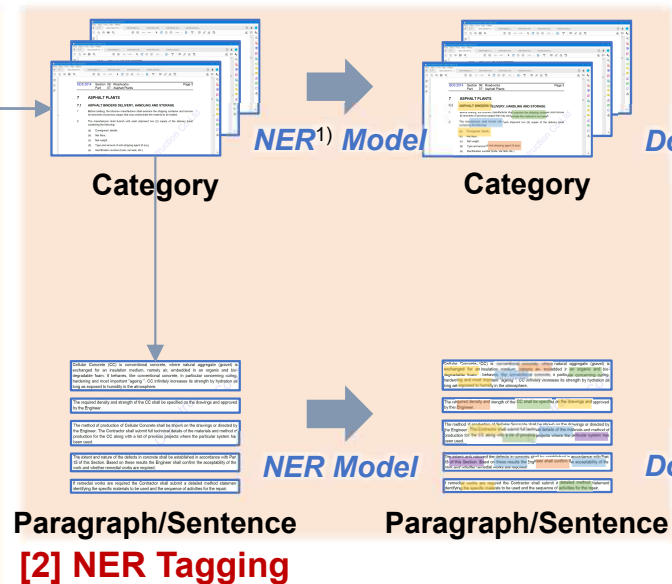
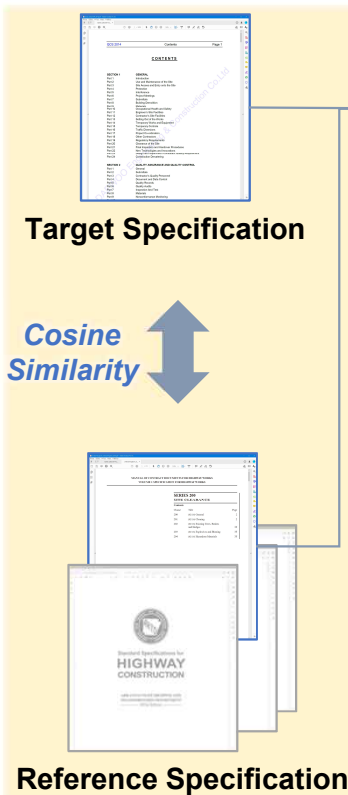
	Number of Damage	CR	Cracking
		HC	Honeycombing
		SC	Scaling
Level 1	1	BR	Breakage
Level 2	2	EF	Efflorescence
Level 3	3 – 5	LE	Leakage
Level 4	6 and more	CE	Corrosion of Exposed Rebar

Location		Left							Middle Left							Center							Middle Right							Right						
Span Number		1							2							3							4							5						
Damage Type		CR	HC	SC	BR	EF	LE	CE	CR	HC	SC	BR	EF	LE	CE	CR	HC	SC	BR	EF	LE	CE	CR	HC	SC	BR	EF	LE	CE	CR	HC	SC	BR	EF	LE	CE
Condition Grade	A		L1																																	
	B									L3			L1							L1					L1		L3	L1					L3			
	C		L1			L1															L1						L1	L1						L1		L1
	D		L2					L1												L4			L4							L1				L4		L1
	E																																			



Automatic Road Construction Specifications Review using Natural Language Processing and Text Mining

[1] Selection of Reference Specification



	...	V _{UK_1}	V _{UK_2}	V _{UK_3}	V _{UK_4}	...
...	...	...	...	...	...	...
V _{Qat_1}	...	0.48	0.83	0.17	0.85	...
V _{Qat_2}	...	0.55	0.79	0.59	0.12	...
V _{Qat_3}	...	0.15	0.48	0.69	0.38	...
V _{Qat_4}	...	0.84	0.44	0.54	0.17	...
V _{Qat_5}	...	0.37	0.64	0.88	0.50	...
...	...	...	...	...	...	...

Most Relevant Category

	...	V _{UK_1_1}	V _{UK_1_2}	V _{UK_1_3}	V _{UK_1_4}	...
...	...	...	...	...	...	...
V _{Qat_4_1}	...	0.50	0.16	0.15	0.13	...
V _{Qat_4_2}	...	0.65	0.88	0.14	0.52	...
V _{Qat_4_3}	...	0.36	0.84	0.32	0.20	...
V _{Qat_4_4}	...	0.12	0.35	0.56	0.95	...
V _{Qat_4_5}	...	0.30	0.34	0.77	0.13	...
...	...	...	...	...	...	...

