Service Intelligence Week 9.

[Learning Operations Data for Industrial & Business Process Management]

Chiehyeon Lim

2022. 10. 24

Expected Schedule after the Midterm

- Week 9
  - 10/24 Mon: Industrial & Business Service Intelligence + Term Project Announcement
  - 10/26 Wed: Practice for Industrial Service Intelligence + Related Special Lecture
- Week 10
  - 10/31 Mon: Metaheuristics for Service Optimization & Data Envelopment Analysis (DEA) for Service Improvement
  - 11/2 Wed: Practices for Genetic Algorithm Development and DEA
- Week 11
  - 11/7 Mon: Term Project Proposals I
  - 11/9 Wed: Term Project Proposals II

Today's Topic in the Framework of This Course

consumer behaviors (user behaviors)

service delivery and experience

quality

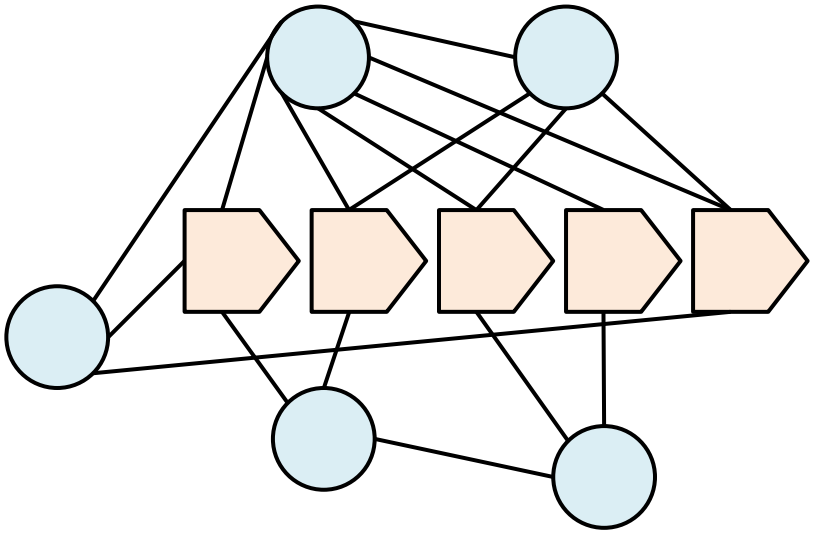
value cocreation

technology and self-service

relationship

innovation

design and development



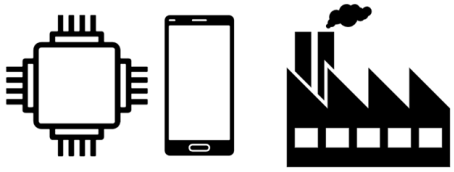
productivity

knowledge and employee management

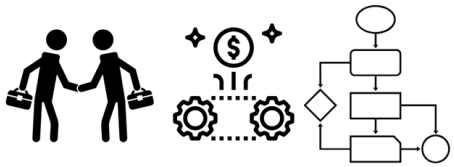
cost and pricing

service operations and supply chain management

Process Management (Services) in Industry and Society



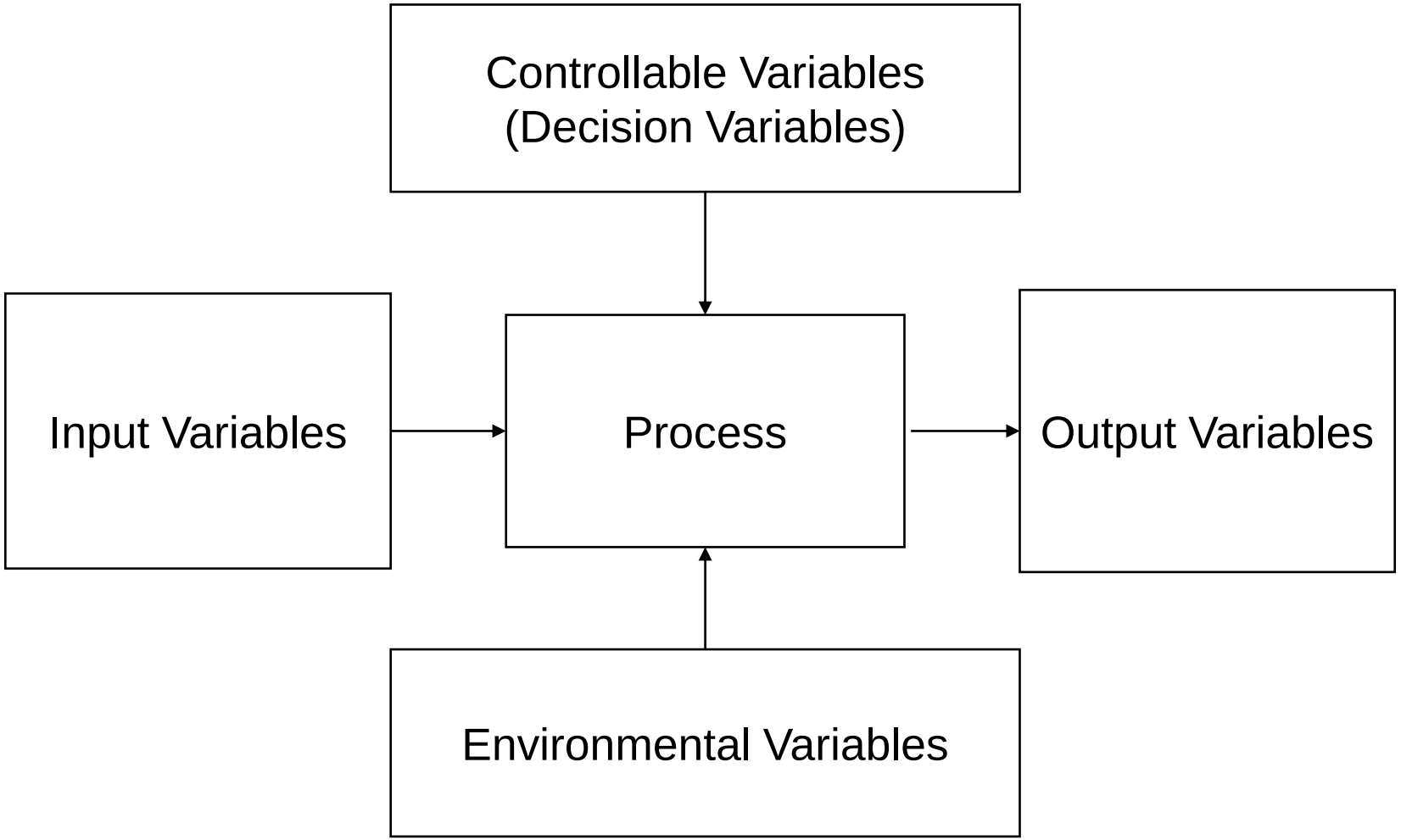
Industrial Process Management
(Manufacturing Process Management)



Business Process Management

Personal Process Management

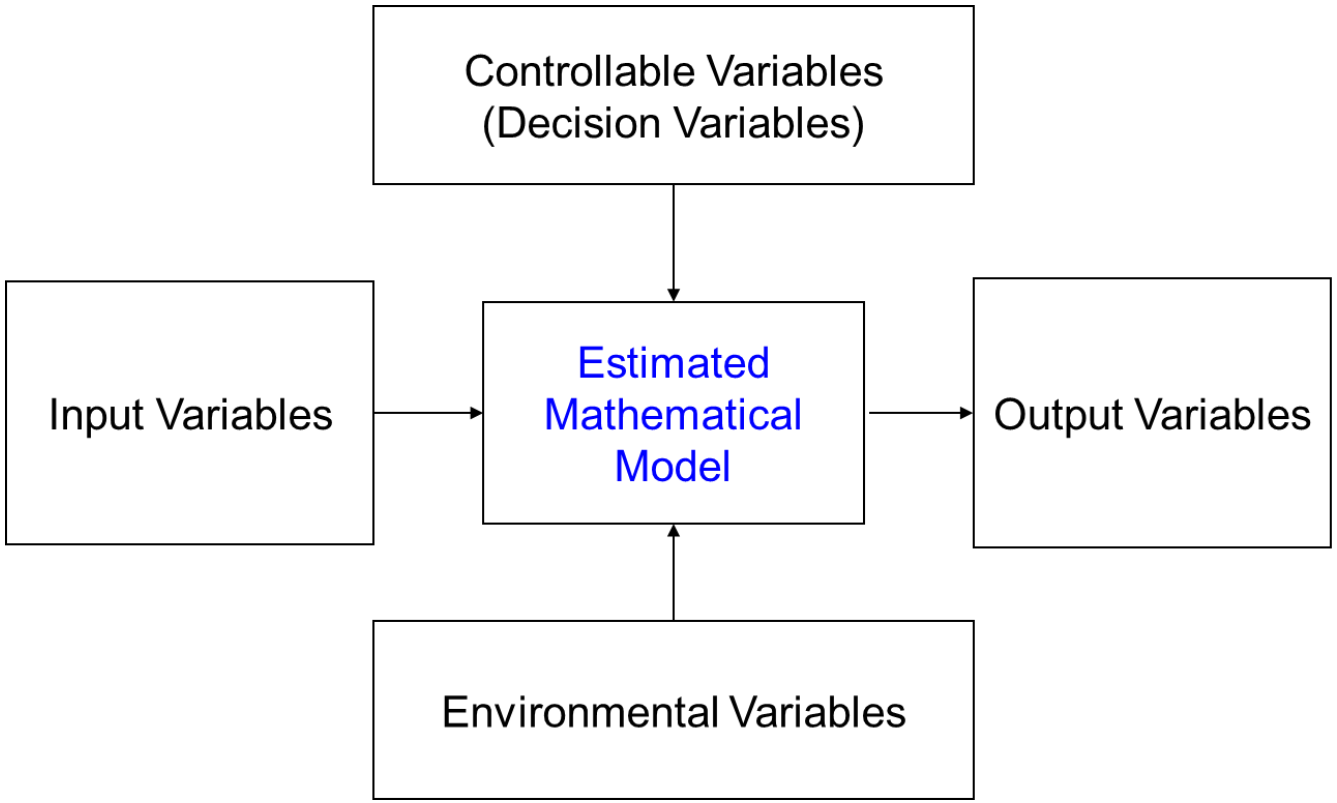
Conceptual Framework of Process Management



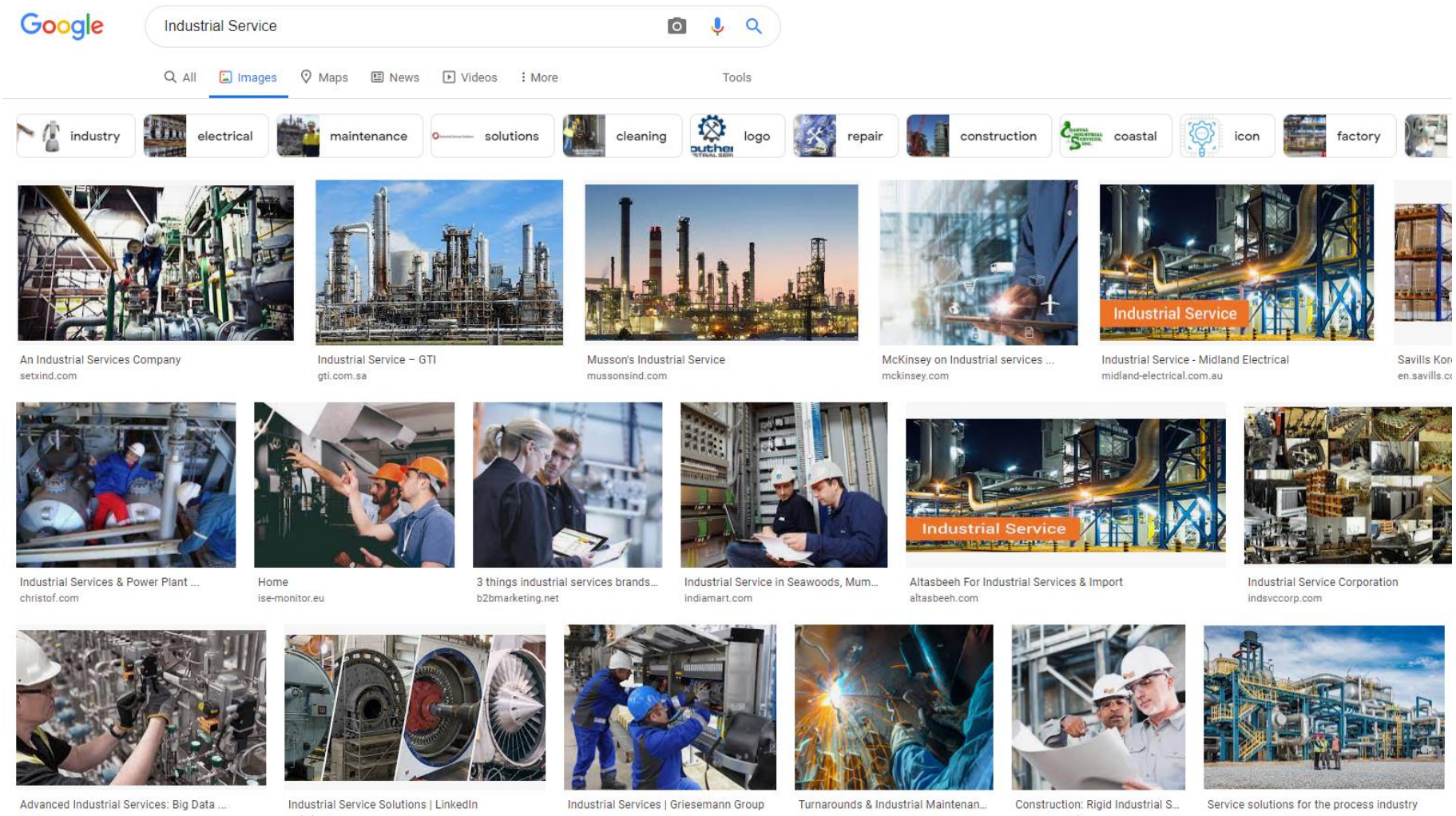
Conceptual Framework of Data-driven Process Management

"Model building" "Search optimal setting for **x**"

$$y = f(\mathbf{x}, \boldsymbol{\theta}) + \varepsilon \quad \rightarrow \quad \hat{y}(\mathbf{x}) \quad \rightarrow \quad \underset{\mathbf{x} \in \Omega}{\text{optimize}} \ \hat{y}(\mathbf{x})$$

