Service Intelligence

[Course Wrap-up]

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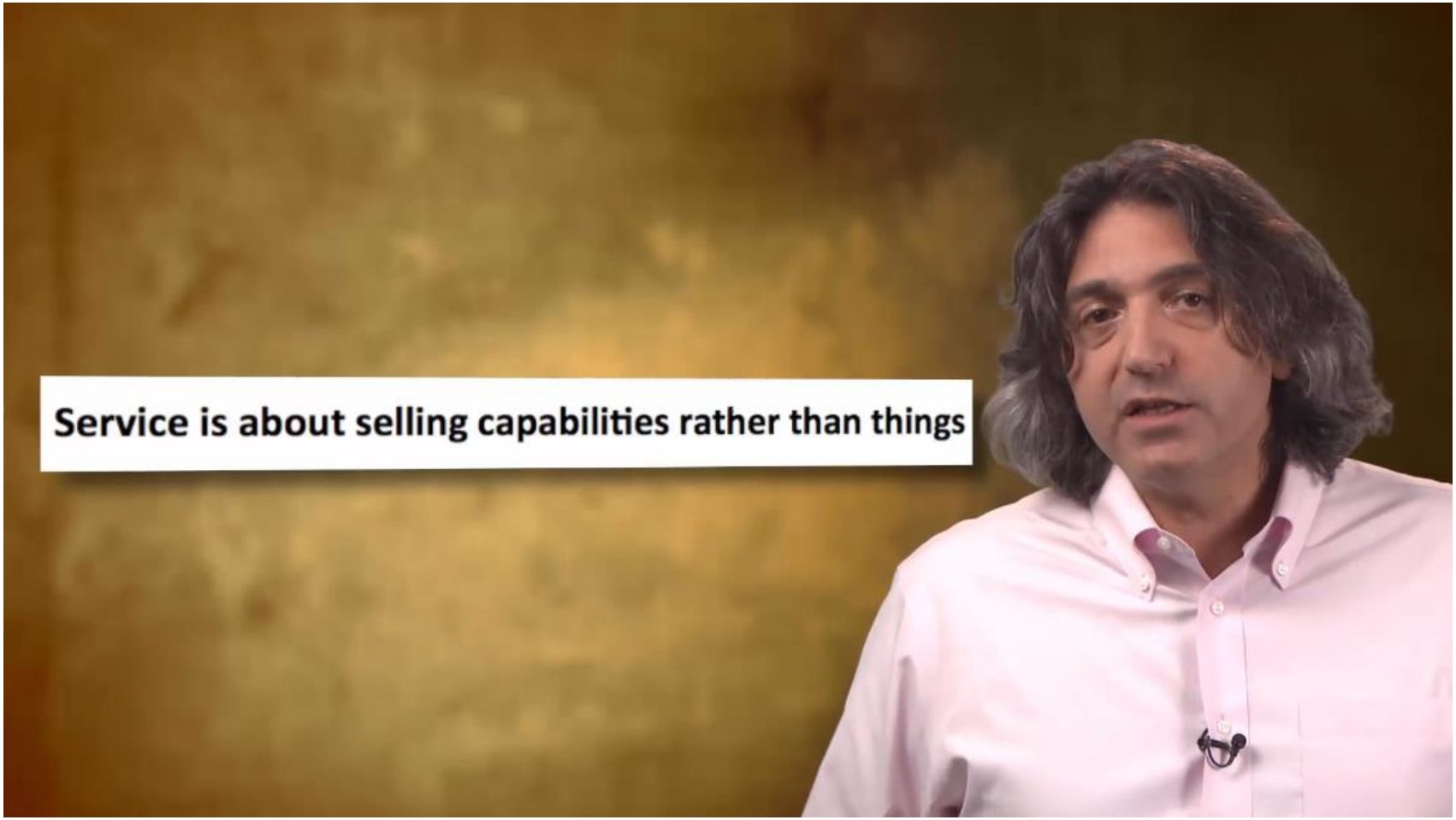
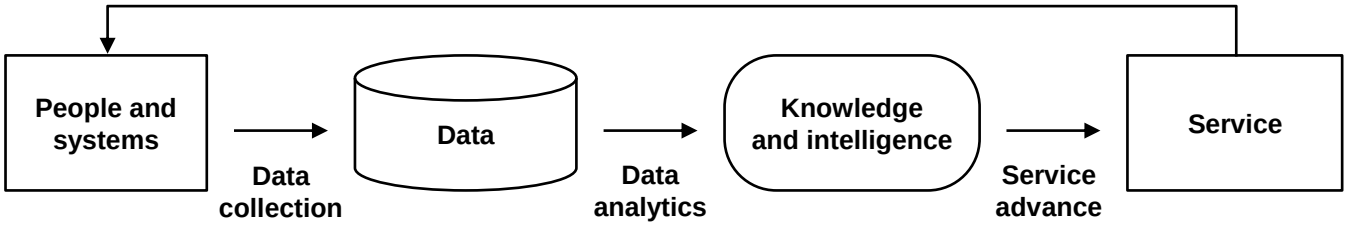
2022. 12. 7

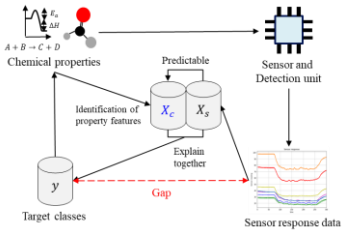
Service is Simply to Serve Customers: Help Tasks or to Do the Tasks

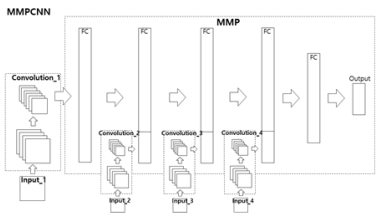


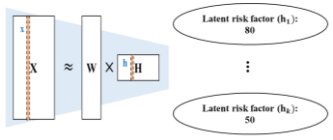
A Framework of Service Intelligence

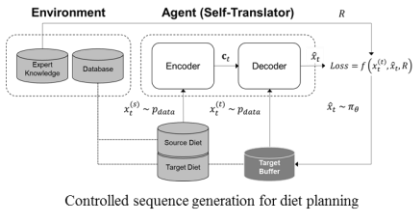
Help tasks of people or automate the tasks