Most Relevant Paragraph/Sentence

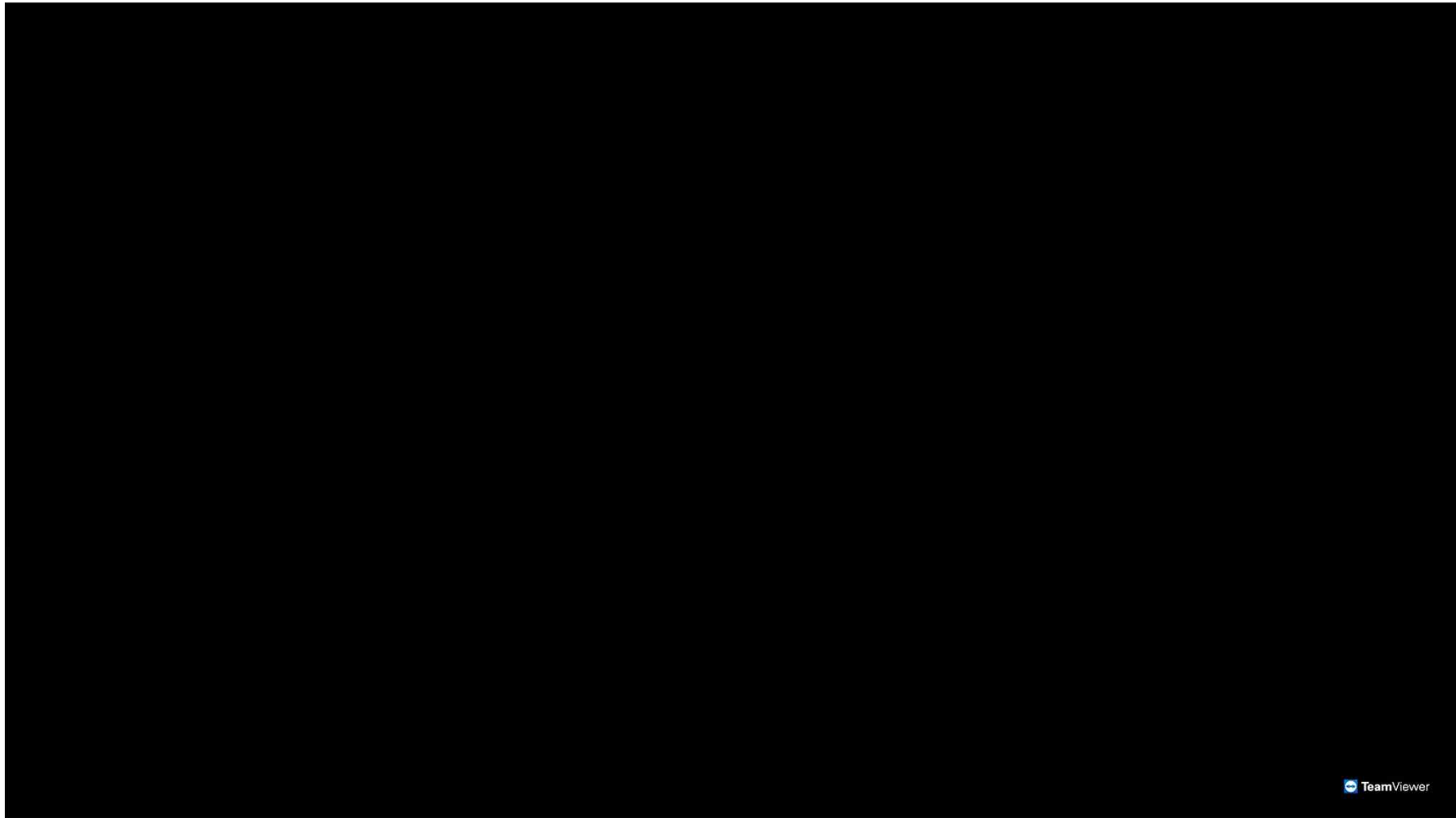
[4] Paragraph/Sentence Matching

Specification Review Results

		ORG	ACT	ELM	STD	REF
Qatar 06_Roadworks 05_Ashphalt Works 5.2.3_materials (coarse aggregate)	1		retained	Coarse aggregate / mineral aggregate / sieve / Marshall mix design	2.36 mm / 4.75 mm	ASTM
	2		shall consist	Coarse aggregate / crushed natural stones / gravel		
	...			...		
United Kingdom 09_Road Pavements 9.1_Bituminous Pavement Mixtures	1		retained	Coarse aggregate / mineral aggregate / sieve / Marshall mix design	4.78 mm / 2.21 mm	ASTM
	2		must consist	Fine aggregate / crushed natural stones / gravel		
	...			...		