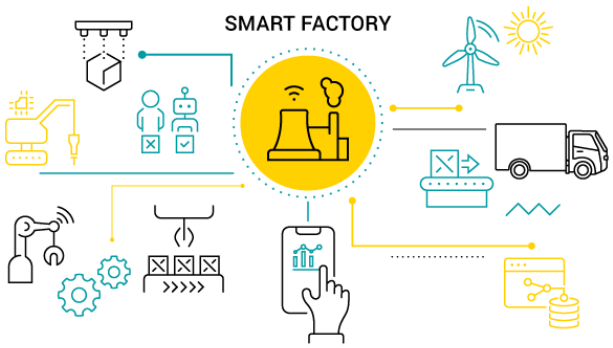


Industrial “B2B” Services

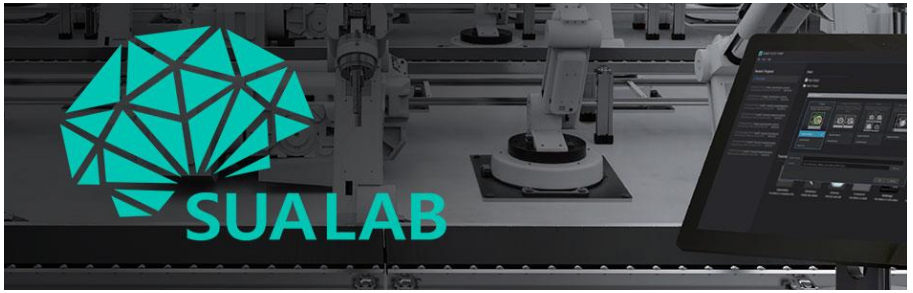


Some of the Representative Industrial Services

- SAP, SAS, SUALAB, SKT…
  - Smart factory service solutions

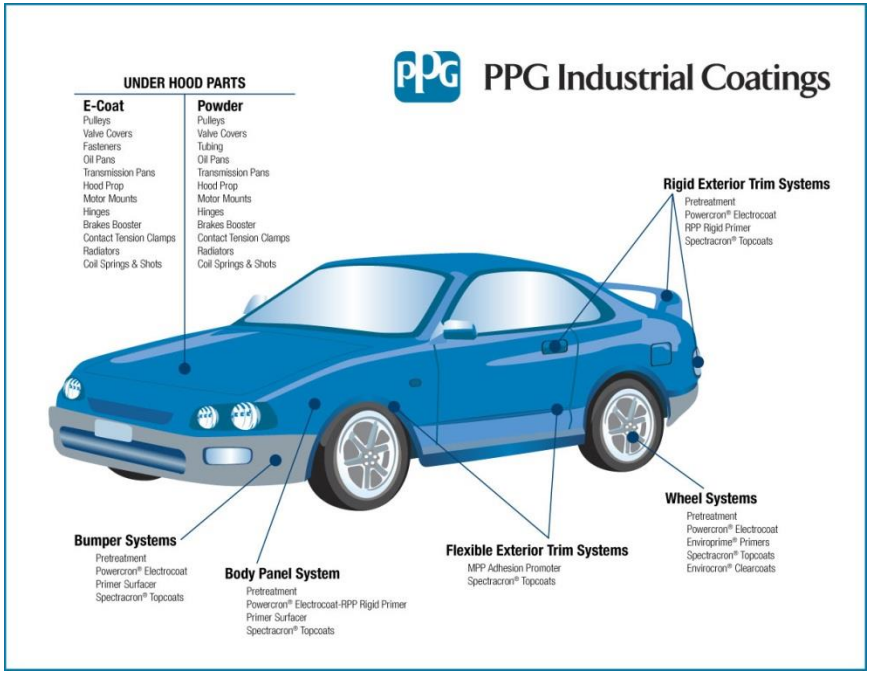


PLATAINE®
people-smart automation



Some of the Representative Industrial Services

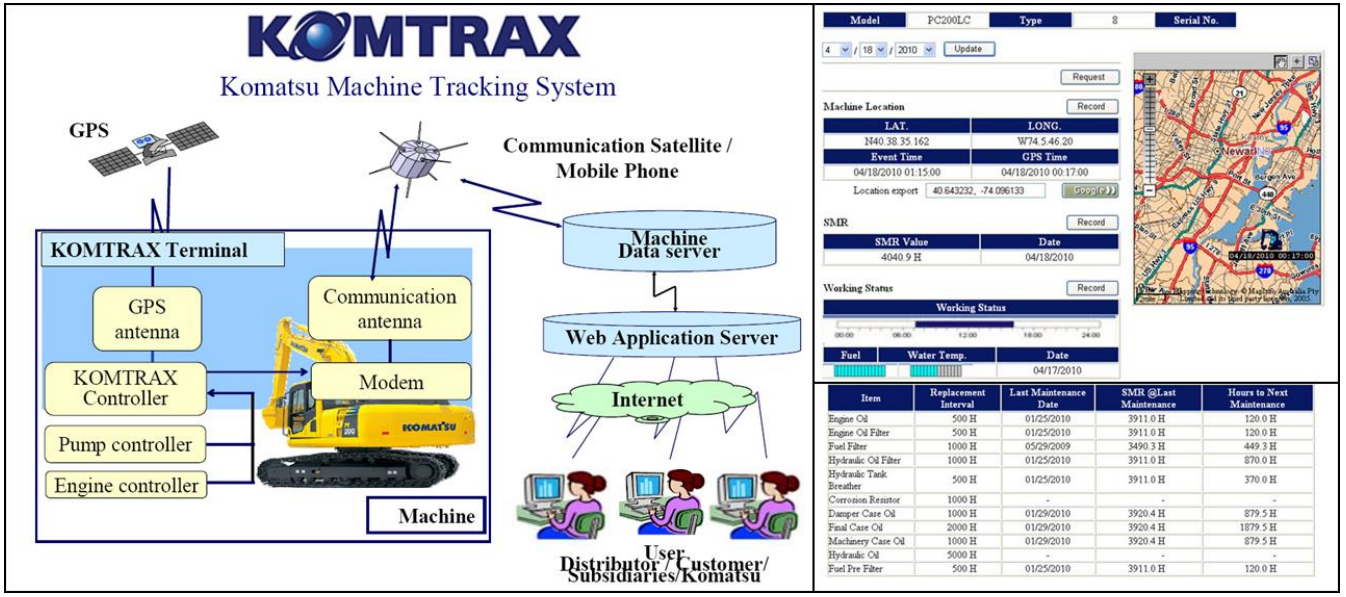
- PPG
  - Providing painting solution, instead of selling paint itself
  - Pay per car painted



Source : http://corporateportal.ppg.com

Some of the Representative Industrial Services

- Komatsu KOMTRAX: PHM (Prognostic Health Management)
  - Monitoring the health of equipment
  - Benefits
    - Efficient diagnosis of equipment health and preventive problem solving
    - Maximize the availability of equipment



Some of the Representative Industrial Services

- Aircraft Engine of Rolls-Royce: “Power by the Hour”

Key financial data	2008	2007	2006	2005	2004
Underlying revenue £m	**4,502** +11%	4,038 +3%	3,907 +15%	3,406 +11%	3,072 +13%
Underlying profit before financing £m	**566** +0%	564 +8%	523 +19%	441 +112%	208 +24%
Net assets £m	**246**	2,260	1,889	1,315	1,357
Other key performance indicators					
Order book £bn	**43.5** +21%	35.9 +80%	20.0 +5%	19.0 +17%	16.2 +13%
Engine deliveries	**987**	851	856	881	824
Underlying services revenues £m	**2,726**	2,554	2,310	2,016	1,838
Underlying services revenues %	**61**	63	59	59	60
% of fleet under management	**57**	55	48	45	45

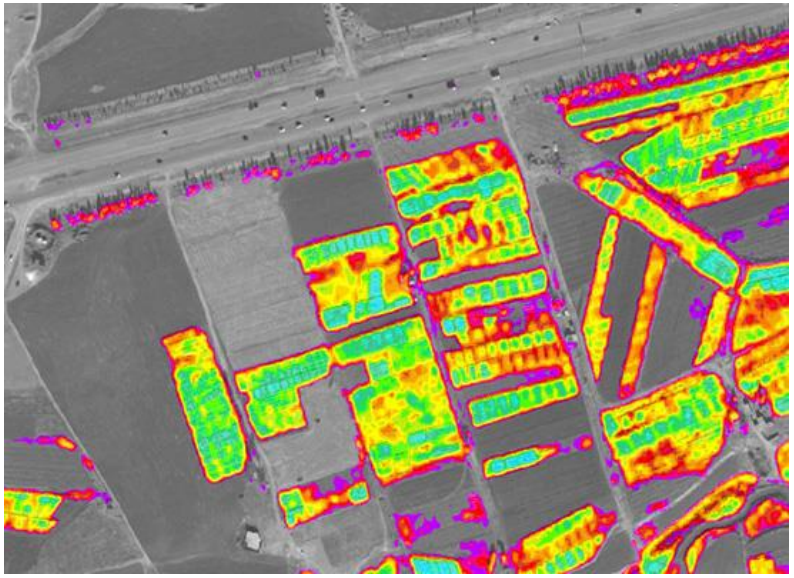
Underlying revenue
£4.5bn

Market opportunity over 20 years
US$1,250bn

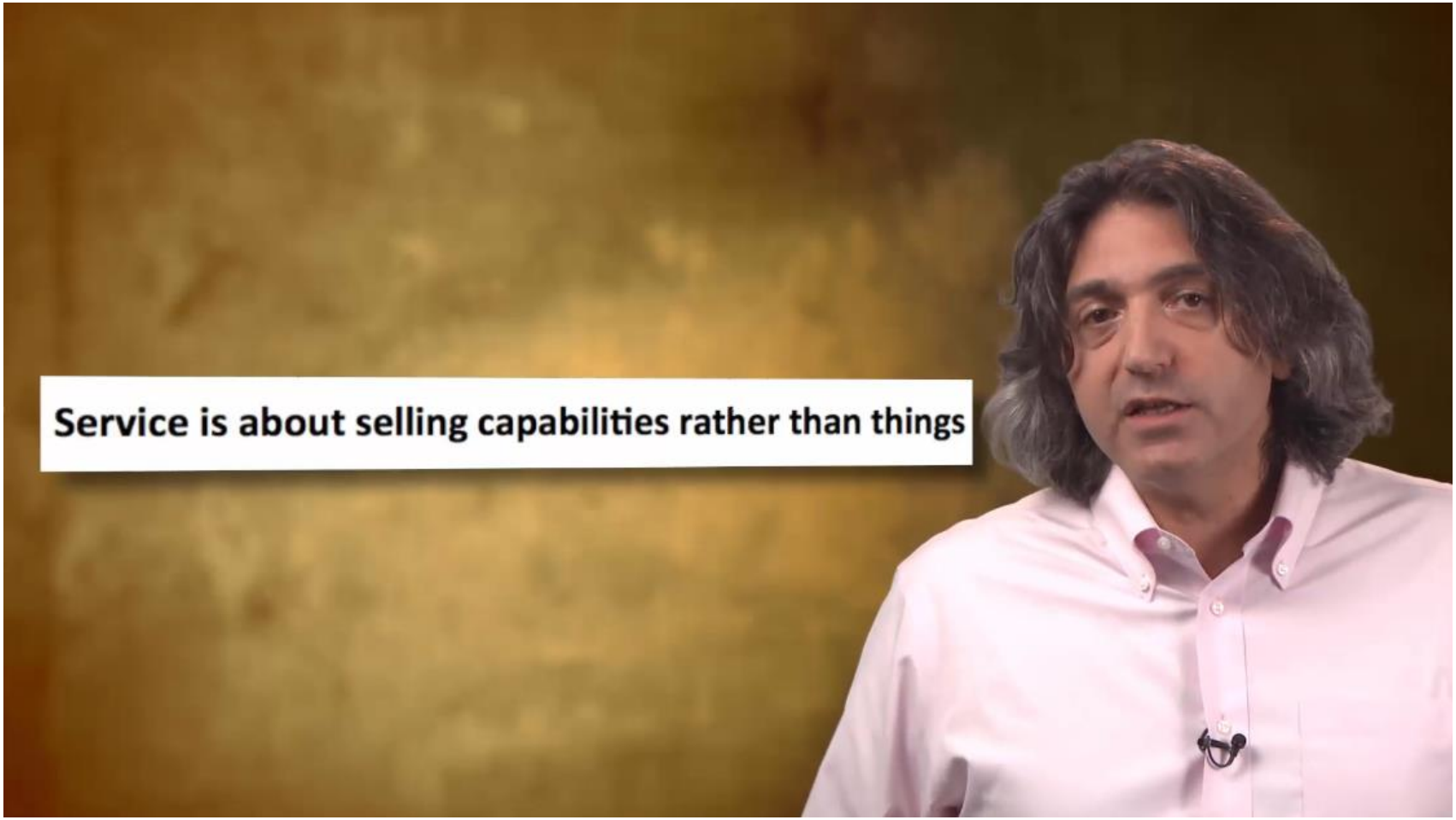
“Power by the hour”: Diagnosing and maintaining engines periodically, and being paid per service hour

Some of the Representative Industrial Services

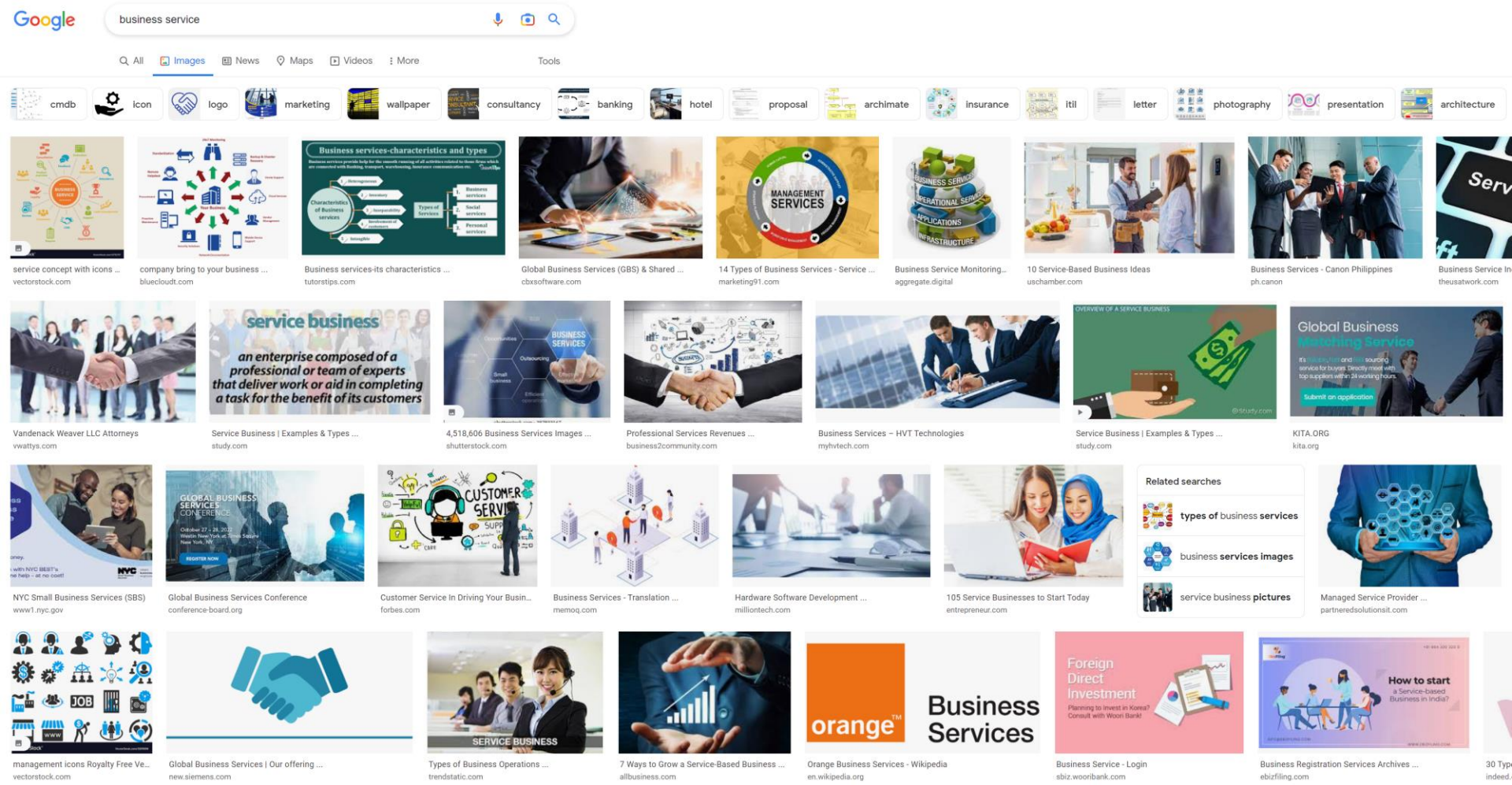
- John Deere
  - Cultivator + (Location-based) manuring service



Service is Simply to Serve Customers: Help Tasks or to Do the Tasks



Other “B2B” Services in General



Some of the Representative Business Services

- Xerox
  - Xerox Advisor Service = Copiers/Printers + Document management solution
  - Pay per copy

Document Advisor Services
Offering Brief

Xerox Document Advisors leverage the value of the document as a key communications tool.

Optimize client responsiveness, process control and cost-efficiency of document-related communications.

"We take a strategic approach to documents so your company can take full advantage of the latest technologies and techniques for reducing costs, driving improved response rates and building customer loyalty."

John Oppy
General Manager
Document Advisor Program Office
Xerox Global Services

Cost reduction is just the beginning.

With document spend typically accounting for 5–15 percent of the revenue of an organization, it constitutes a significant opportunity to realize savings. More importantly, effective document management and maintenance of brand integrity can impact customer loyalty and profits.

Unfortunately, document ownership and spend are often fragmented between multiple lines of business and operational units, with document owners using different suppliers and different processes to produce similar documents. Absence of a well-managed document strategy creates a lack of visibility of end-to-end costs, loss of brand control and excessive, obsolete stock.