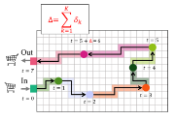
Controlled sequence generation for diet planning

knowledge discovery and intelligence development

health care

mobility

hospitality



retail services

for advancing services in industry and society

Topics of the Service Intelligence Course

Service Review Mining

Behavioral Data Mining

Recommender Systems Development

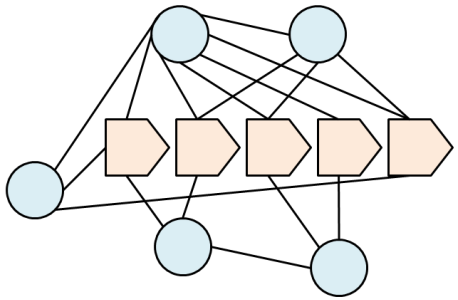
consumer behaviors (user behaviors)

service delivery and experience

Service Quality Evaluation and Improvement

All Weeks

technology and self-service



quality

value cocreation

relationship

innovation

design and development

productivity

Customer Segmentation and Service Customization

Special Lectures on Service Intelligence

knowledge and employee management

cost and pricing

service operations and supply chain management

Service Process Assessment and Improvement

Service Optimization

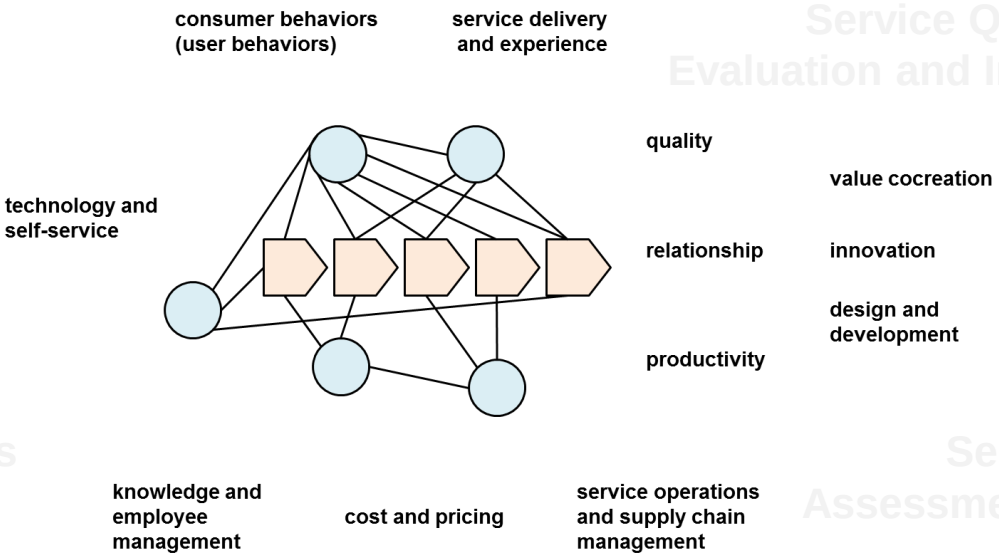
Industrial Service Intelligence

Topics of the Service Intelligence Course

Service Review Mining

Behavioral Data Mining

Recommender Systems Development



Service Quality Evaluation and Improvement

All Weeks

Customer Segmentation and Service Customization

Special Lectures on Service Intelligence

Service Process Assessment and Improvement

Service Optimization

Industrial Service Intelligence

Recommender Systems for Services

recommend

verb [T]

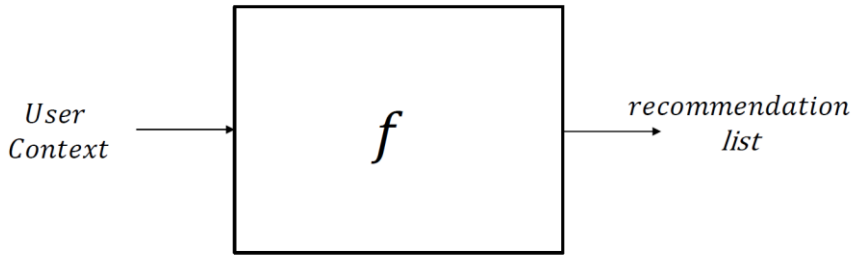
UK /ˌrek.əˈmend/ US /ˌrek.əˈmend/

B1

to suggest that someone or something would be good or suitable for a particular job or purpose, or to suggest that a particular action should be done:

- *I can recommend the chicken in mushroom sauce - it's delicious.*
- *She has been recommended **for** promotion.*
- *The headmistress agreed to recommend the teachers' proposals **to** the school governors.*
- [+ (that)] *The doctor recommended **(that)** I get more exercise.*
- [+ -ing verb] *I recommend writ**ing** your feelings down on paper.*
- *The city **has much/little to** recommend it (= it has many/few pleasant qualities).*

$$y = f(x)$$



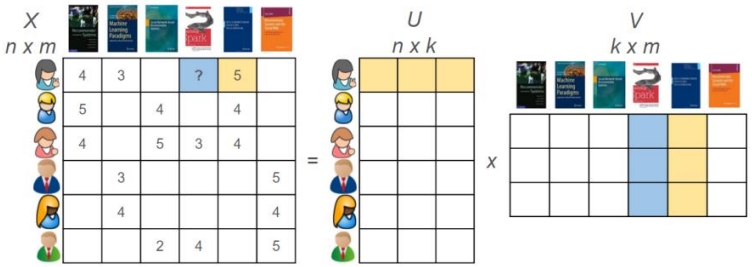
Reference: https://dictionary.cambridge.org/dictionary/english/recommend

Approaches of Recommender Systems: A Data Perspective

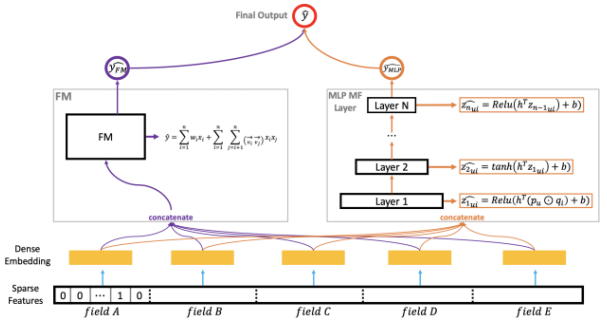
- Recommender systems use analytic techniques to compute the value that a user would purchase one of the items; the techniques vary according to the purposes and data

	Item 1	Item 2	Item 3	…	Item m-1	Item m
User 1	…	…	…	…	…	…
User 2	…	…	…	…	…	…
User 3	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
User n-1	…	…	…	…	…	…
User n	…	…	…	…	…	…

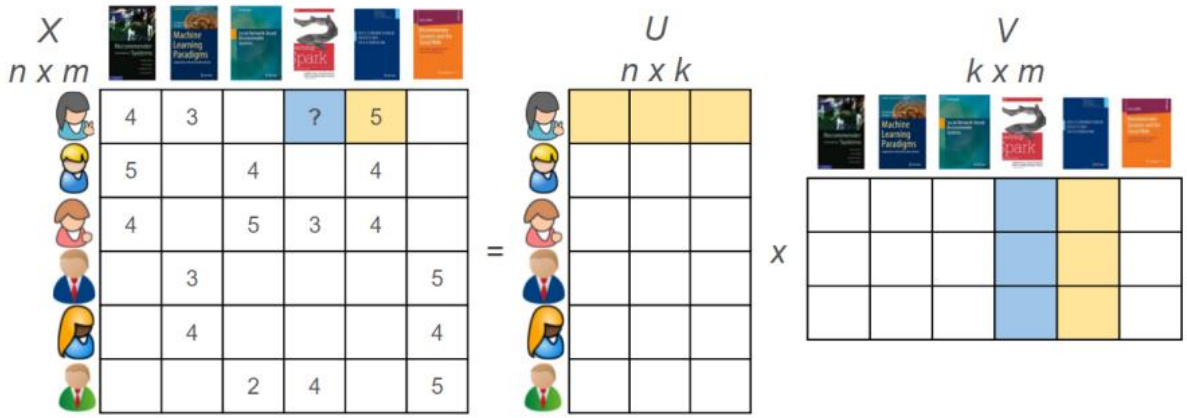
	Feature 1	Feature 2	Feature 3	…	Feature m-1	Feature m
Transaction 1	…	…	…	…	…	…
Transaction 2	…	…	…	…	…	…
Transaction 3	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
Transaction n-1	…	…	…	…	…	…
Transaction n	…	…	…	…	…	…