1) Named Entity Recognition
2) Deep Structured Semantic Model

■ Application Example



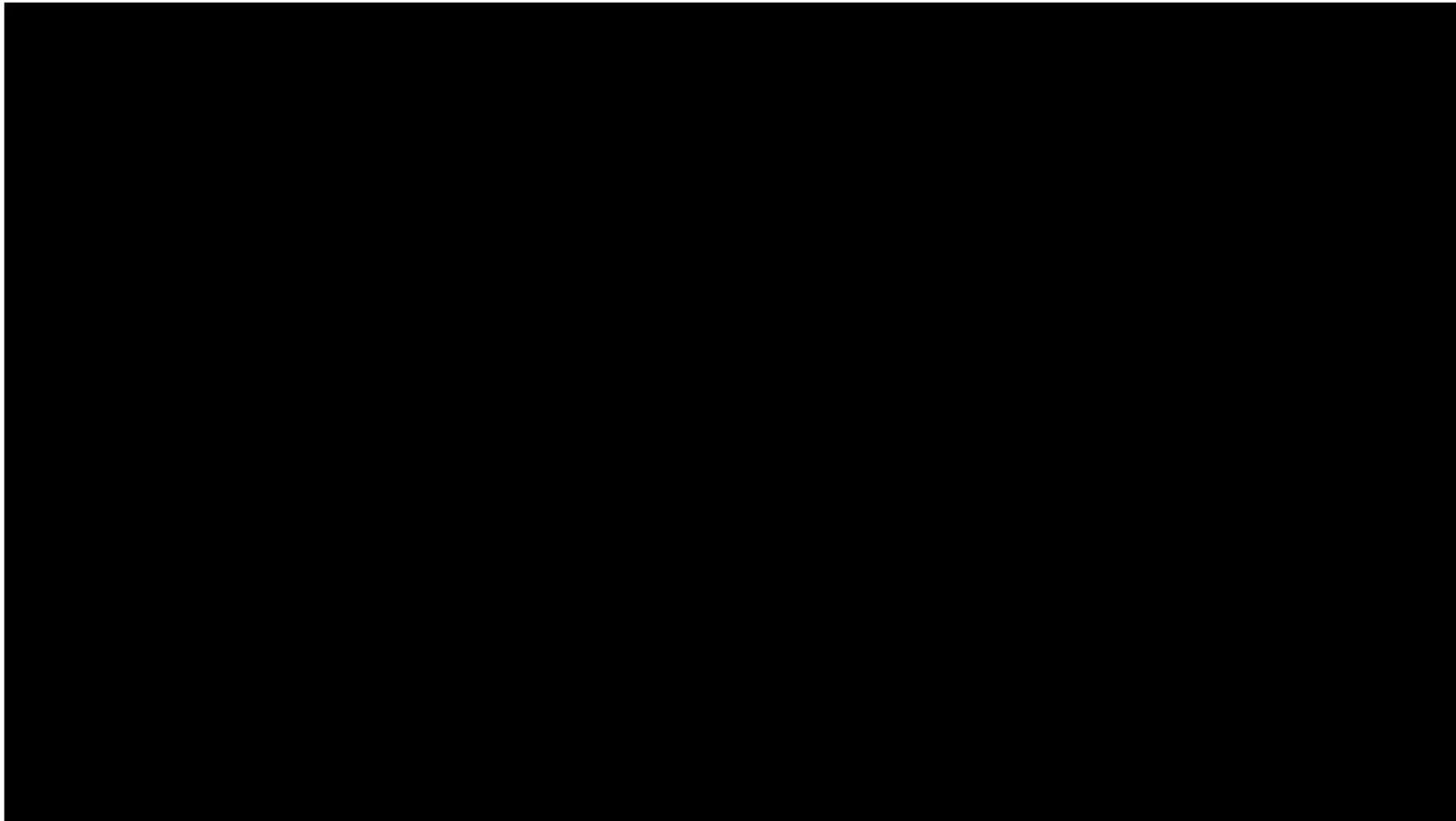
♦ Six must-have construction tech tools (2016)