THE RIGHT SOLUTION
FOR *YOUR* CHALLENGE

Challenge: Creating customer-relevant communications

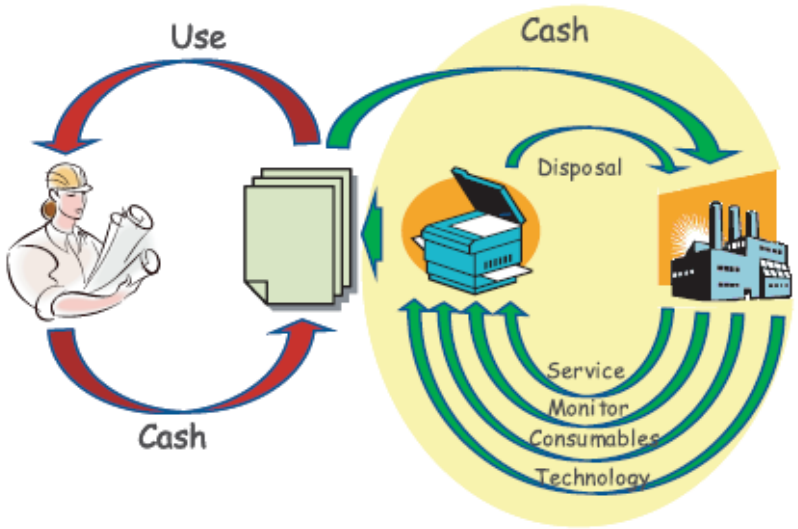
Using the latest in design and behavioral science, Advisors help implement both paper and digital communications that work to dramatically improve mission-critical document effectiveness.

Challenge: Moving an internal print-shop to digital

By remaining current on the latest production and publishing trends and processes, Advisors work with on-site Xerox professionals to develop and implement efficient and less-costly digital document solutions.

Challenge: End-to-end management of all documents

Whether printed internally, externally or posted electronically, Advisors help achieve cost savings through effective use of technology and appropriate conversion of applications to digital.

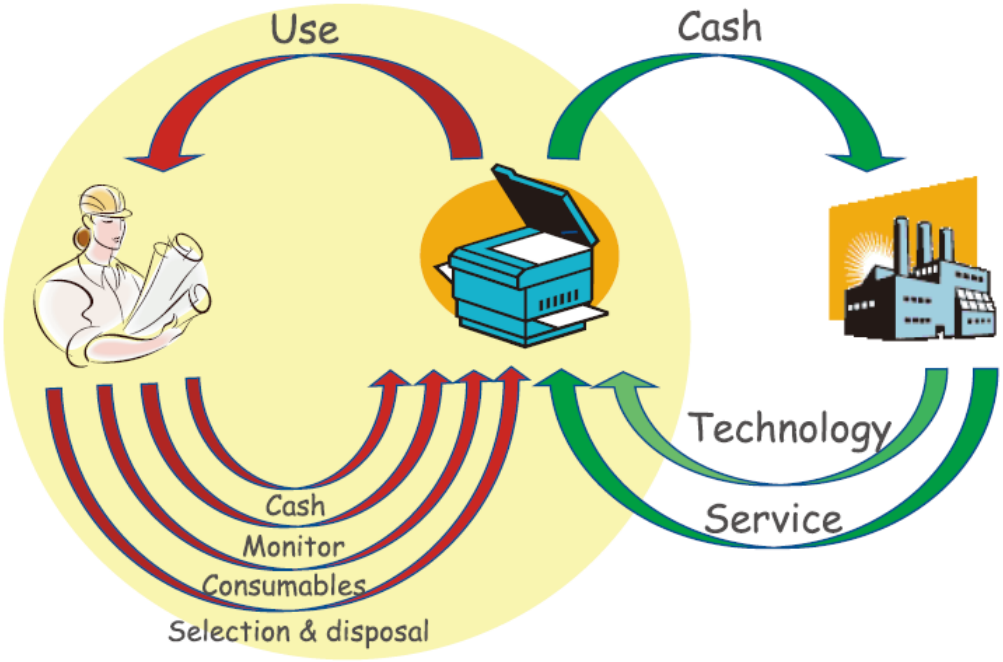


Document Management Solution: Tasks to be Supported

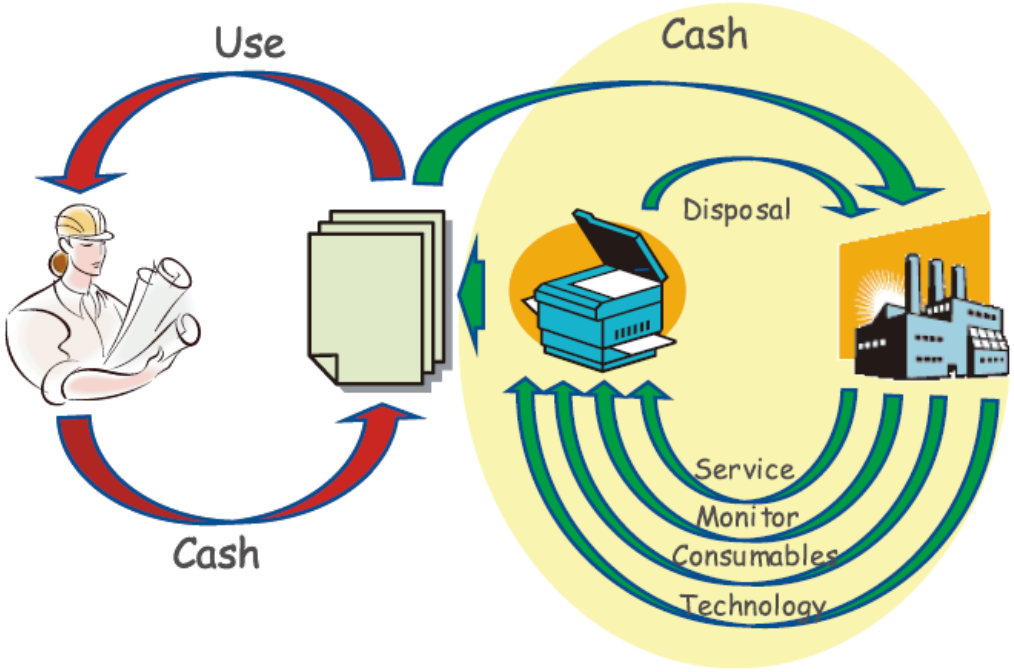
"Minimize the cost and environmental impacts"

"Minimize annoying tasks"

"Increase the availability of the machines"



Document Management Solution: Tasks to be Supported



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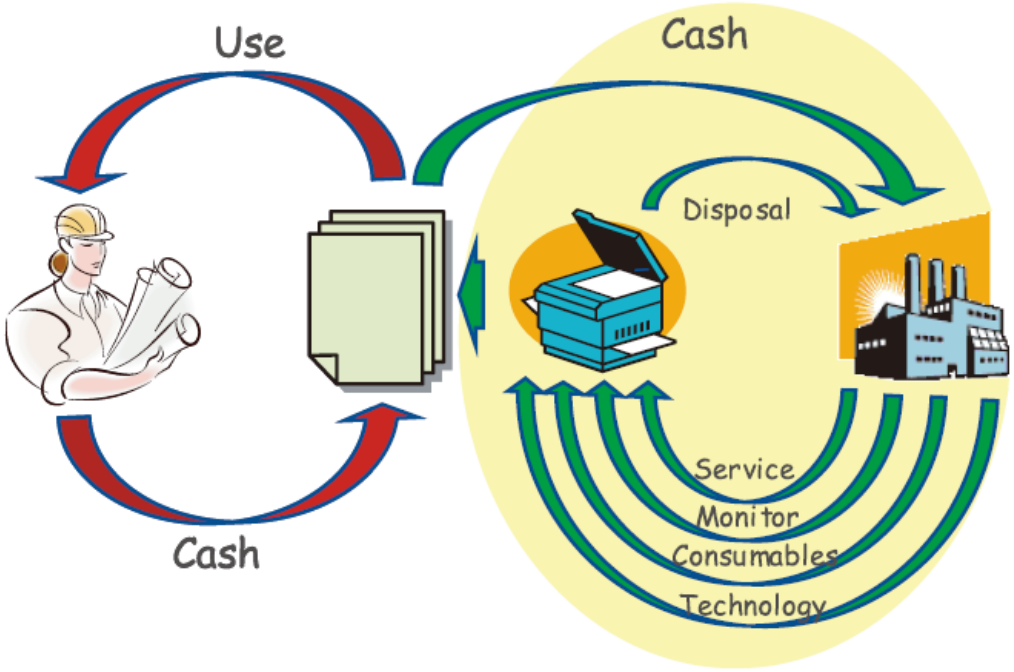
Document Management Solution: Tasks to be Supported

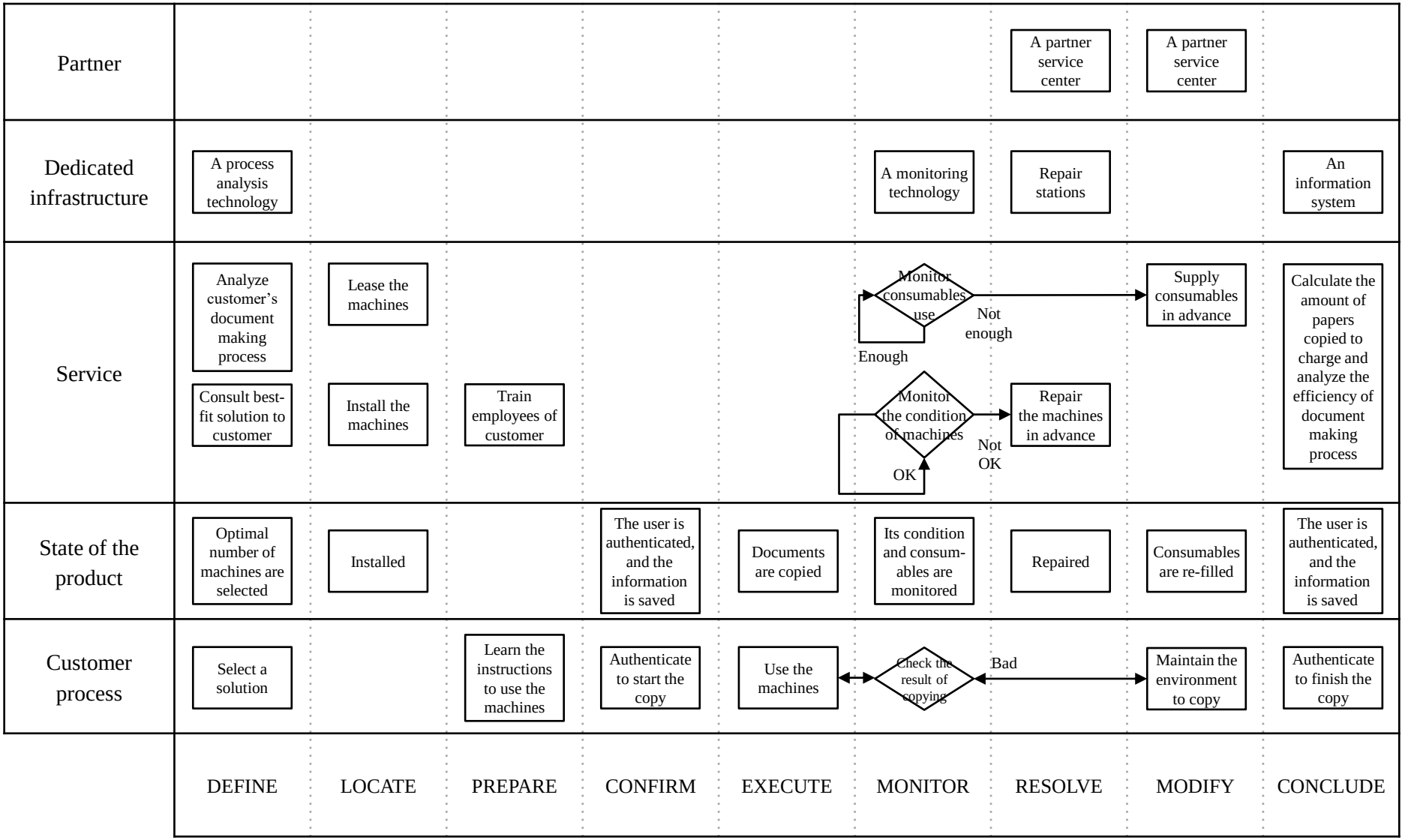


"Lease out optimal number of the machines"

"Remotely monitor the machines and consumables use"

"Maintain the machines and consumables in advance"

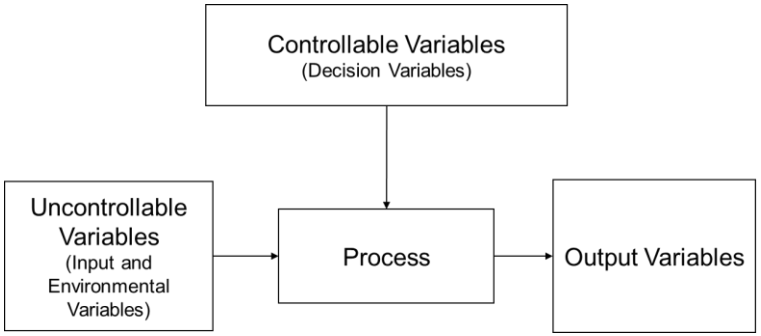
Document Management Solution: Tasks to be Supported



How to Develop Industrial & Business Services?

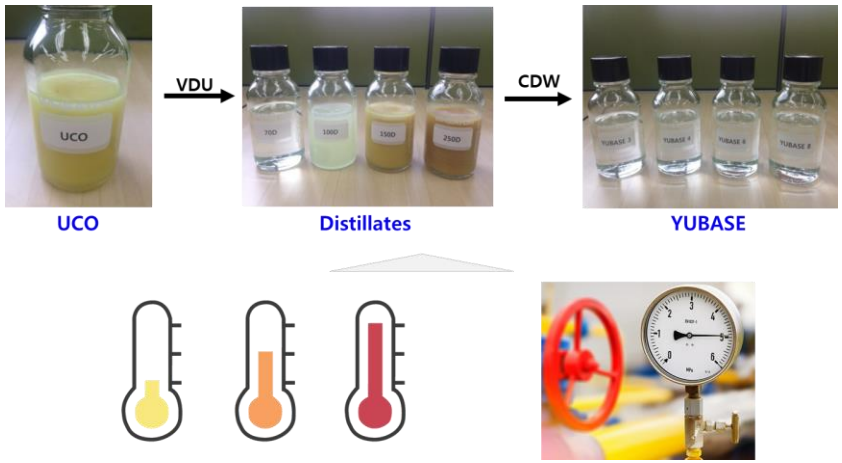
- Key success factors of industrial services (Reinartz and Ulaga, 2008)
  - Focus on customers' processes regarding the industrial operations and machines
  - Build on existing capabilities and strengths regarding the industrial operations and machines
  - Standardize the back office service processes

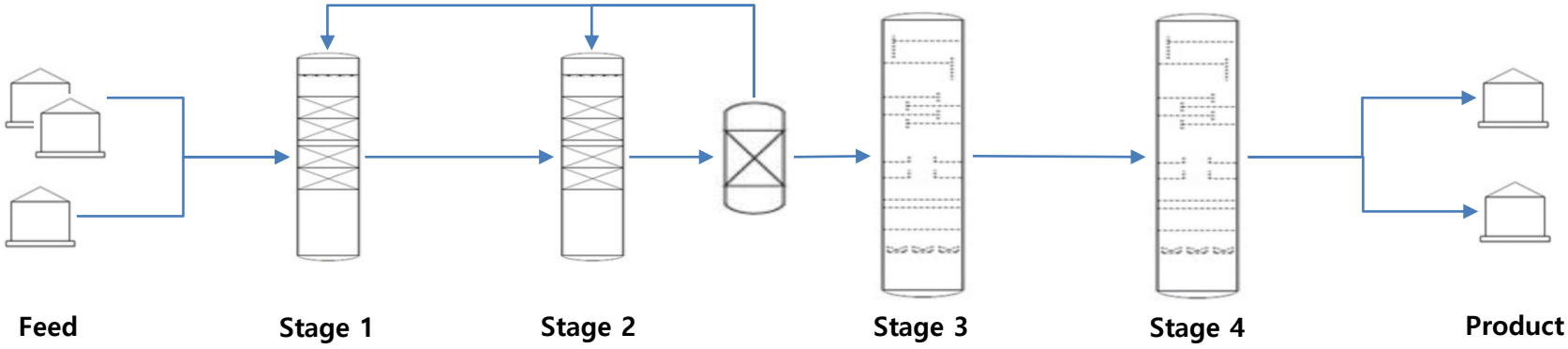
- Key success factors of industrial & business service intelligence
  - Focus on data on customers' processes
  - Build on a knowledge-base on existing capabilities
  - Standardize the back office intelligence service