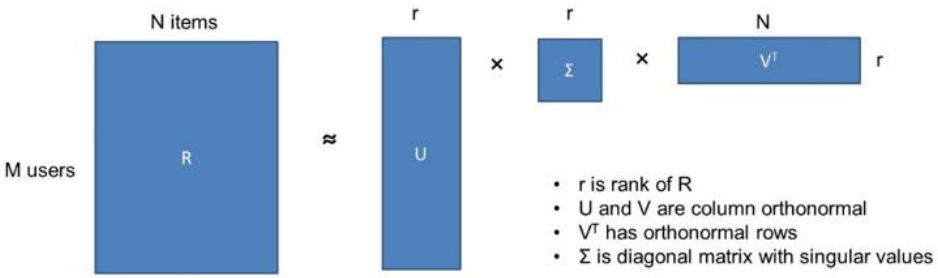


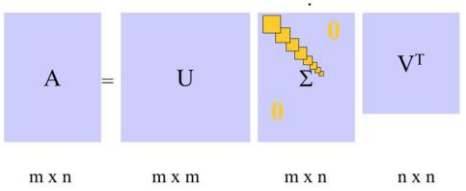
$$\hat{y}(\mathbf{x}) := w_0 + \sum_{i=1}^{n} w_i\, x_i + \sum_{i=1}^{n} \sum_{j=i+1}^{n} \langle \mathbf{v}_i, \mathbf{v}_j \rangle\, x_i\, x_j$$

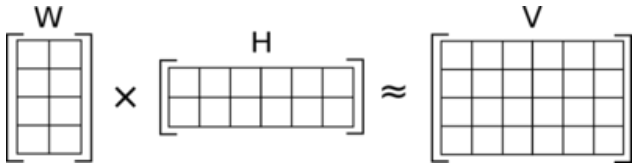


Matrix Factorization for Recommender Systems









initialize: $\mathbf{W}$ and $\mathbf{H}$ non negative.

Then update the values in $\mathbf{W}$ and $\mathbf{H}$ by computing the following, with n as an index of the iteration.

$$\mathbf{H}^{n+1}_{[i,j]} \leftarrow \mathbf{H}^{n}_{[i,j]} \frac{((\mathbf{W}^n)^T\mathbf{V})_{[i,j]}}{((\mathbf{W}^n)^T\mathbf{W}^n\mathbf{H}^n)_{[i,j]}}$$

and

$$\mathbf{W}^{n+1}_{[i,j]} \leftarrow \mathbf{W}^{n}_{[i,j]} \frac{(\mathbf{V}(\mathbf{H}^{n+1})^T)_{[i,j]}}{(\mathbf{W}^n\mathbf{H}^{n+1}(\mathbf{H}^{n+1})^T)_{[i,j]}}$$

Until $\mathbf{W}$ and $\mathbf{H}$ are stable.

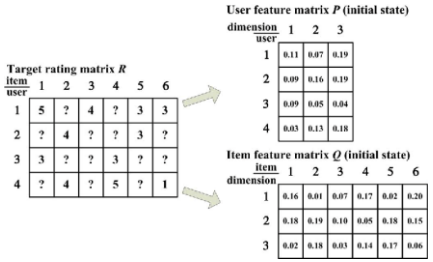


Image source: https://medium.com/@lineyin/the-singular-value-decomposition-and-pca-cae825ff28fc
https://www.dataminingapps.com/2020/02/singular-value-decomposition-in-recommender-systems/
https://en.wikipedia.org/wiki/Non-negative_matrix_factorization

Factorization Machine for Recommender Systems

$$\hat{y}(\mathbf{x}) := w_0 + \sum_{i=1}^{n} w_i\, x_i + \sum_{i=1}^{n} \sum_{j=i+1}^{n} \langle \mathbf{v}_i, \mathbf{v}_j \rangle\, x_i\, x_j \qquad (1)$$

where the model parameters that have to be estimated are:

$$w_0 \in \mathbb{R}, \quad \mathbf{w} \in \mathbb{R}^n, \quad \mathbf{V} \in \mathbb{R}^{n \times k} \qquad (2)$$

And $\langle \cdot, \cdot \rangle$ is the dot product of two vectors of size k:

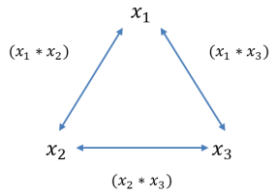
$$\langle \mathbf{v}_i, \mathbf{v}_j \rangle := \sum_{f=1}^{k} v_{i,f} \cdot v_{j,f} \qquad (3)$$

A row $\mathbf{v}_i$ within $\mathbf{V}$ describes the i-th variable with k factors. $k \in \mathbb{N}_0^+$ is a hyperparameter that defines the dimensionality of the factorization.

$$\begin{aligned}
&\sum_{i=1}^{n} \sum_{j=i+1}^{n} \langle \mathbf{v}_i, \mathbf{v}_j \rangle\, x_i\, x_j \\
&= \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \langle \mathbf{v}_i, \mathbf{v}_j \rangle\, x_i\, x_j - \frac{1}{2} \sum_{i=1}^{n} \langle \mathbf{v}_i, \mathbf{v}_i \rangle\, x_i\, x_i \\
&= \frac{1}{2} \left(\sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{f=1}^{k} v_{i,f}\, v_{j,f}\, x_i\, x_j - \sum_{i=1}^{n} \sum_{f=1}^{k} v_{i,f}\, v_{i,f}\, x_i\, x_i \right) \\
&= \frac{1}{2} \sum_{f=1}^{k} \left(\left(\sum_{i=1}^{n} v_{i,f}\, x_i \right) \left(\sum_{j=1}^{n} v_{j,f}\, x_j \right) - \sum_{i=1}^{n} v_{i,f}^2\, x_i^2 \right) \\
&= \frac{1}{2} \sum_{f=1}^{k} \left(\left(\sum_{i=1}^{n} v_{i,f}\, x_i \right)^2 - \sum_{i=1}^{n} v_{i,f}^2\, x_i^2 \right)
\end{aligned}$$

$$\hat{y}(\mathbf{x}) := w_0 + \sum_{i=1}^{n} w_i\, x_i + \frac{1}{2} \sum_{f=1}^{k} \left(\left(\sum_{i=1}^{n} v_{i,f}\, x_i \right)^2 - \sum_{i=1}^{n} v_{i,f}^2\, x_i^2 \right)$$

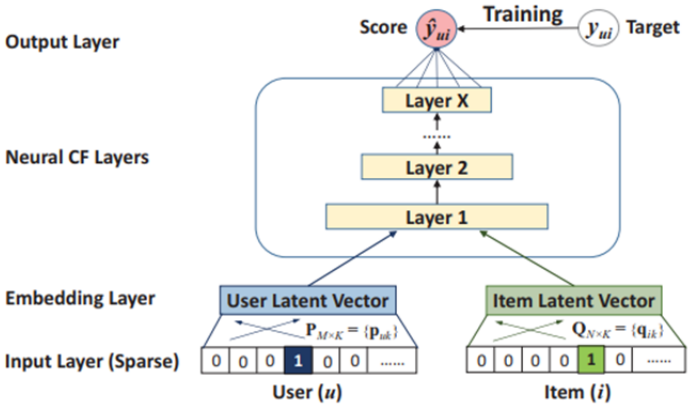
$$\frac{\partial}{\partial \theta} \hat{y}(\mathbf{x}) = \begin{cases} 1, & \text{if } \theta \text{ is } w_0 \\ x_i, & \text{if } \theta \text{ is } w_i \\ x_i \sum_{j=1}^{n} v_{j,f} x_j - v_{i,f} x_i^2, & \text{if } \theta \text{ is } v_{i,f} \end{cases}$$