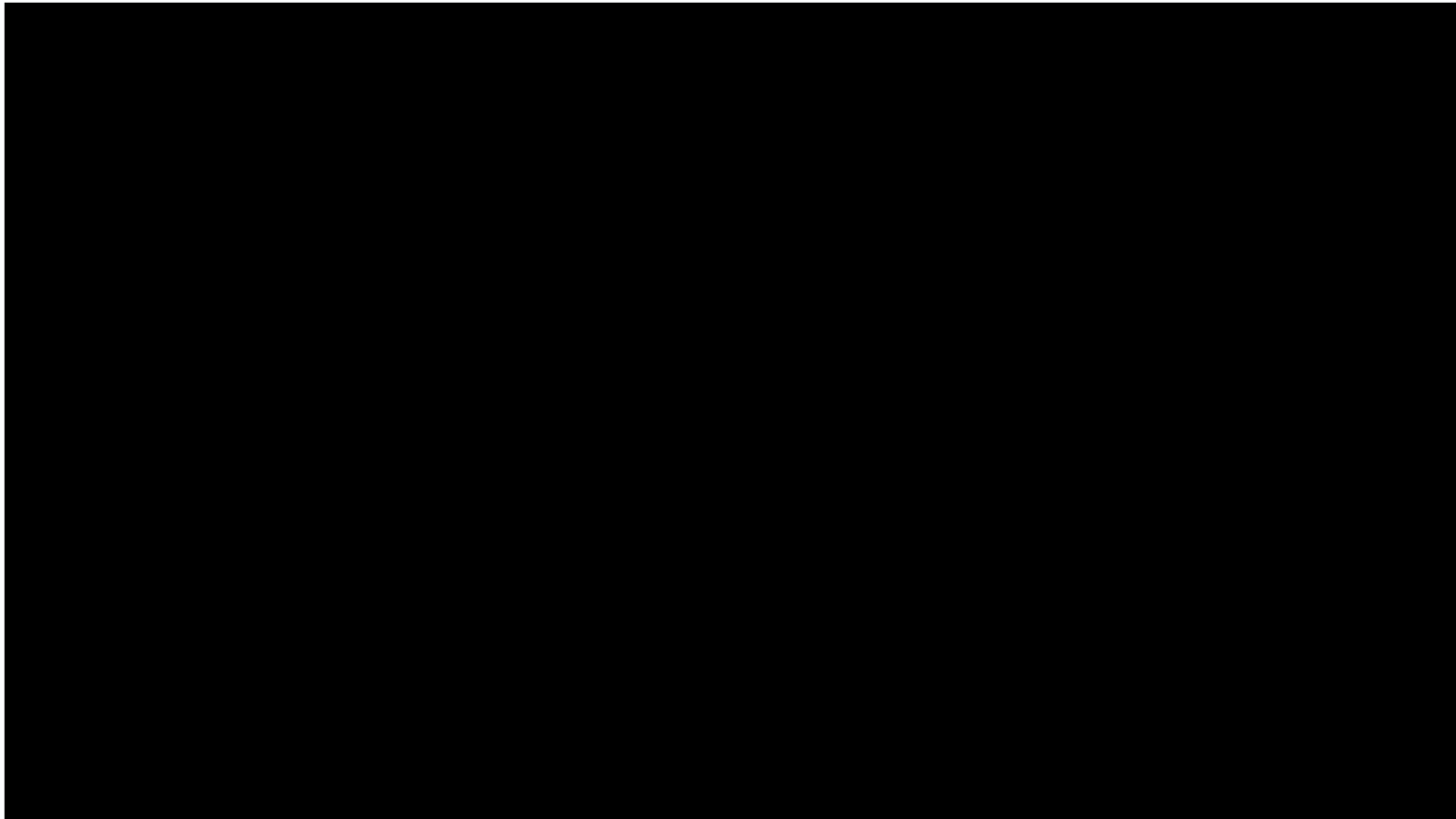
- Drone surveying
- 3D Printing
- Smart Roads
- Transparent Solar Panels
- Smart Helmet
- Anti-collision Software

◆ Six must-have construction tech tools (2016)

- ~~○ Drone surveying~~
- ~~○ 3D Printing~~
- Smart Roads
- Transparent Solar Panels
- Smart Helmet
- ~~○ Anti-collision Software~~







출처: Autodesk, 2016