Examples of Industrial Process Management with Service Intelligence

Difficulty of “Professional” Tasks of Manufacturing





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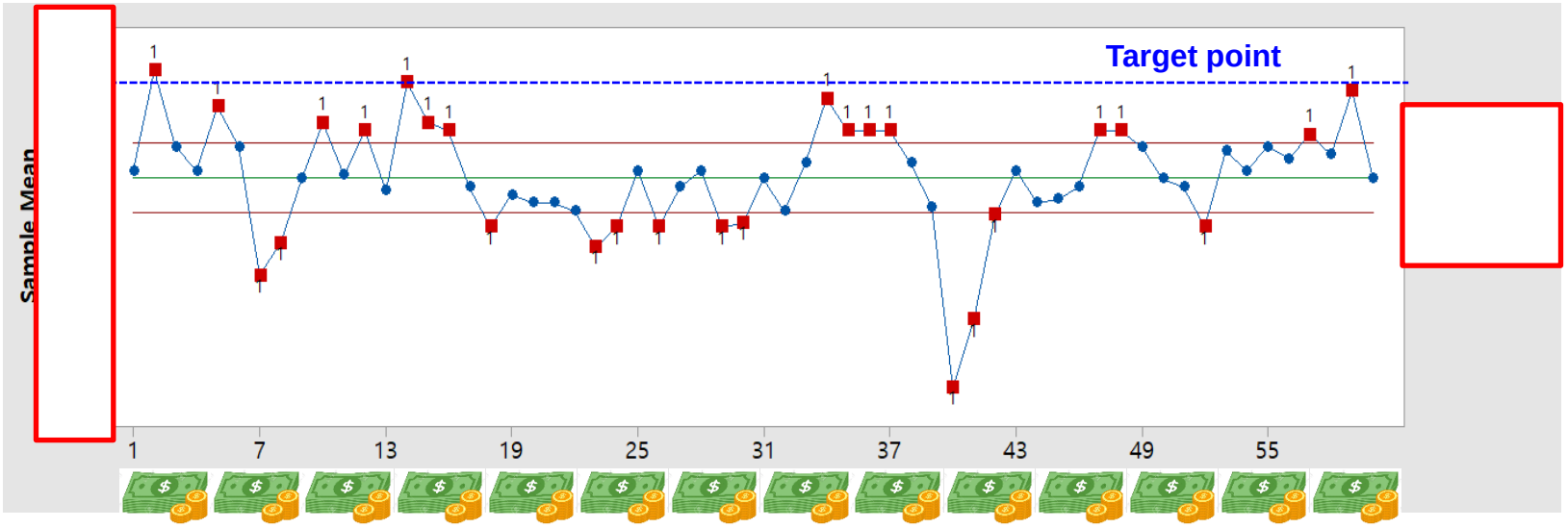
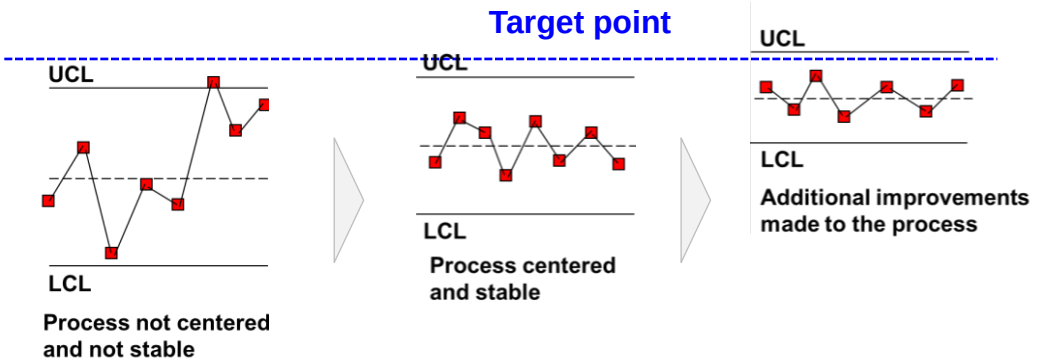
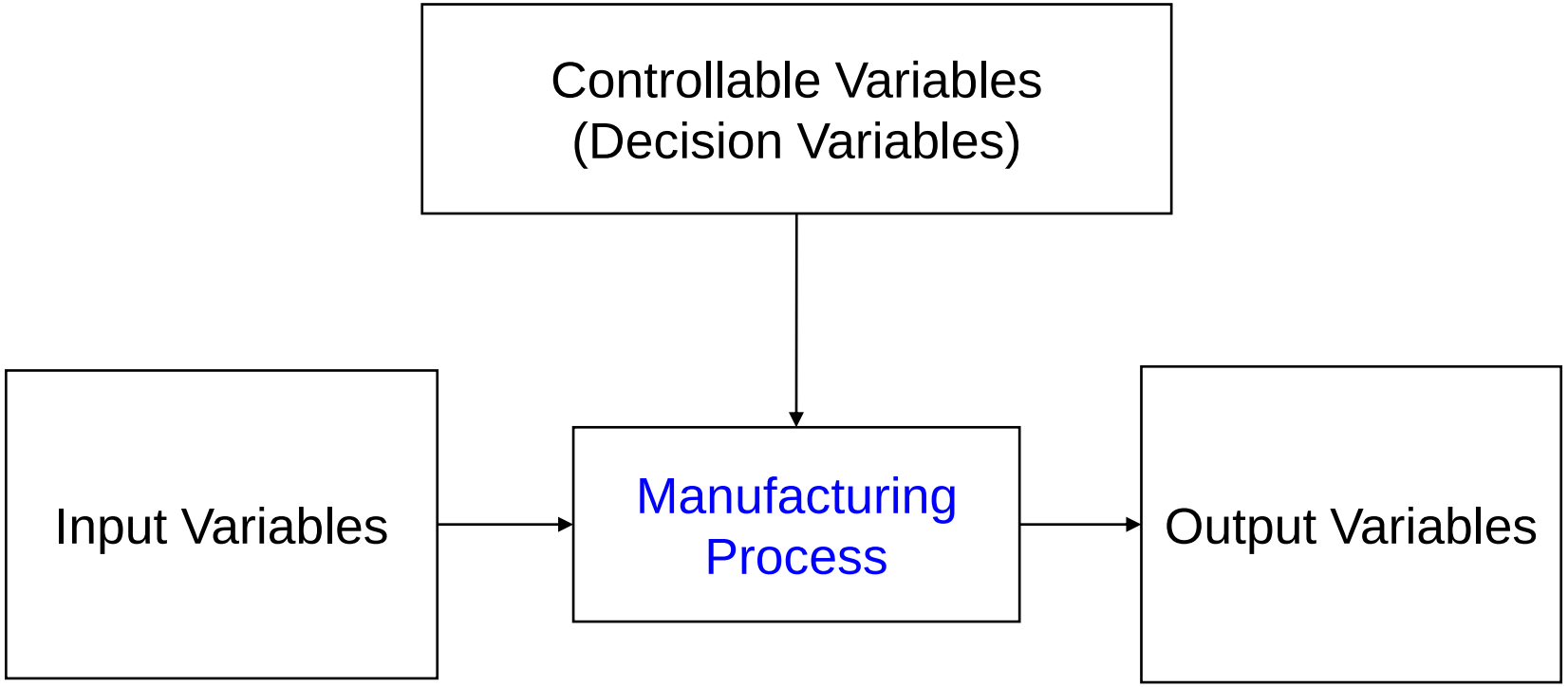
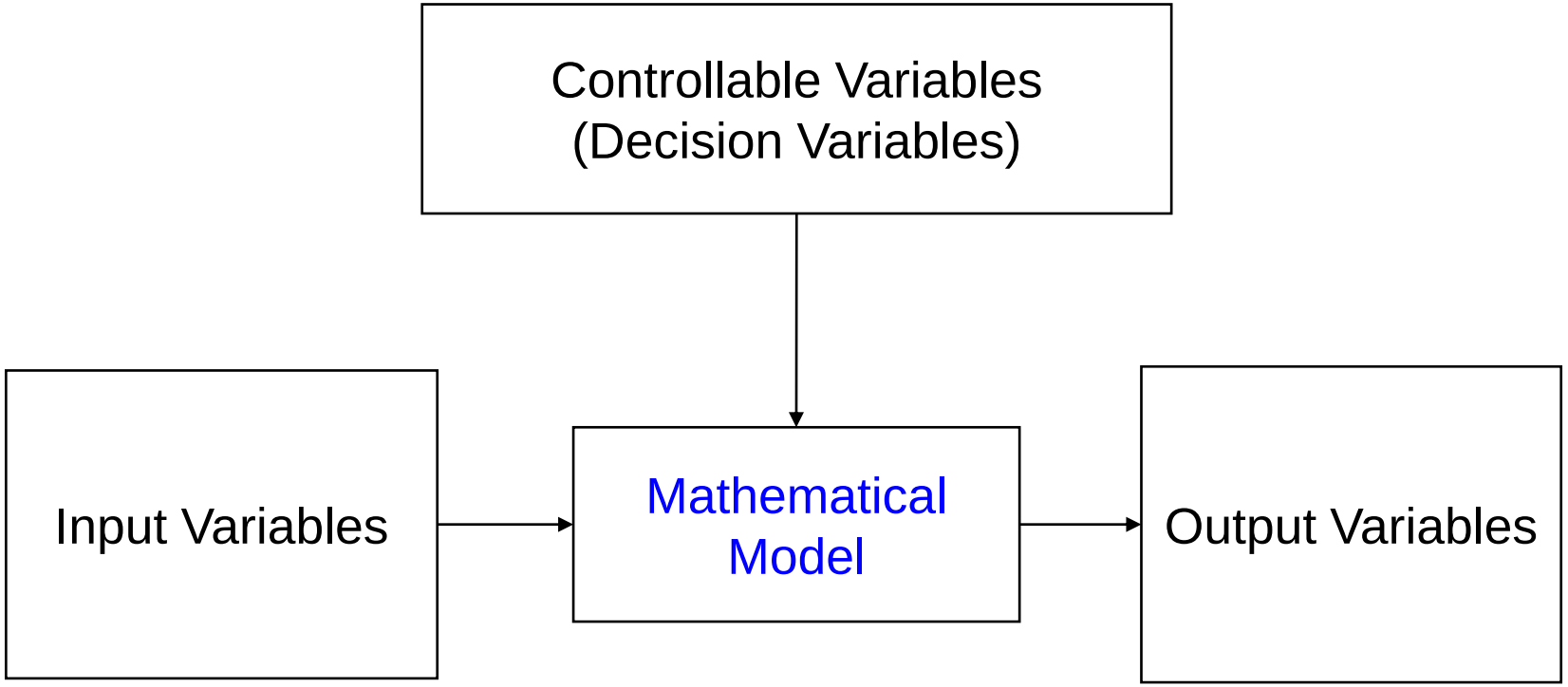




Manufacturing Process Management with Service Intelligence



Manufacturing Process Management with Service Intelligence



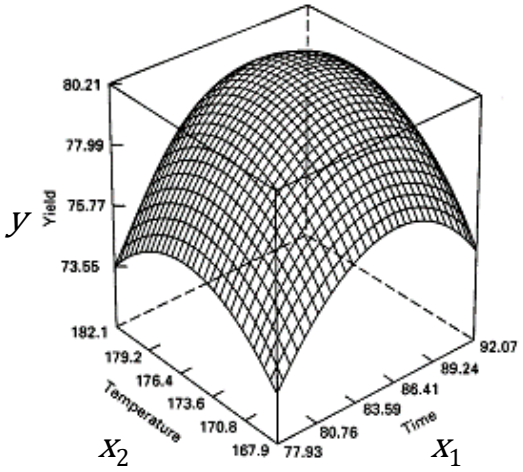
Manufacturing Process Management with Service Intelligence

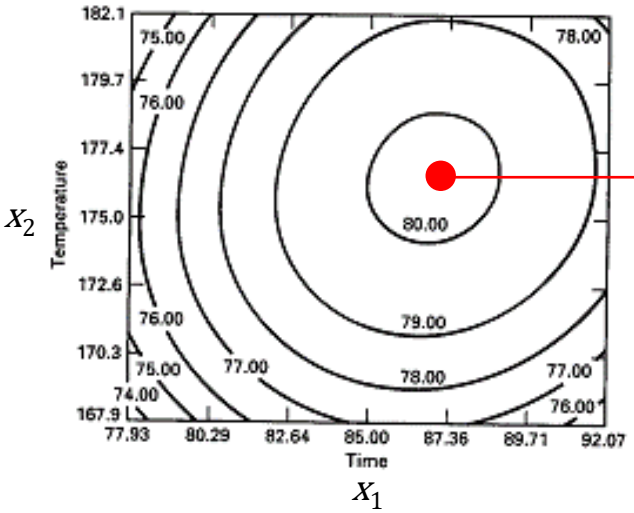
"Model building" "Search optimal setting for **x**"

$$y = f(\mathbf{x}, \boldsymbol{\theta}) + \varepsilon \quad \rightarrow \quad \hat{y}(\mathbf{x}) \quad \rightarrow \quad \underset{\mathbf{x} \in \Omega}{\text{optimize}} \ \hat{y}(\mathbf{x})$$

Example*

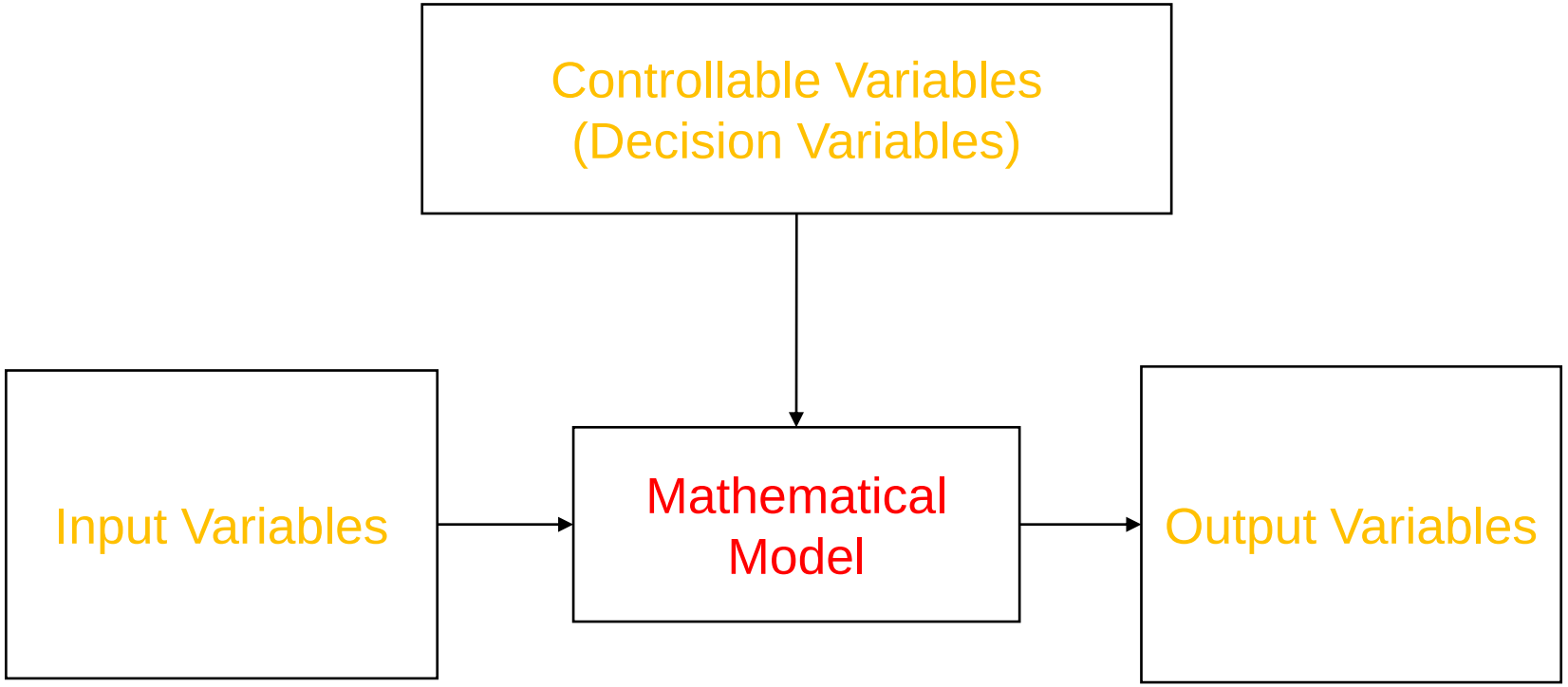
y = process yield (Larger the better),
x_1 = reaction time, x_2 = reaction temperature