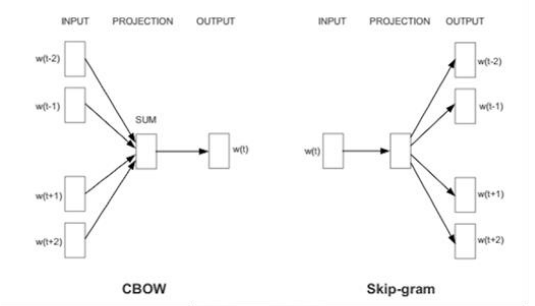


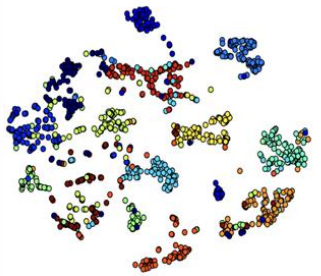
Reference: https://www.jefkine.com/recsys/2017/03/27/factorization-machines/
https://ieeexplore.ieee.org/abstract/document/5694074?casa_token=CV0m3FJ7U3UAAAAA:1rubmy3hLA6hvfRzAxZV4ykDx4kufMqEsGPX69_eJckG3BP05EJCh7DEkUcSmGQzc6JhEf37dX4
https://math.stackexchange.com/questions/1801403/decomposition-of-a-positive-semidefinite-matrix

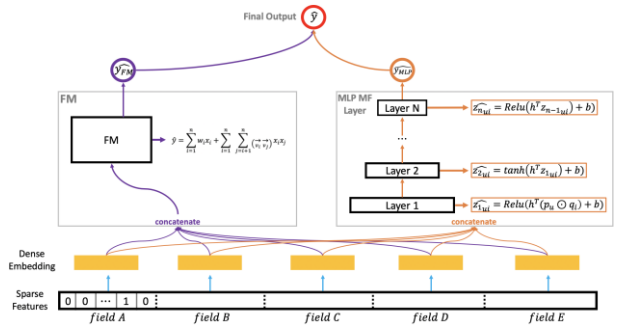
Deep Learning for Recommender Systems

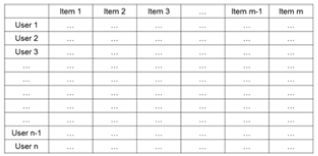
- Deep-learning-based nonlinearity consideration complements the traditional approaches
- Deep-learning-based representation/embedding complements the traditional approaches









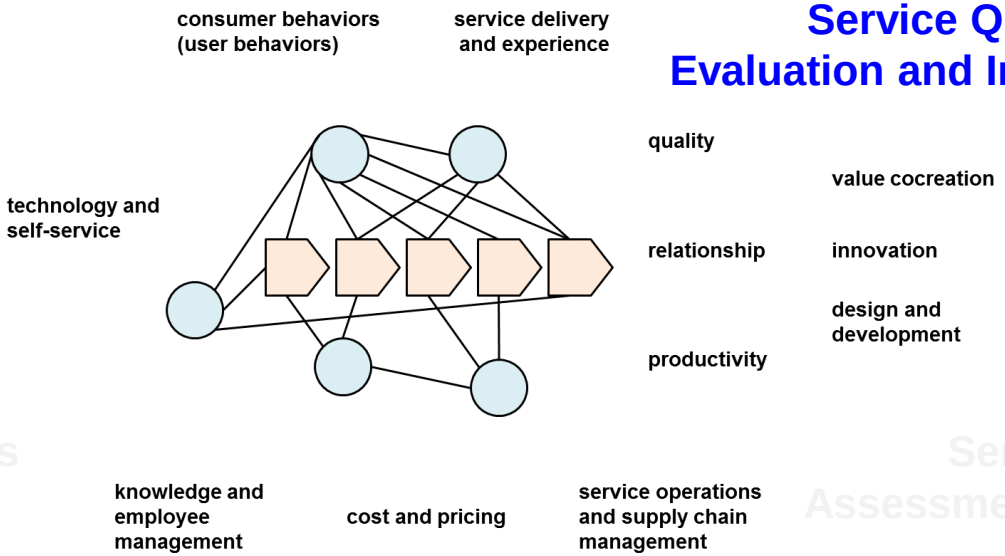


- Euclidean distance
- Cosine similarity
- Jaccard coefficient
- Pearson correlation coefficient
- …

Assignment 2 (by 9.16 11:59 pm)

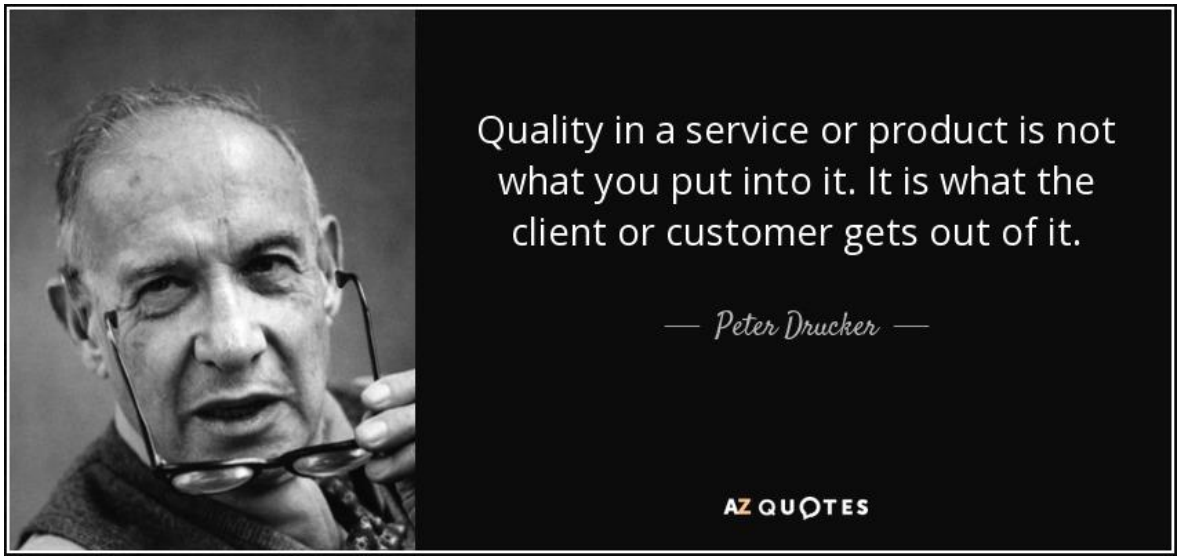
- There are two types of practice demonstrated by TAs. One approach is to use the user-item matrix and the other is to use the transaction-feature matrix. By yourself, (1) identify several (i.e., top k) recommendations using one of the two approaches with the given datasets. Of course you can try both.
- (2) Then, evaluate and interpret the recommendation outcomes quantitatively (e.g., calculate the recall, calculate the similarities between the recommended items) and qualitatively (e.g., interpret the factorization outcome, identify the characteristics of the top k recommended items). Do it all by yourself, and describe the analysis/interpretation process and outcome in detail.
- (3) Assume you need to use your recommender system for real-world service (i.e., streaming service or hypermarket service). How can you improve your recommender system to be used for the service effectively? For example, what kinds of data should you use further? How would you design a method for using/learning the data? Think beyond these examples in your own creative, unique way!
- (4) You must have your own interested or favorite service WITHOUT a recommender system (i.e., it should be different with the intelligent services discussed in the class). Discuss the requirements of original recommender system development for the service. Describe the requirements in detail.
- (5) If you would conduct a study on the recommender system development for the service, how would you conduct the research in your own creative, unique way? What kinds of data and methods are you going to collect, analyze, and learn? 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 recommender system paper related to the service you are interested or concerned.
- Upload your code and a several paragraph essay on the tasks (1)~(5) in the Blackboard.

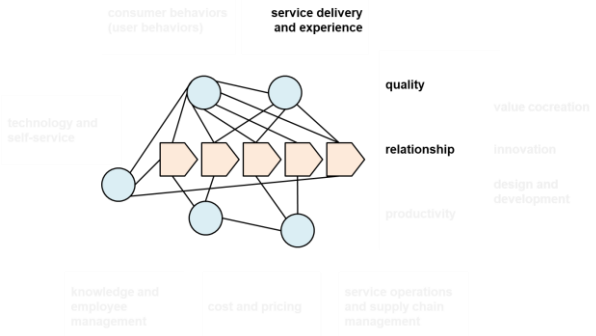
Topics of the Service Intelligence Course



Service Quality

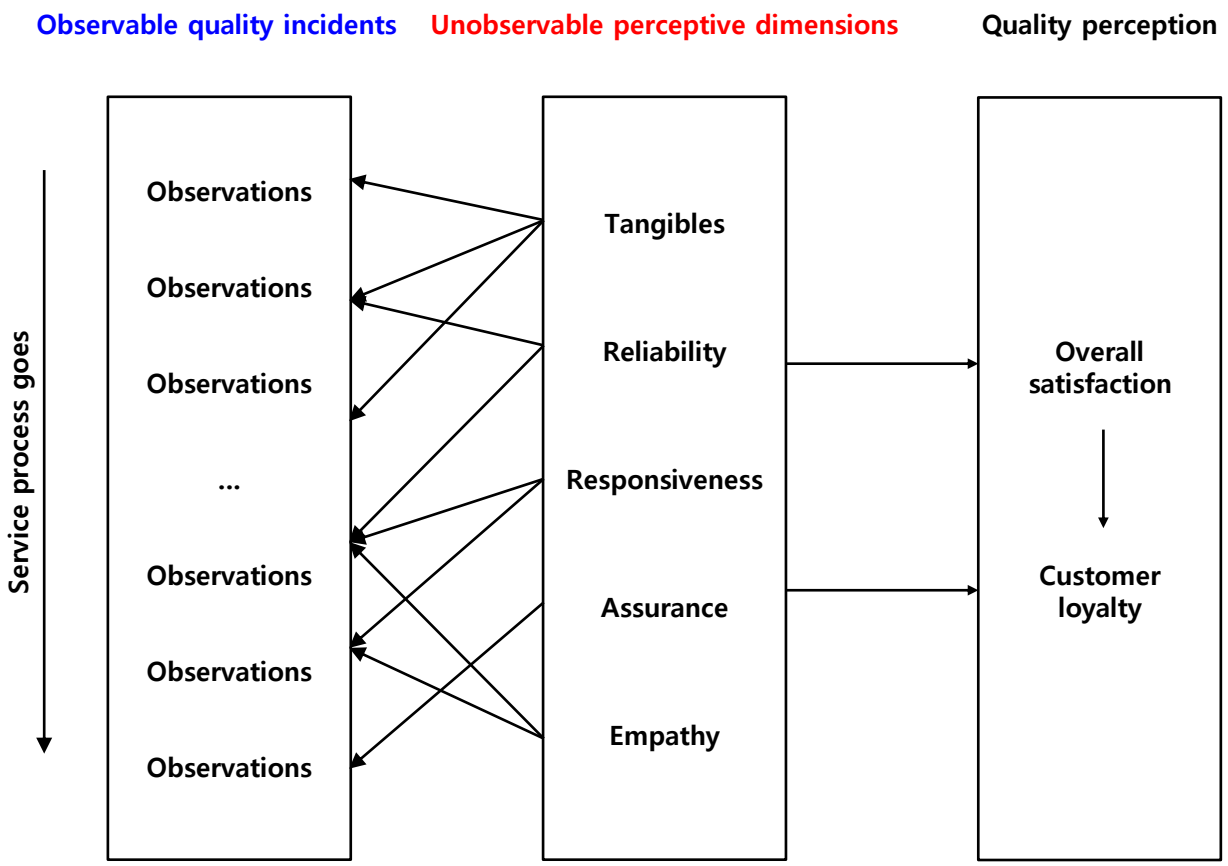
- A perspective of quality





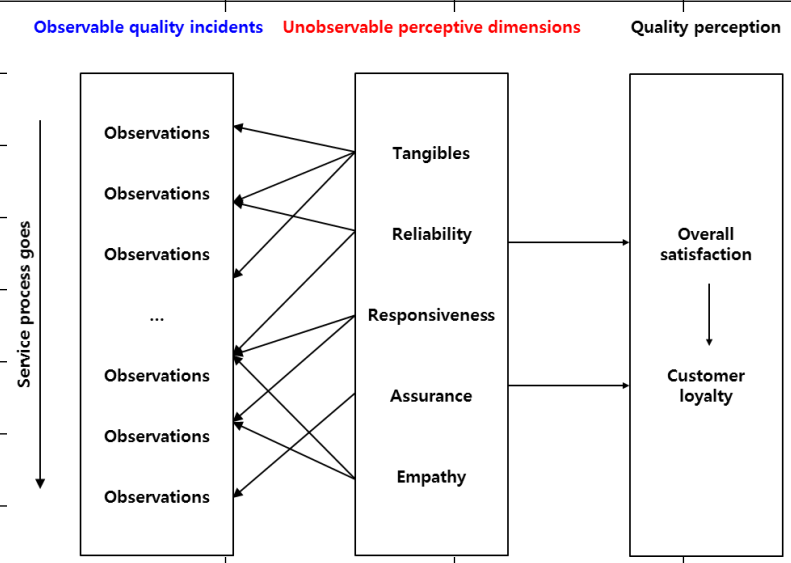
- A definition of service quality
  - "The totality of characteristics of a service that bears on its ability to satisfy stated and *implied* needs of customers."