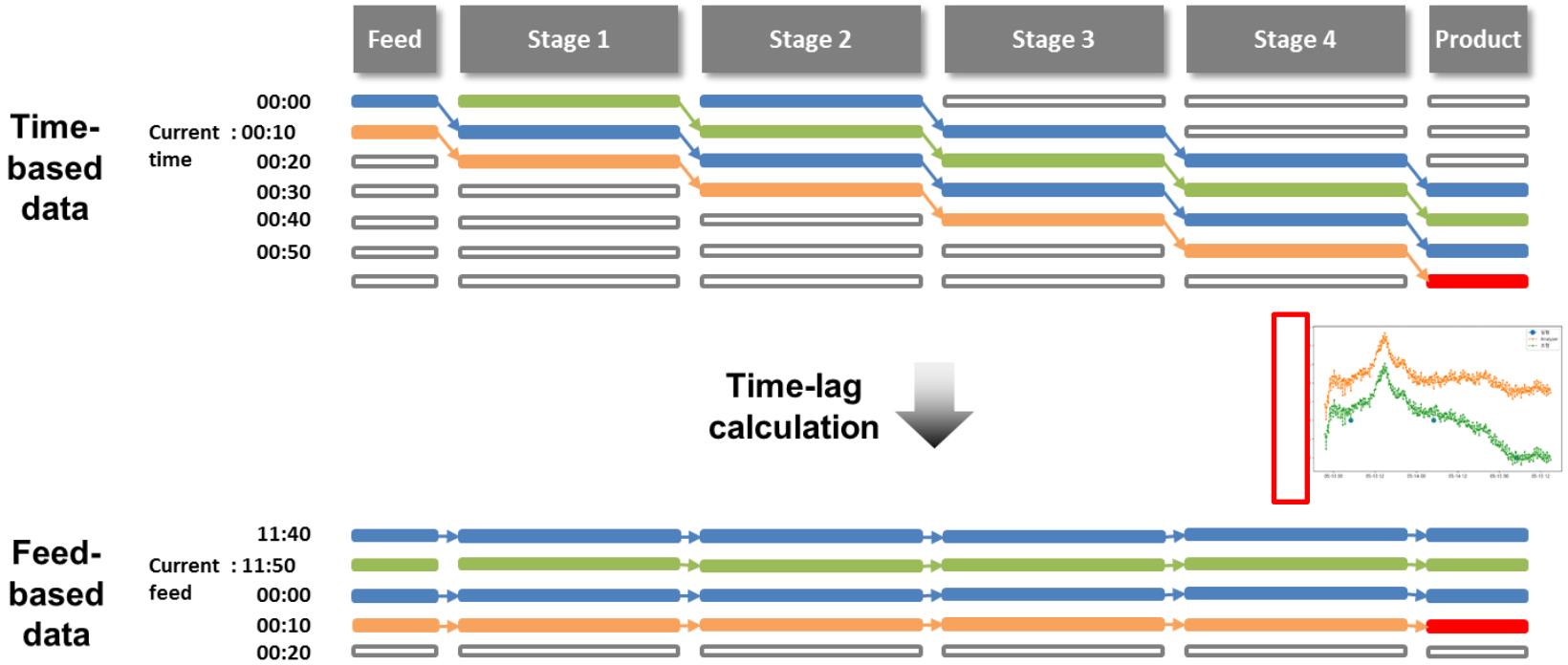


$\hat{y}_1^* = 80.21$ at $\mathbf{x}^* = (87.0, 176.5)$

Manufacturing Process Management with Service Intelligence

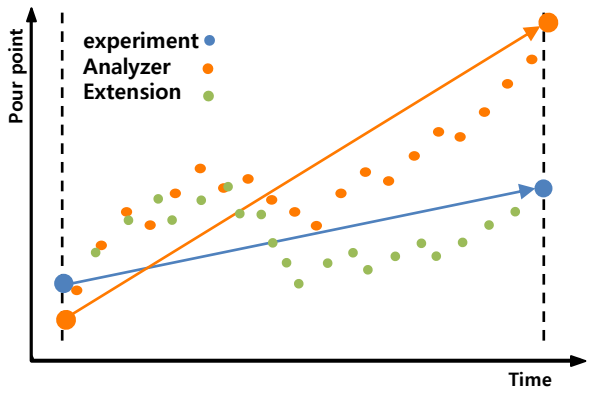


Data Preprocessing

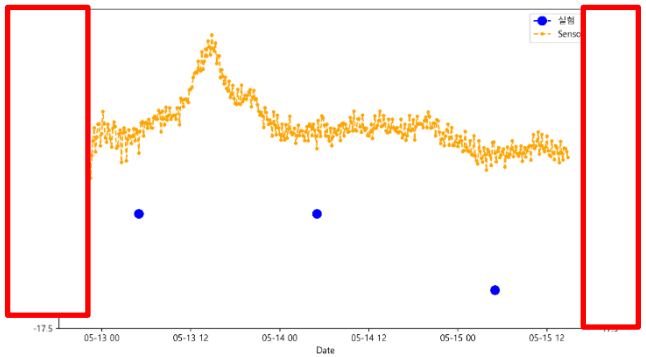


Data Preprocessing

- Analyzer data
  - Hard to trust original value
  - Possible to trust the trend of analyzer data
- Extend the trend of analyzer data
  - Reflect the slope of experiment data

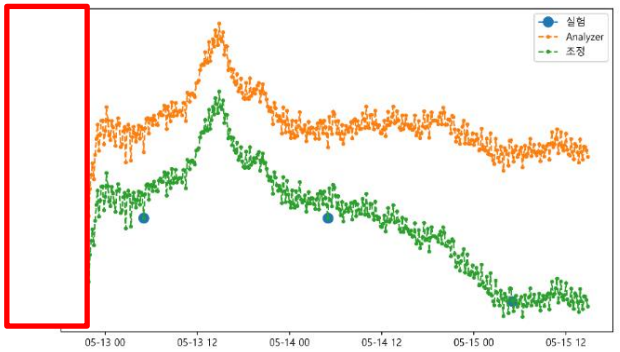


Extend data with Analyzer data



Before extension

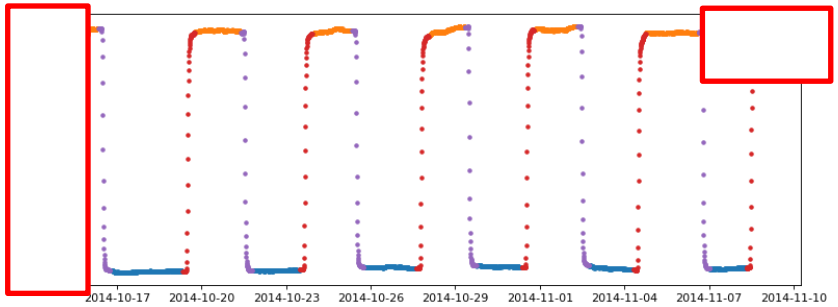
Extension



Extended data

Data Preprocessing

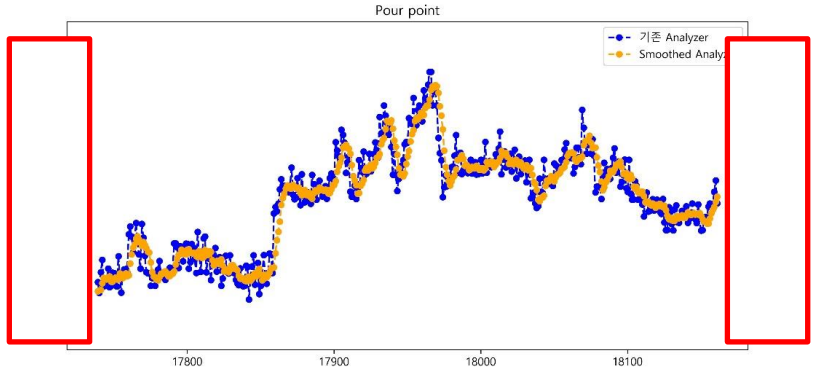
- Dividing data
  - Divide data according to the product



- Feed data duplication
  - From same tank, assumed to have same properties in a certain time

Time	Product 1	Product 2	F 1	F 2	F 3	F 4	F 5
08:00	1		4.3	136	33	1.1	6.4
	1		4.3	136	33	1.1	6.4
09:00	1		4.3	136	33	1.1	6.4
	1		4.3	136	33	1.1	6.4
10:00	1		4.3	136	33	1.1	6.4
...	Product Changed				...		
21:00		1	6.8	141	45	1.2	4.7
		1	6.8	141	45	1.2	4.7
22:00		1	6.8	141	45	1.2	4.7
		1	6.8	141	45	1.2	4.7
23:00		1	6.8	141	45	1.2	4.7

- Smoothing & Sliding window
  - Smoothing to reduce noise of sensor data
  - Sliding window to reflect mixture of oil in process



Prediction Model Development

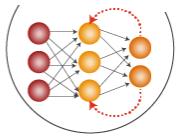
Input Data
(Pre-processed)

Data \ Type	Original (x_t)	window
Feed	Feed	$Feed_t, Feed_{t-1}, \ldots$
Process Data	Stage I	$S1_t, S1_{t-1}, \ldots$
	Stage II	$S2_t, S2_{t-1}, \ldots$
	Stage III	$S3_t, S3_{t-1}, \ldots$
	Stage IV	$S4_t, S4_{t-1}, \ldots$
	Data Smoothing	
	$Mean(\sum_{i=0}^{n} x_{t-i})$	

Model

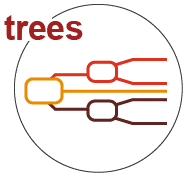
$$y = f(\mathbf{x}, \boldsymbol{\theta}) + \varepsilon$$

neural networks



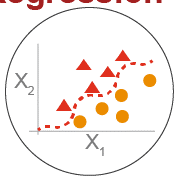
Process-based explanation (Skipped NN)

Decision trees



Rule-based explanation (XGBoost)

Regression



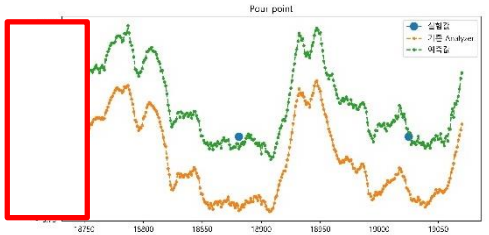
Linear coefficient calculation (LR Bagging)

Result

$$\hat{y}(\mathbf{x})$$

Pour point

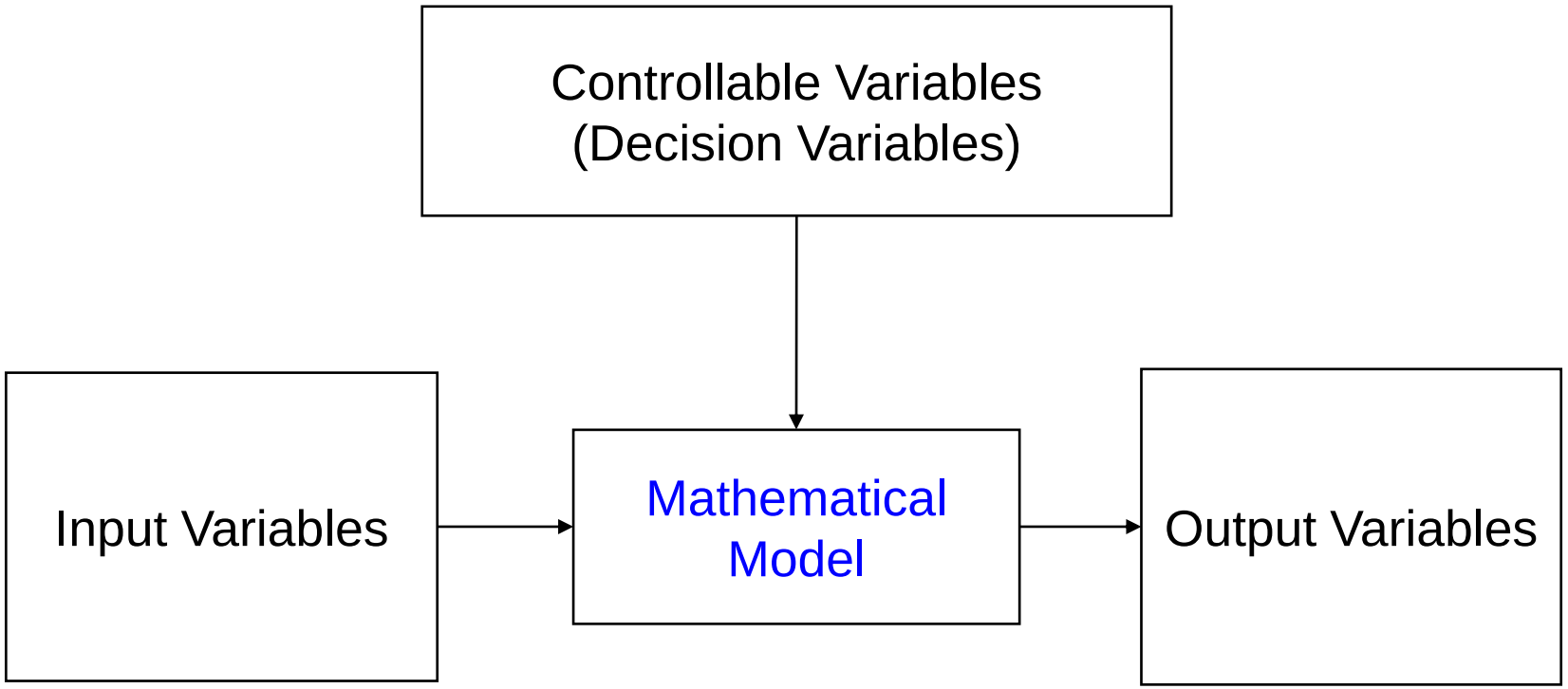
NOACK



Process Control Optimization

"Model building" "Search optimal setting for **x**"

$$y = f(\mathbf{x}, \boldsymbol{\theta}) + \varepsilon \rightarrow \hat{y}(\mathbf{x}) \rightarrow \underset{\mathbf{x} \in \Omega}{\text{optimize}}\ \hat{y}(\mathbf{x})$$



Prediction Model Development → Process Control Optimization

"Model building" "Search optimal setting for **x**"

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$$Minimize\ (\widehat{y_{pp}} - T_{pp})^2 + (\widehat{y_{nk}} - T_{nk})^2$$

$$s.t. \quad X_i^{LB} \le X_i \le X_i^{UB}$$

Control variable examples:

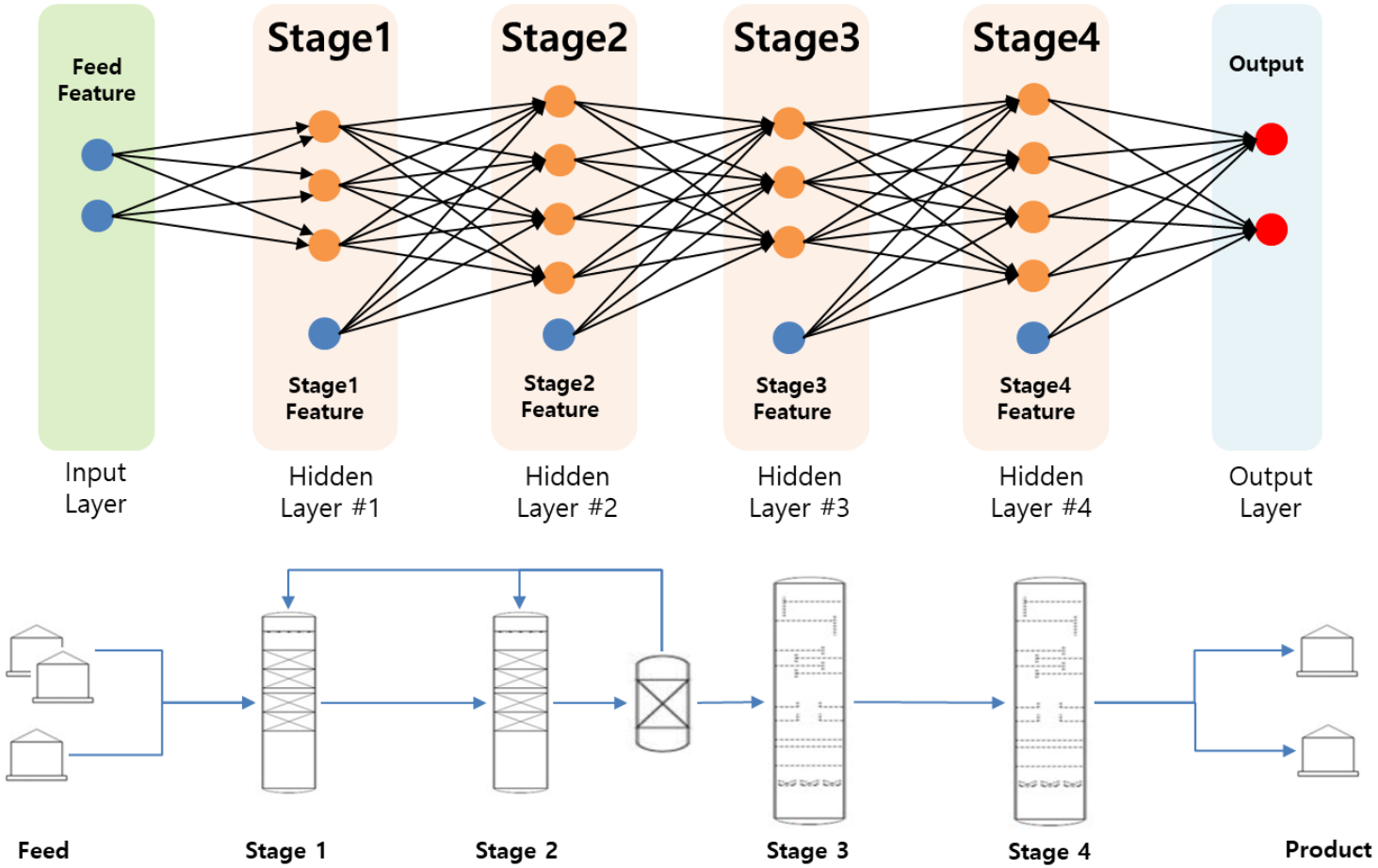
Input variable examples:

$$\widehat{y_{pp}} \approx -0.58x_1 - 4.00x_2 + 0.12x_3 - 0.12x_4 + 0.30x_5 - 1.41x_6 + 0.15x_7 - 2.26x_8 - 0.24x_9 + 1.23x_{10} + 4.14x_{11} + 1.88x_{12} + 1.24x_{13} + 3.52x_{14} + F_{pp}(z)$$

$$\widehat{y_{nk}} \approx 0.06x_1 + 0.14x_2 - 0.28x_3 + 1.39x_4 + 0.01x_5 - 0.39x_6 - 0.20x_7 + 0.12x_8 - 0.14x_9 - 0.25x_{10} - 0.60x_{11} - 0.31x_{12} + 0.12x_{13} - 0.58x_{14} + F_{nk}(z)$$

	Feed							Control variables												
Case 1	4.19	131	383	457	2.9	1.9	33	131.867	161.853	314.455	232.058	5057.398	93.864	225.822	160.965	5.407	2362.279	62.913	32.047	52.472	1986.68

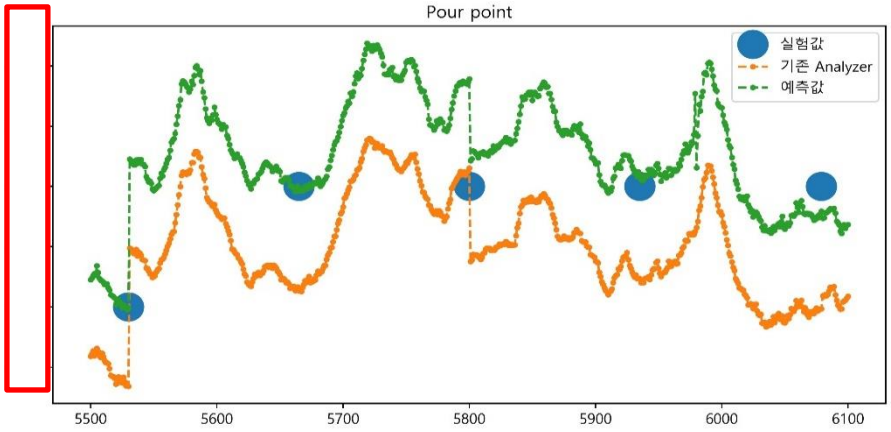
“High-Performance” Prediction Model Development

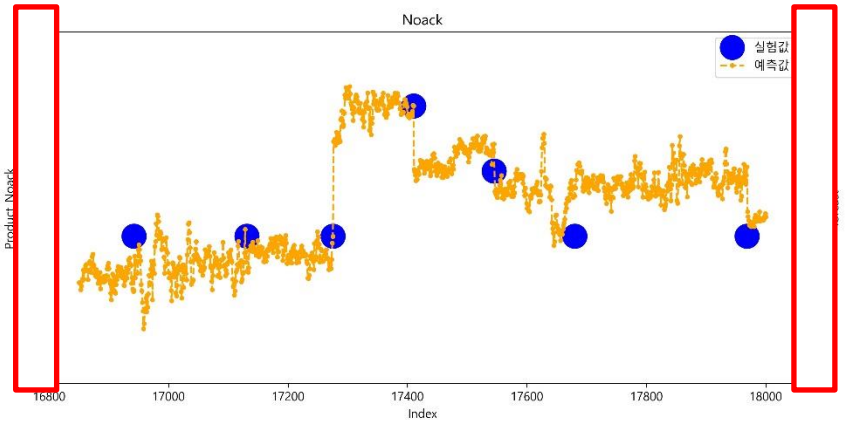


Reference: Kim, K., Cho, H., Yoon, K., Lee, J., Lim, C., Chun, J. and Kim, D., "MMP Net: A Neural Network Architecture to Represent Multi-stage Manufacturing Processes without Intermediate Outputs," *IISE Transactions*, Under Revision, 2022.

“High-Performance” Prediction Model Development

	Pour point prediction performance		
	RMSE (℃)	MAE (℃)	R_square (%)
One of the existing models	0.8225	0.7017	0.4539
An MMP Net model	0.7311	0.5597	0.5483





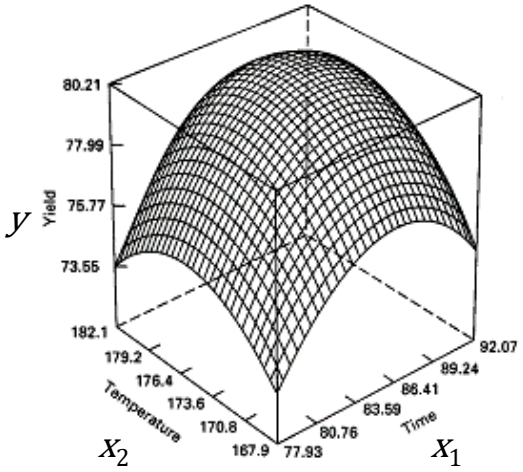
Manufacturing Process Management with Service Intelligence

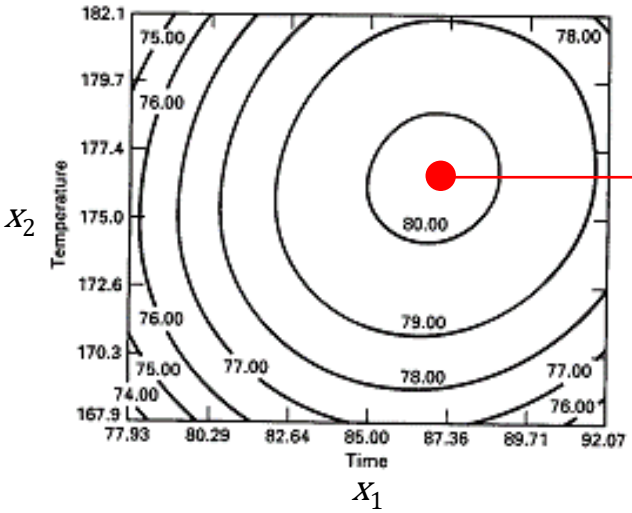
"Model building" "Search optimal setting for **x**"

$$y = f(\mathbf{x}, \boldsymbol{\theta}) + \varepsilon \quad \rightarrow \quad \hat{y}(\mathbf{x}) \quad \rightarrow \quad \underset{\mathbf{x} \in \Omega}{\text{optimize}} \ \hat{y}(\mathbf{x})$$

Example*

y = process yield (Larger the better),
x_1 = reaction time, x_2 = reaction temperature





$\hat{y}_1^* = 80.21$ at $\mathbf{x}^* = (87.0, 176.5)$

Process Control Optimization with Computational Intelligence

Process control optimization model

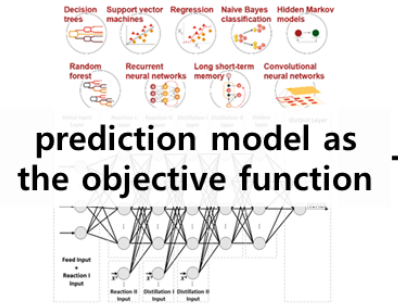
$$s.t.\quad 0 \le IDW\ WABT \le 350 \quad control(IDW\ WABT)$$
$$0 \le H0851\ T\ out \le 315 \quad control(H0851\ T\ out)$$
$$0 \le Vac\ TWR\ STM \le 3700 \quad control(Vac\ TWR\ STM)$$

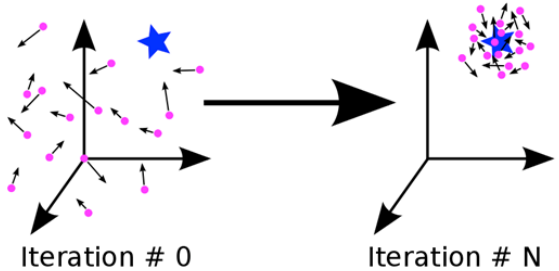
$$1.\ optimize\ (\hat{y}_{pp} - T_{pp})^2$$
$$2.\ optimize\ (\hat{y}_{nk} - T_{nk})^2$$

Satisfy constraints → **Control x value** → **Optimize the objective**

Consider process stability → **Control the process** → **Optimize the product quality**

Process control optimization based on a black-box prediction model





- Select algorithm's parameters
  - Population size
  - Objective function f (*) for fitness evaluation
  - Maximum no. of generations
  - Mutation probability
  - Etc.
- Begin
  - Generate initial population
  - Calculate fitness value for initial population
- Repeat until stopping criterion is met
  - Select parents from current population based on their fitness
  - Inheritance: Generate children through crossover and mutation
  - Generate new population using some replacement strategy

In case the prediction model does not provide a mathematical function,

mathematical optimization is impossible; a computational intelligence should be used

Process Control Optimization Illustration

$$y = f(\mathbf{x}, \boldsymbol{\theta}) + \varepsilon$$

Model building

$$\hat{y}(\mathbf{x})$$

Search optimal setting for **x**

$$\underset{\mathbf{x}\in\Omega}{\text{optimize}}\ \hat{y}(\mathbf{x})$$

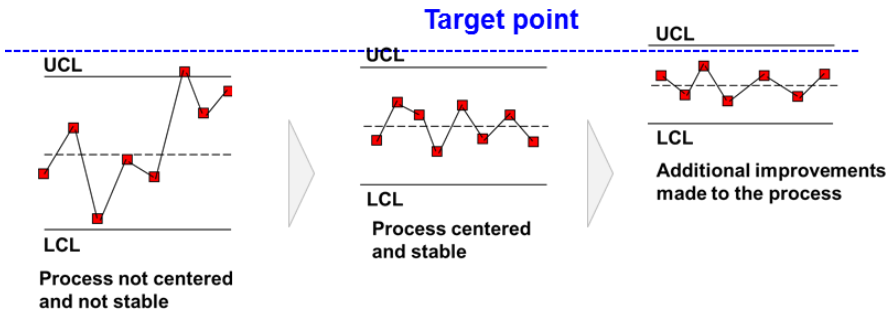
Control variable \ Time	09:00			09:10		
	Current value	Optimal control value	Output	Current value	Optimal control value	Output
Variable 1	320.99	321.5		321.02	321.5	
Variable 2	75.99	71		75.96	70	
Variable 3	1800.3	1700		1800.5	1700	
Variable 4	64.09	63		65.1	63	

$$Minimize\ (\widehat{y_{pp}} - T_{pp})^2 + (\widehat{y_{nk}} - T_{nk})^2$$

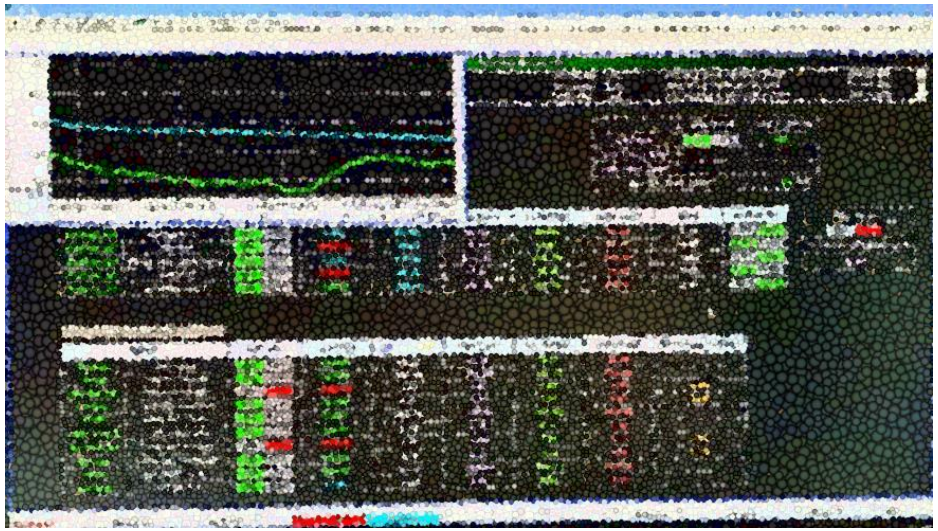
$$s.t.\quad X_i^{LB} \le X_i \le X_i^{UB}$$

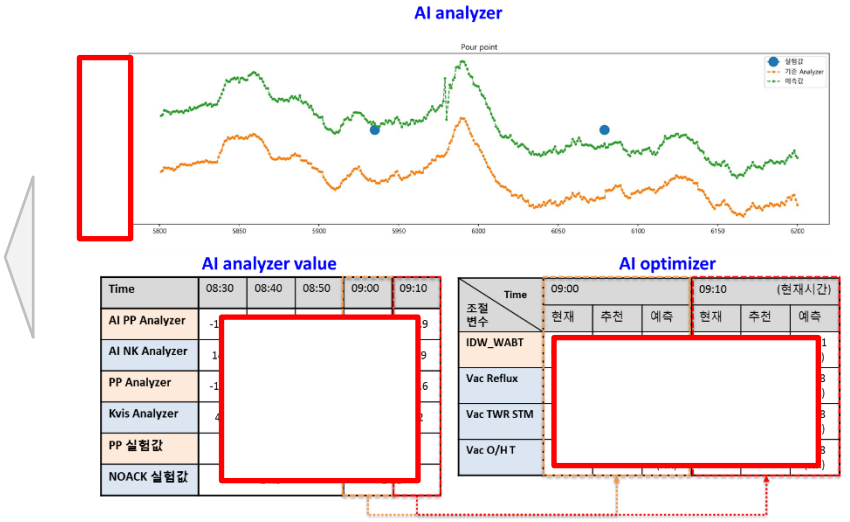
Control variable examples:

Input variable examples:

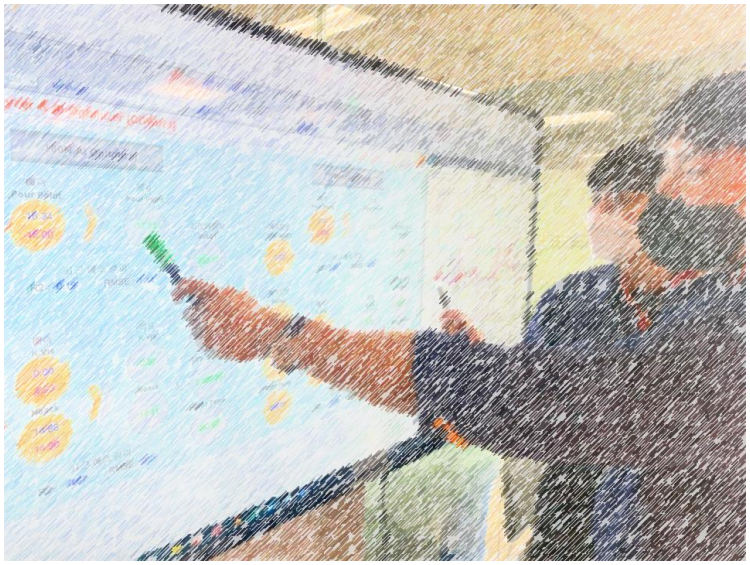


Service Solution Development

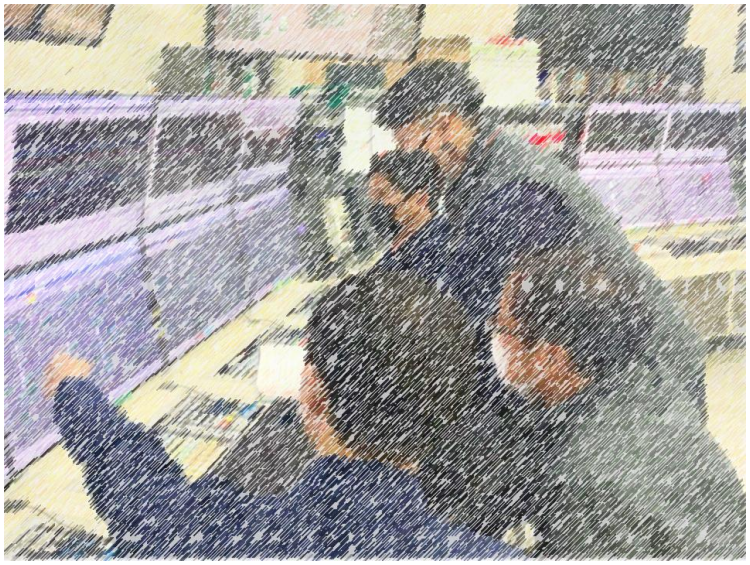




Service Solution Development

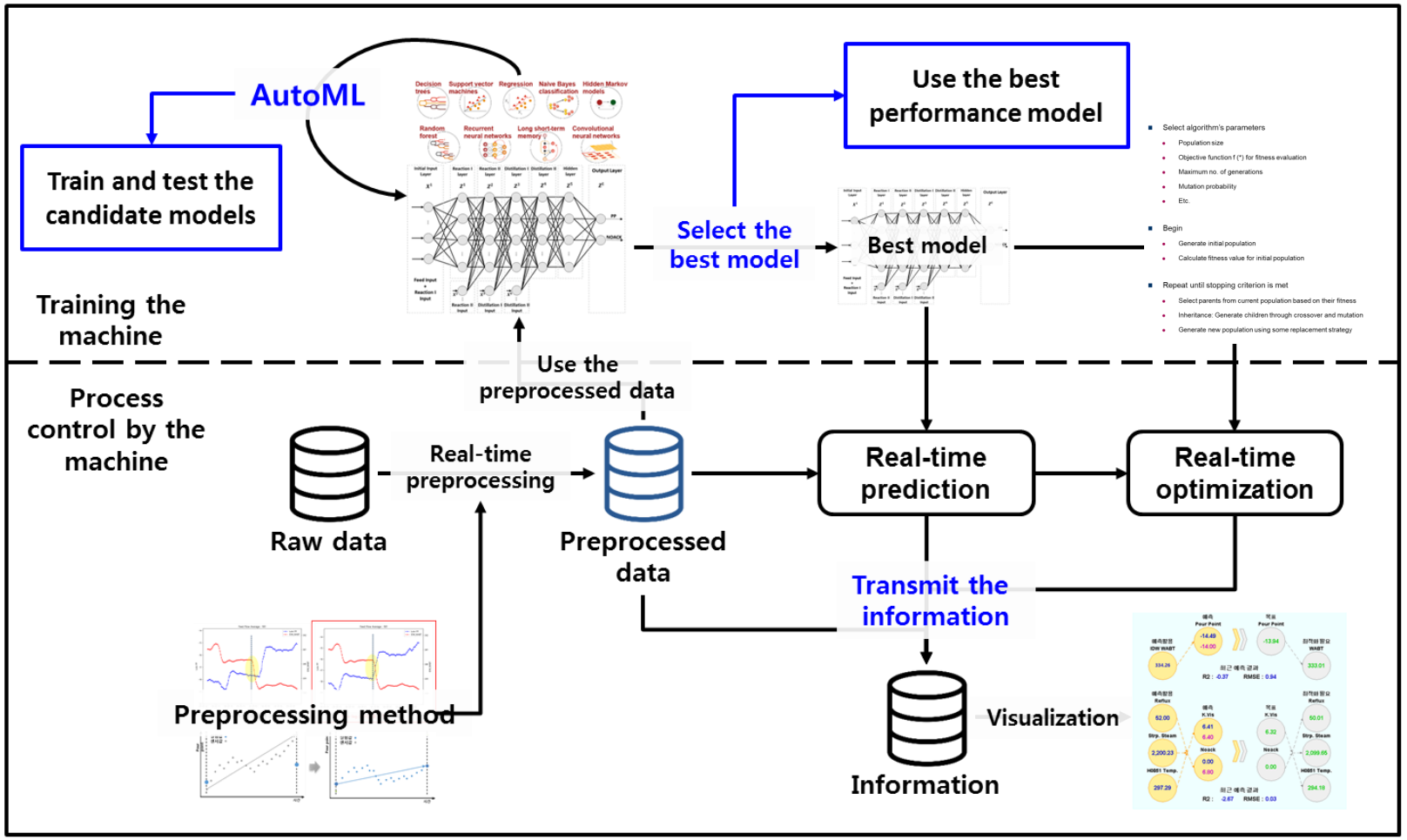


Service



Service Solution Development

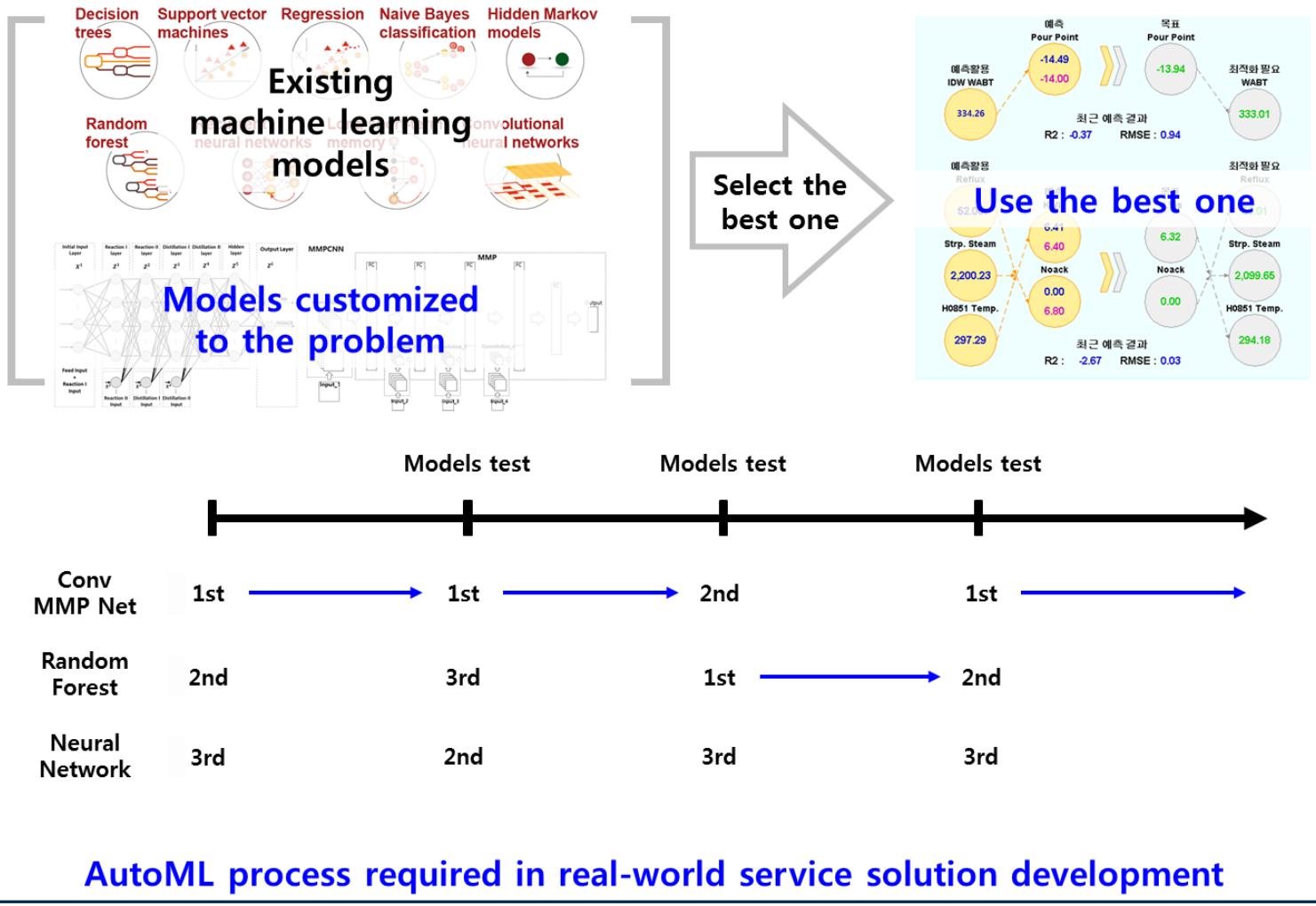
Service solution implementation



Service solution should be automated to support real-time task support

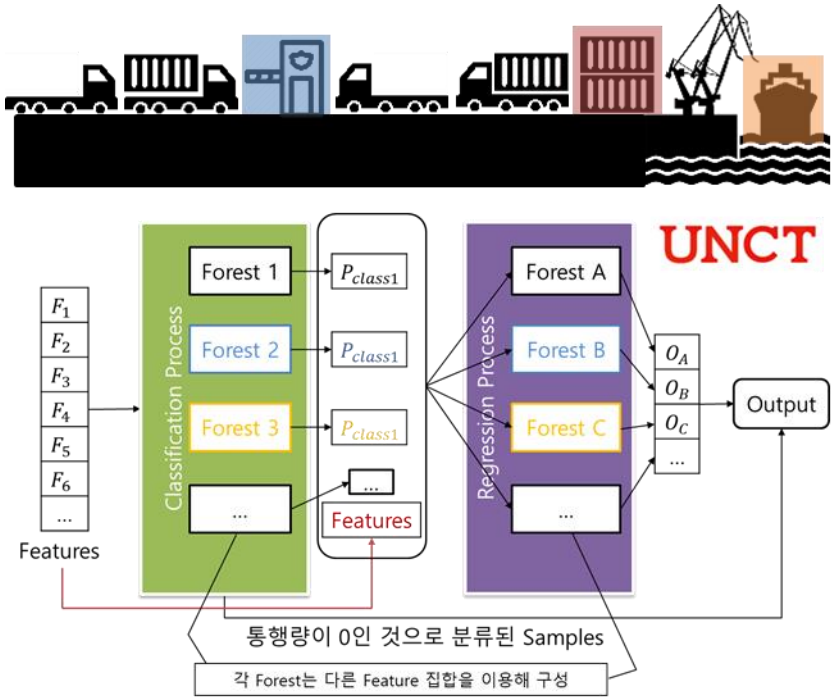
Service Solution Development

Prediction model for service solution



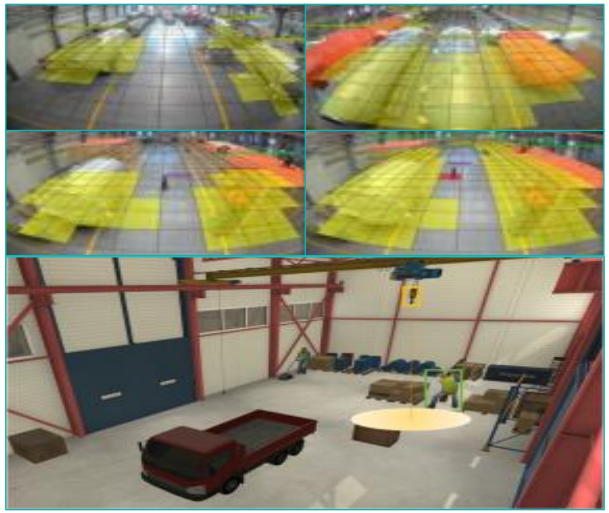
Examples of Industrial Process Management with Service Intelligence

Logistics Process Management with Service Intelligence



Safety Monitoring with Service Intelligence

Safety Monitoring with Service Intelligence

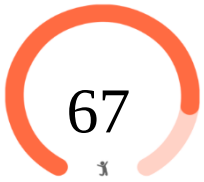


Safety Monitoring with Service Intelligence

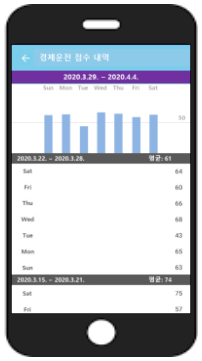
Dangerous behaviors → **Behavior variables** → **Representation** → **Safety score** → **Monitoring and intervention service**

V_1 (S.A.)

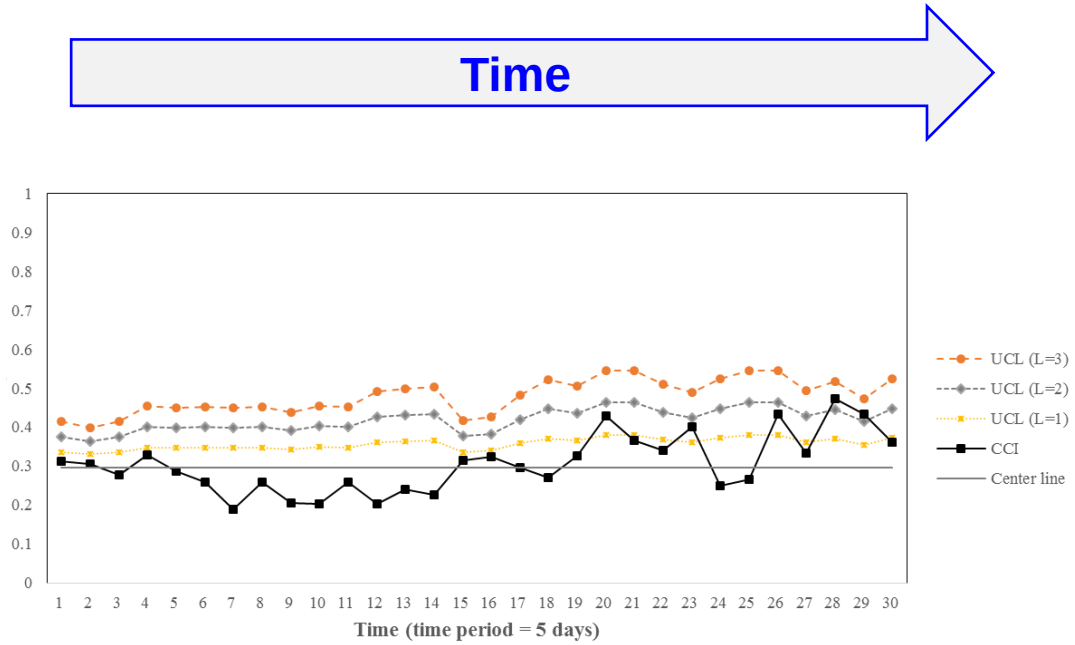
V_7 (S.D.)



0 ~ 100



Safety Monitoring with Service Intelligence



Safety Monitoring with Service Intelligence

II. 사고 개요

- ❖ 일시: 2016년 2월 17일 (수요일) 23시 10분
- ❖ 장소: EPDM공정 TK-330 Bottom Drain Point
- ❖ 내용: TK-330 (Crumb Slurry Surge Tank)내 이물질 여부 확인을 위한 Drain과정에서 Hot Water가 왼쪽 발에 튀어 화상을 입음

Spec Check 작업 중 Drain Point에서 나온 Hot water에 화상

- 1,2 번 Valve Close 후, 3번 Cap을 Open하는 과정에서 Line 내 체류되어있던 Hot Water에 화상을 입음
- 설비 구조상 1,2번 Valve와 3번 Cap 사이에 Dead Point가 존재함.