Illustration of Service Quality Evaluation



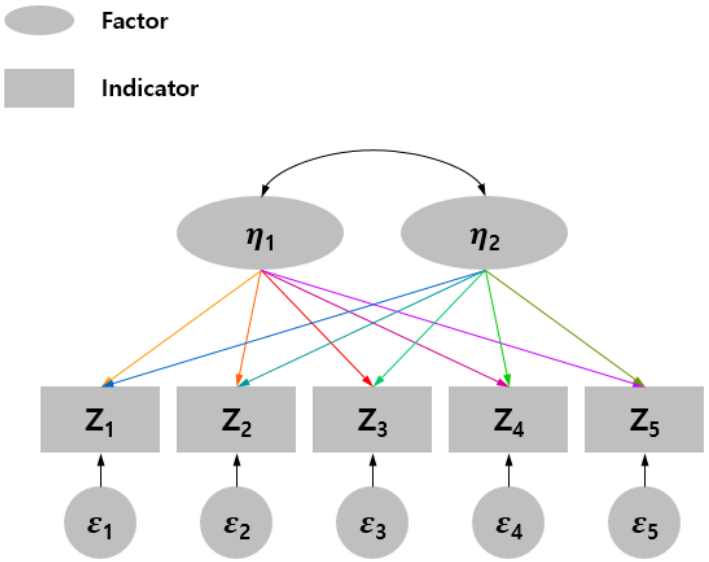
Service Quality “Representation”

	Feature 1	Feature 2	Feature 3	…	Feature m-1	Feature m
Customer 1	…	…	…	…	…	…
Customer 2	…	…	…	…	…	…
Customer 3	…				..	…
…	…				..	…
…	…				..	…
…	…				..	…
…	…				..	…
…	…				..	…
…	…				..	…
…	…				..	…
Customer n-1	…	…	…	…	…	…
Customer n	…	…	…	…	…	…



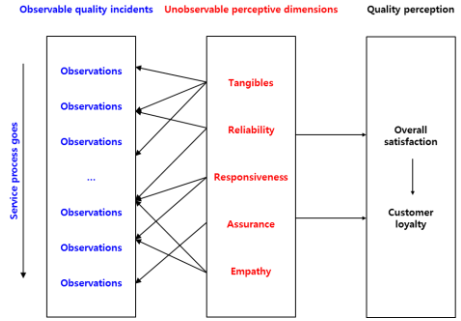
Factor Analysis for Service Quality Representation

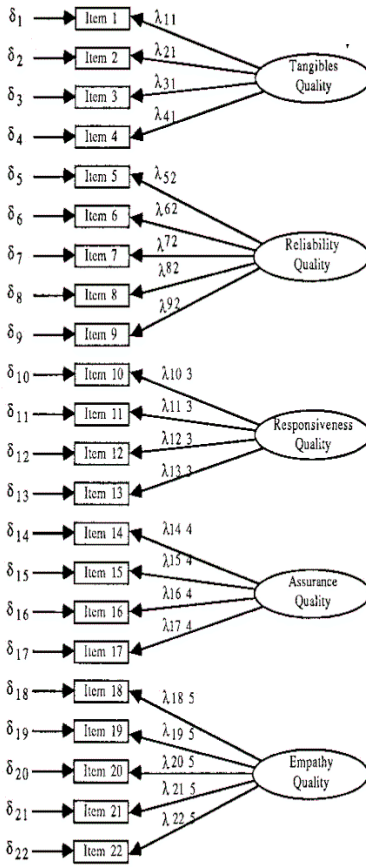
- Statistical method to analyze observable variables in understanding a specific topic
- To identify the underling constructs (i.e., to represent latent variables)



$$Z_1 = \lambda_{11}\eta_1 + \lambda_{12}\eta_2 + \varepsilon_1$$
$$Z_2 = \lambda_{21}\eta_1 + \lambda_{22}\eta_2 + \varepsilon_2$$
$$Z_3 = \lambda_{31}\eta_1 + \lambda_{32}\eta_2 + \varepsilon_3$$
$$Z_4 = \lambda_{41}\eta_1 + \lambda_{42}\eta_2 + \varepsilon_4$$
$$Z_5 = \lambda_{51}\eta_1 + \lambda_{52}\eta_2 + \varepsilon_5$$

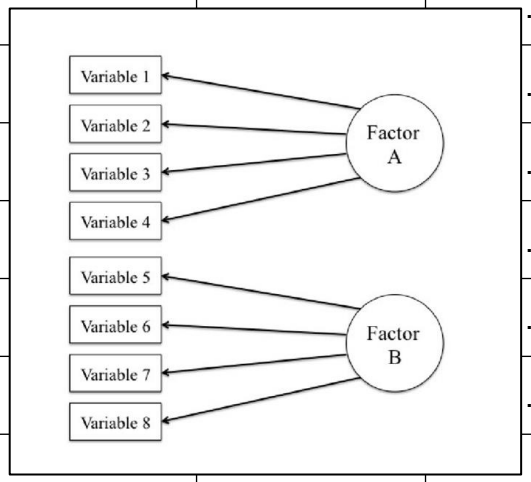
F_1 loading | F_2 loading | unique loading

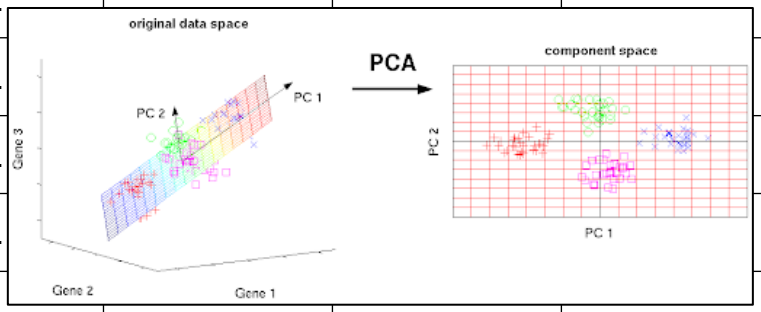


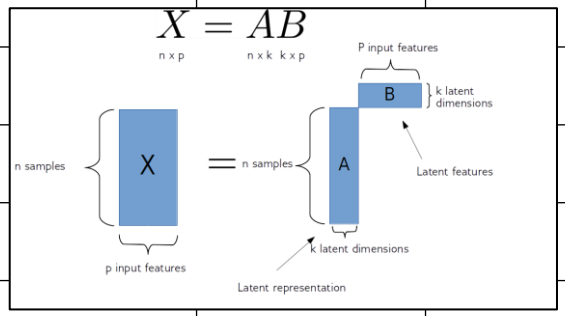


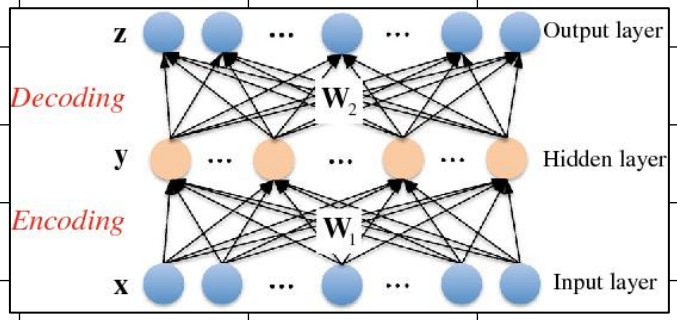
Other Methods for Service Quality Representation

	Feature 1	Feature 2	Feature 3	…	Feature m-1	Feature m
Customer 1			…	…	…	…
Customer 2			…			
Customer 3			…			
…			…			
…			…			
…			…	…	…	…
…			…	…	…	…
…						
…						
…						
Customer n-1						
Customer n	…	…	…	…	…	…









Validation of the Quality Dimensions

Construct Validity

1 Convergent Validity

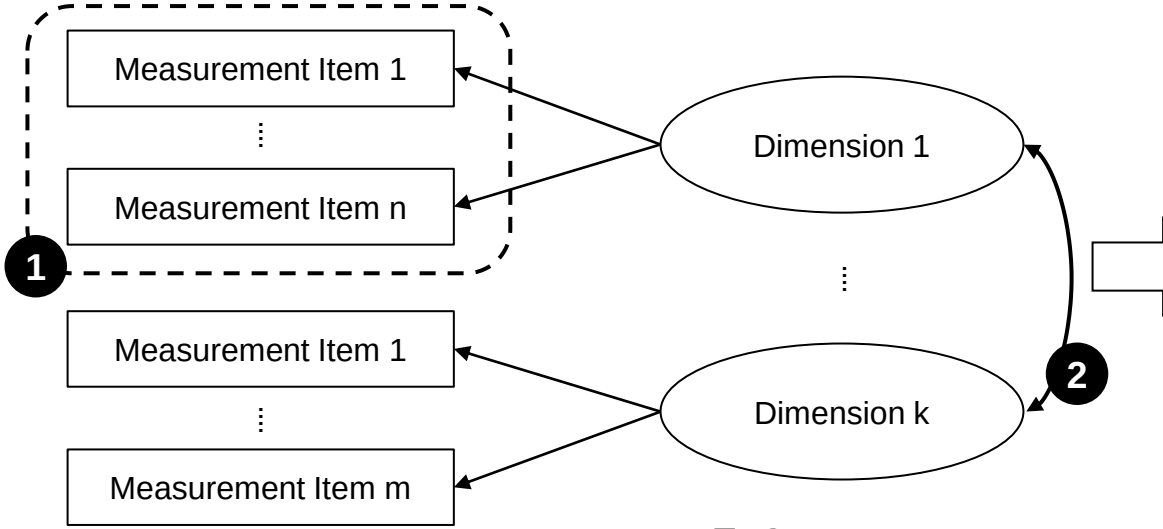
The extent to which a set of the items assumed to represent a dimension does in fact converge on the same dimension

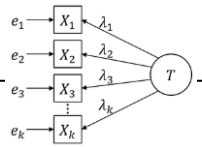
2 Discriminant Validity

The extents to which measures of theoretically unrelated dimension do not correlate with one another

3 Predictive Validity
(Nomological Validity)

The extents to which the score of one dimension is empirically related to the scores of other conceptually related constructs





$$\frac{(\sum \lambda_i{}^2)}{(\sum \lambda_i{}^2) + (\sum_i var\,(\varepsilon_i))}$$

TABLE 6

Relative Importance of the Five Dimensions in Predicting Overall Quality

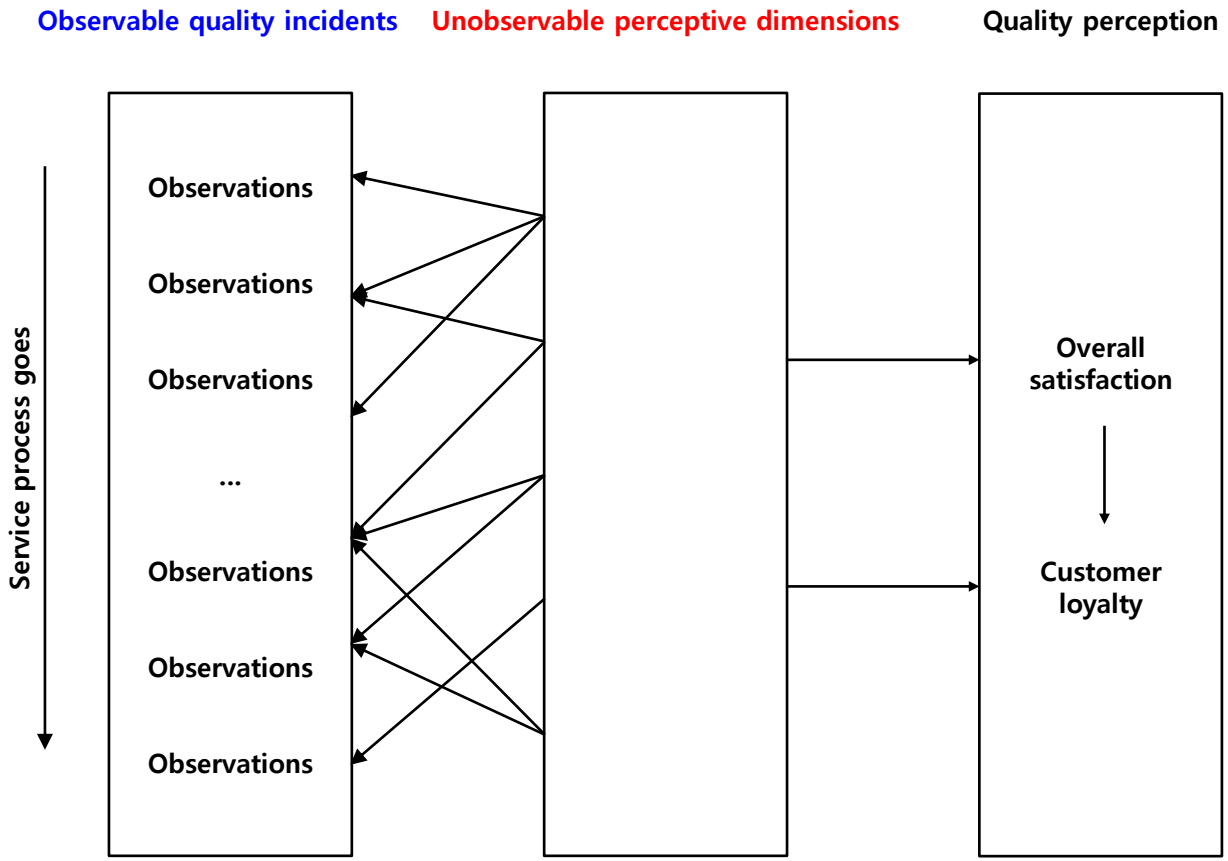
Dimension	Standardized Slope Coefficient	Significance Level of Slope[a]	Adusted R^2	
Bank				
Tangibles	.13	.07	.28 ($p < .00$)	
Reliability	.39	.00		
Responsiveness	.07	.35		
Assurance	.13	.09		
Empathy	.01	.89		

Reference: Peter (1981)

Assignment 3 (by 09.23 11:59 pm)

- Read Article 3. Summarize the article (one paragraph) with your own comments to the article (one paragraph) (i.e., two paragraphs in total).
- By yourself, complete the identification of the latent factors indicating the quality of the Onecare mobile healthcare service based on the practice demonstrated by the TA. Use the user-question matrix data provided. Do it all by yourself, and describe the identification process and outcome in detail. Interpret the outcome (i.e., interpret the quality dimensions you identified).
- Discuss the "quality representation and measurement of service systems from a customer/user perspective" (focus on the service system you are interested or concerned). What other data and learning methods can be used for the identification of the latent factors indicating the quality of a service? Describe your thoughts/ideas on learning service quality dimensions with data about customer perception, behaviors, etc., in detail.
- What dimensions do you think we should consider for the evaluation of quality of AI-based services? i.e., As a user/customer of AI services (or as an undergraduate student researcher), what are the requirements of AI service you think important? And why do you think so? Describe the rationale or reasons for your suggestion.
- Furthermore, assume that you actually need to represent and evaluate the quality of an AI-based service in your company or institute. How would you develop a quality representation and measurement method for the service? What AI-based service are you going to focus on? What kinds of data and methods are you going to collect, analyze, and learn? Describe your research plan in detail. If possible, visualize your research framework clearly (e.g., draw image, mathematical model).
- Upload your code and a several paragraph essay in the Blackboard.