구분1(공장	관리번호	발생일시	팀	발생설비	발생기능	개요	조치사항	향후대책	Lessons Le	발생원인	근본원인(F1번째테이블(R1~R40)		
"hdPlntNm	"txtEtcNo"	"dtOccrDa	"cboOccrD	"txtTeam"	"txtFcltNm	"hhdAccFu	"taOverVie	"taActCnt	"taTurMsr	"taLessons	NamoData	RCause1	RCause2	RCause3
운영_에너	SKE-UL-NN	2016-10-1	화요일	석유제품운		생산	Y-T326	Flexible	Flexible ho	Flexible	<Nan	작업적요인	작업환경	작업통로 부
정유공장	SKE-UL-NN	2016-11-2	일요일	Aromatic설		기타	#2MDU열	잡초 제거	1. 안전	조금한 마	<Nan	인적요인	정신적 요인	주의력 부족
Aromatic	SKGC-UL-1	2016-11-1	목요일	Aromatic설	PRODUCT	생산	공정의	온도에	1. Mode	주기적으로	<Nan	공정설비 요	이상 시 조	이상 시 조
Olefin	SKGC-UL-1	2016-11-0	목요일	Olefin생산	SULFURIC	생산	정기보수 주	신속히 접	이후 주의	철저히 안	<Nan	관리적요인	관리체계	점검/감사/
Aromatic	SKGC-UL-1	2016-11-2	월요일	Aromatic설		생산	L/O D/M 7	2인1조로	이동 Route	항상 작업	<Nan	작업실수 요	작업환경	정리정돈 미
운영_에너	SKE-UL-NN	2016-11-2	화요일	석유출하3팀		생산	PMA생산	끈을 탄탄	끈매듭(	SBS를 출기	<Nan	작업적요인	작업방법	작업방법 부
Olefin	SKGC-UL-1	2016-03-2	일요일	PC생산 출	901-E 3 중	생산	901-E T	자동에 갈	정비작업물	고소지역 작	<Nan	작업적요인	작업방법	예방체계 부
제주물류센	SKE-LO-NN	2016-11-2	일요일	제주물류센	업무용 책상	기타	제주물류	1. 책상 일	1. 근무시	사무실 내	<Nan	인적요인	정신적 요인	주의력 부족
Polymer	SKGC-UL-1	2016-11-2	화요일	Polymer운	기타	생산	750Kg 자체	주변에 대기	25Kg Ba	서울러	<Nan	관리적요인	작업절차	사용안됨
기타	SKE-UL-NN	2016-11-2	금요일	석유품질팀		기타	공정 시료	GC-052	모든 GC장	모든 GC장	<Nan	설비관리 요	예방정비/점	정기품질 미
운영_에너	SKE-UL-NN	2016-10-1	목요일	석유출하3팀	NAC사무실	기타	석간근무	외부에서 사	사무실	출입문을 부	<Nan	인적요인	정신적 요인	주의력 부족
Olefin	SKGC-UL-1	2016-12-0	토요일	Olefin생산	NCC FLAR	생산	FLARE S	내리기	경사진 곳0	차량주차시	<Nan	인적요인	정신적 요인	주의력 부족
운영_에너	SKE-UL-NN	2016-10-1	월요일	석유출하3팀	PMA MIX	생산	사고일	Valve STEN	1. 작업	작업시 서	<Nan	작업실수 요	작업환경	정리정돈 미
동력_에너	SKE-UL-NN	2016-10-0	토요일	동력3팀	Y-B203-BF	생산	B203 T/	작업을 요청	장치 설	현장에 사	<Nan	작업적요인	작업환경	작업통로 부
전주물류센	SKE-LO-NN	2016-12-0	월요일	전주물류센	보일러	생산	전주물류센	보호장갑 착	* 드레인	우리 주변	<Nan	작업적요인	작업방법	작업방법 부
석유 운활유	SKI-RD-NN	2016-12-0	월요일	운활유기술	항온항습기	장치	1. 운활	1. 항온	1. 사고1	1. 사고 발	<Nan	설비적요인	성능유지	유지/보수
Offsite	SKIPC-IC-1	2016-11-1	금요일	운영1팀	TK-910-35	기타	2016.11	첨부와	이와같은	작전후 상	<Nan	설비적요인	사양	예상못한
대전물류센	SKE-LO-NN	2016-12-0	화요일	대전물류센	사무실 계단	기타	2016. 1	- 계단를	- 계단	사무실 이	<Nan	인적요인	정신적 요인	주의력 부족
Olefin	SKGC-UL-1	2016-12-0	금요일	Olefin생산	배수로 뚜	기타	OFF SIT	#3 B/L VC	즉시 작업	아간 순	<Nan	관리적요인	개선관리	개선조치 미

- Water-related
- Fire-related
- Falling
- ...

Practice of Industrial Process Management with Service Intelligence

Service Intelligence for a Sugar Manufacturer

https://www.youtube.com/watch?v=jCKt02NGjfM&ab_channel=DiscoveryUK

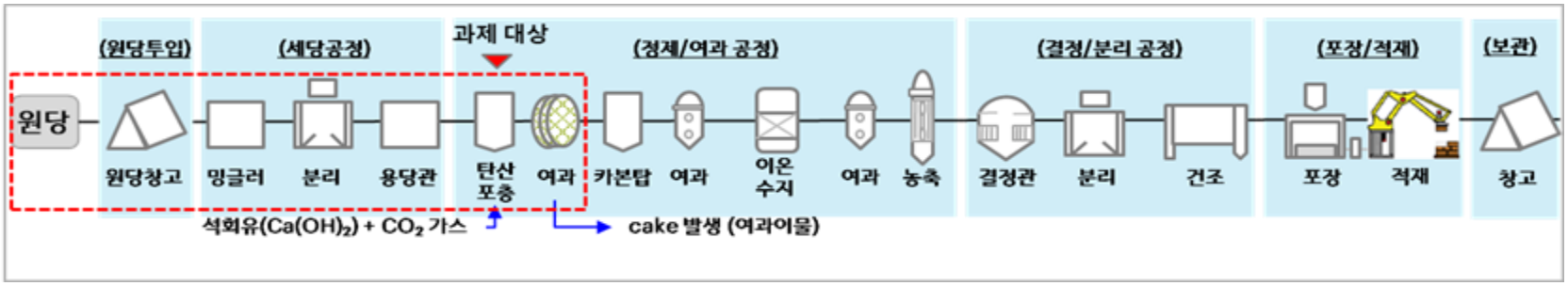
Samyang, the Sugar Manufacturer

samyang
삼양사

큐원

- 1924. 10 삼양사 창립
- 1955. 12 울산제당공장(50 MT/Day)준공
- 1967. 7 한국산업규격표시(KS)인증 취득
- 1992. 8 정제공정자동화
- 2000. 3 ISO 9001, 14001 인증 취득
- 2003. 5 HACCP 인증 취득
- 2007. 6 설탕생산 천만 톤 달성
- 2007. 9 OHSAS 18001 인증 취득
- 2007. 10 ISO 22000 인증 취득
- 2009. 1 정제당시설 1,450MT/Day 증설
- 2009. 3 온실가스배출 감축실적 인증서
- 2010. 5 탄소 성적표지 인증서
- 2012. 6 FSSC22000 인증 취득
- 2013. 9 업계최초 식약처 HACCP 지정
- 2017. 4 기능성 설탕 공장 설립
- 2018. 11 ISO 45001 인증 취득

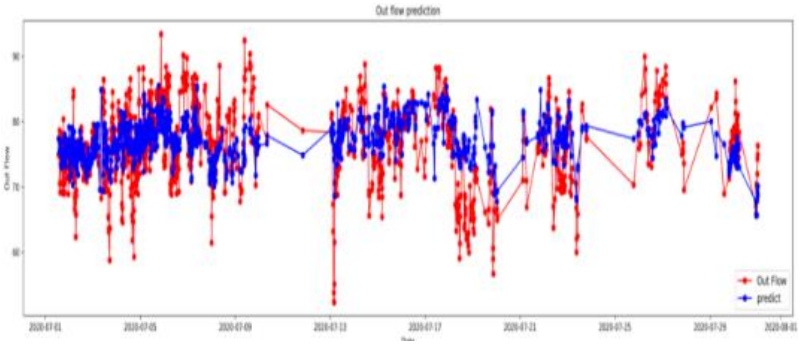
Samyang, the Sugar Manufacturer

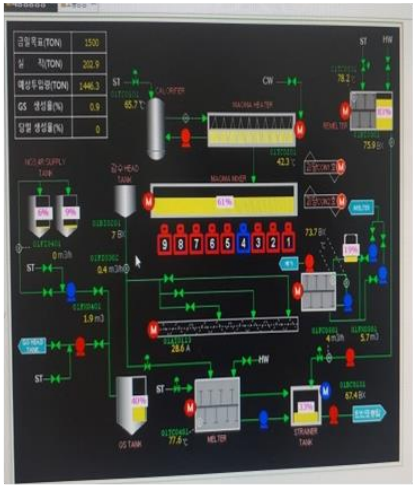


Samyang, the Sugar Manufacturer

"Model building" "Search optimal setting for **x**"

$$y = f(\mathbf{x}, \boldsymbol{\theta}) + \varepsilon \quad \rightarrow \quad \hat{y}(\mathbf{x}) \quad \rightarrow \quad \underset{\mathbf{x} \in \Omega}{\text{optimize}} \ \hat{y}(\mathbf{x})$$





Assignment 6 (by 11.11 11:59 pm)

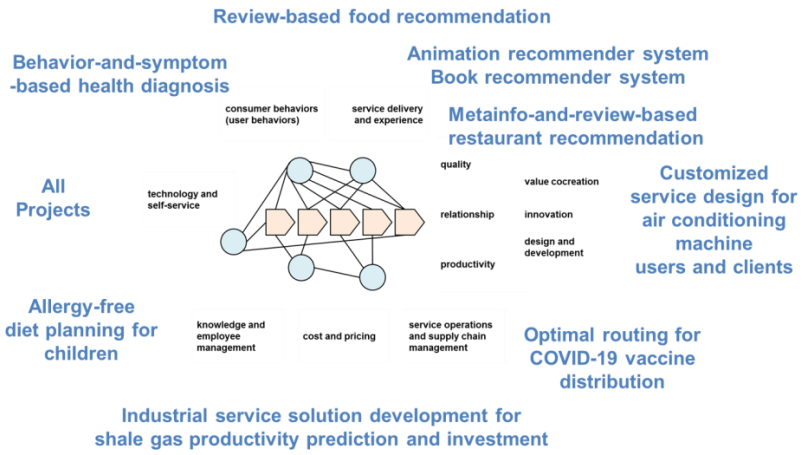
- Based on the practice demonstration by TA Cho, (1) complete the development of a yield prediction model for the sugar manufacturer by yourself. Through trials and tests, develop your own best prediction model. You should compare and interpret multiple prediction models.
- (2) In the prediction model development, think carefully about the controllable variables. You should analyze the variables around the process based on your own descriptive and predictive analyses. For example, interpret the analytics outcomes (e.g., describe the controllable variables you identified significant, interpret their coefficient/importance values in your yield prediction models). As a result, describe what controllable variables should be prioritized in the optimization of the process.
- (3) Optimize the production process and describe the results (e.g., a set of optimal control values). First, based on a linear regression model, use the scipy package for the mathematical optimization. Second, based on a non-linear regression model (e.g., tree-based models, neural network models), complete the provided GA code and use it for the optimization through simulation (refer to the next week practice); of course you can develop your own heuristic optimization algorithm if you want.
- (4) Assume you actually need to use your machine for the sugar manufacturer. Using the finally selected prediction model and your optimizer, think how to manage effectively and improve the sugar production process. Design and develop your own industrial service intelligence solution for this manufacturer (e.g., develop an automated prediction-optimization code package). You must provide visualization contents (e.g., visualization of the predicted values of yield flow, visualization of suggested optimal control values for specific controllable variables) Describe your service intelligence solution in detail. Think beyond the class examples in your own creative, unique way!
- (5) Think about your concerned industrial/business service around UNIST, in Ulsan, in your hometown, or any other interested service that require a machine for its management and improvement. Describe the specific tasks of the service that require the support of a machine. Discuss the requirements of developing such a machine for the service in detail.
- (6) If you would actually conduct a study on developing a machine for the industrial/business service, how would you conduct the research in your own creative, unique way? What kinds of data are you going to collect, analyze, and learn, and what methods are you going to use? Describe your service intelligence development plan in detail. If possible, visualize your plan clearly (e.g., draw an image, construct a mathematical model). To facilitate your thinking, you may want to identify and review a paper or any other reference in the Internet, related to the service you are interested or concerned.
- Upload your code and a several paragraph essay on the tasks (1)~(6) in the Blackboard.

Term Project Announcement:

“Develop Your Own Service Intelligence”

Term Project

- By yourself or with a team member, suggest a term project topic that you would like to solve an important real-world service problem by developing your own service intelligence. Or, you can participate in the following competition and develop a service intelligence that supports the decision making of credit card users.



Hana Financial Group

- Review your previous assignment outcomes. Identify and describe the rooms for improvement. You do not have to redo the assignments. Just try how to improve them.

Assignments, Grading, and Policies

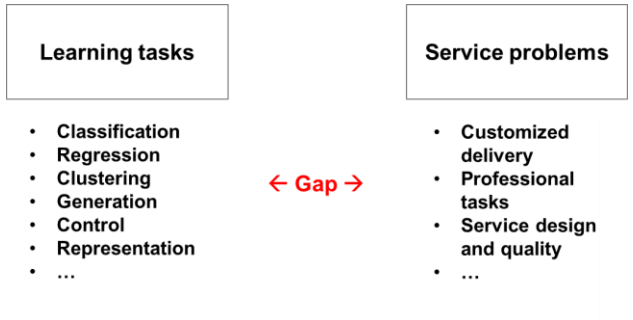
- Assignments
  - You need to complete an assignment as you follow along with the required class
  - Each assignment will require you to answer questions, solve problems, and/or write a report
  - Assignments must be done in the MS Word format and submitted with the filename “Assignment#_ID_Name.docx” (e.g., Assignment1_20201200_ChiehyeonLim.docx)
- Grading

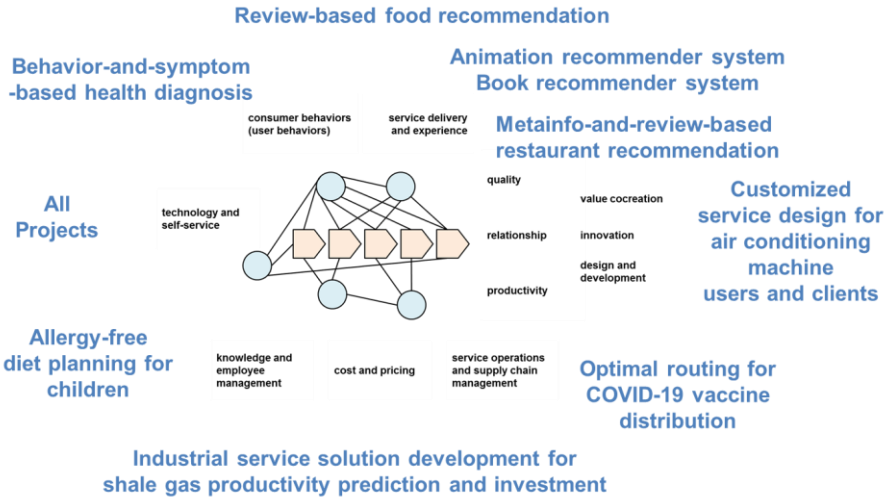
Item	Portion	Criteria
Class Participation	10%	Attendance and In-Class-Presentation for Discussion
Assignments	40%	Comprehension, Completeness, and Creativity
Term Project	50%	Completeness, Adherence to the Course Material, and Creativity

- Other policies: Late work with penalty and NO cheating

Guideline

- Topic selection
  - Type 1: Application of an existing theory or method to an important problem in your own way
  - Type 2: New theory or method development for service problems
  - These are just examples. Do whatever research you are interested, relevant to this course





- Important considerations
  - Start from the course material and/or a specific key paper and make your own contribution reasonably
  - Collection and use of real or at least realistic data is mandatory; Validation is important

Term Project Proposals (by 11/6 Sunday 11:59 pm)

- Presentation file upload due by 11/6 Sunday 11:59 pm

- Presentation operations
  - Presentation file: PPT format within 8 pages
  - Presentation content (examples):

    What service?, What problem and task? (i.e., Motivation of the task support, Clear problem definition),

    What data to analyze and learn? How to collect the data? (real-world or at least realistic simulated data required)

    What intelligence to develop? (e.g., learning and optimization for descriptive, predictive, or prescriptive task)

    Related literature and key reference, Project plan, Expected outcome and contribution, etc…
  - Presentation at: 11/7 Mon & 11/9 Wed
  - Presentation order each day: Random

Expected Schedule about the Term Project

- Week 10
  - 10/31 Mon: Metaheuristics for Service Optimization & Data Envelopment Analysis (DEA) for Service Improvement
  - 11/2 Wed: Practices for Genetic Algorithm Development and DEA
- Week 11
  - 11/7 Mon: Term Project Proposals I
  - 11/9 Wed: Term Project Proposals II
- Week 12
  - 11/14 Mon: Discussion on the assignment outcomes + Special lecture on an AICP competition win topic
  - 11/16 Wed: Special lectures on a sequential recommendation topic + a customer experience clustering topic

Industrial Engineering X Leadership Center: Special Lecture