Quality of AI-based Services? (Assignment 3)



Topics of the Service Intelligence Course

Service Review Mining

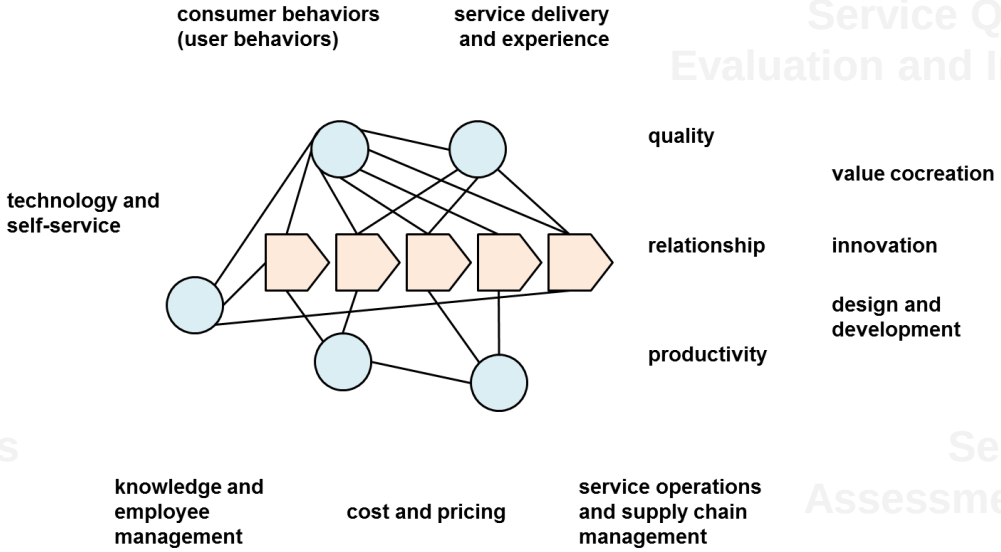
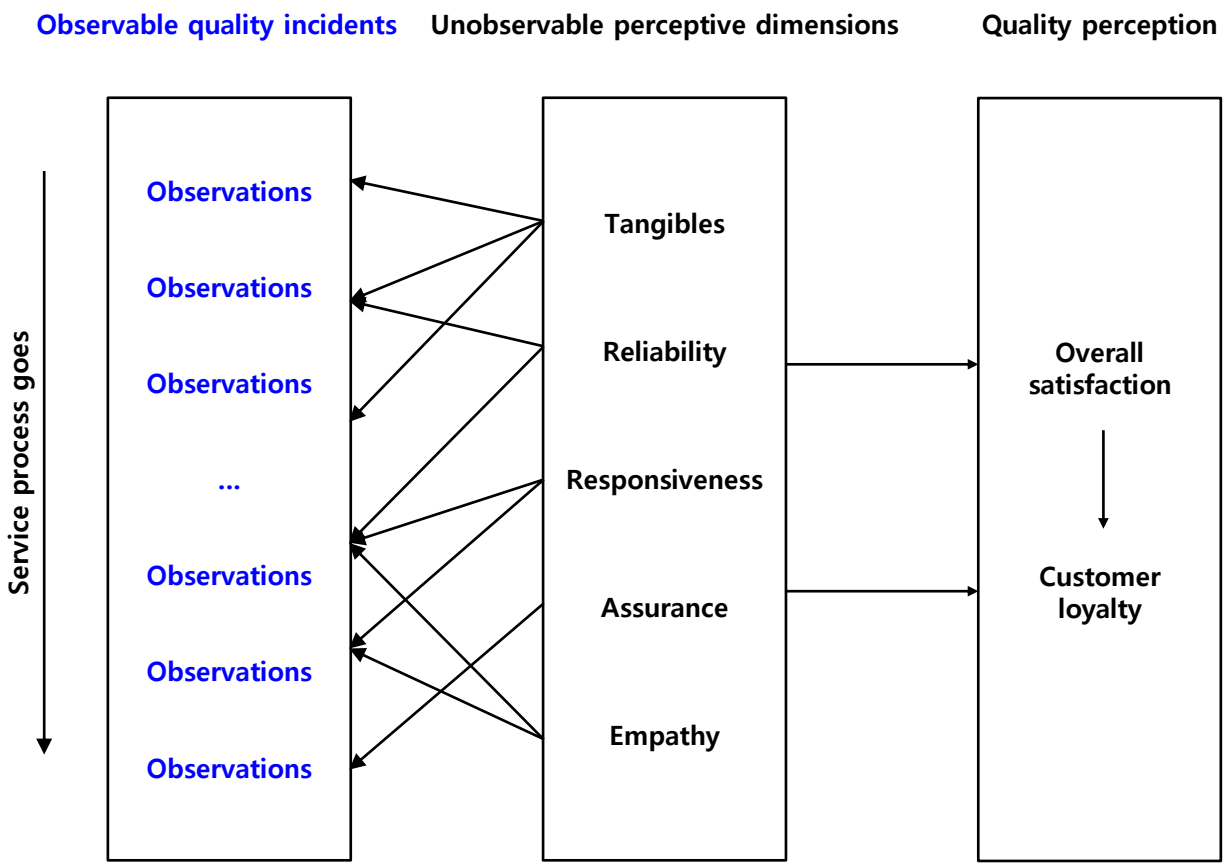


Illustration of Service Quality Evaluation

- What other observations are available these days?

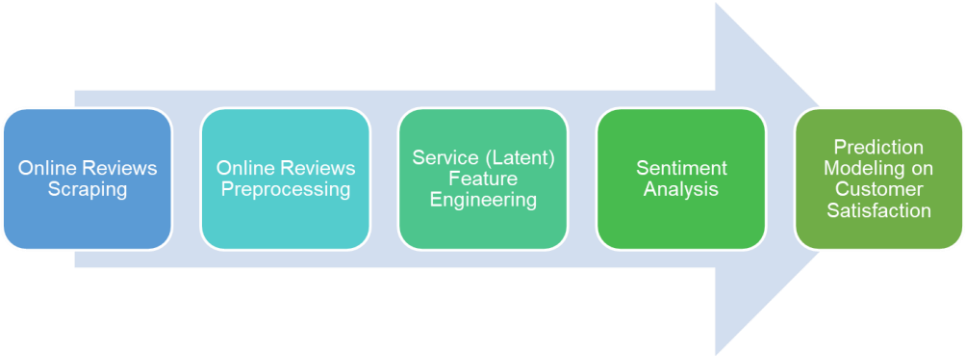


Online Review Mining for Service Improvement

- What other observations are available these days?

vs

Online Review Mining Framework for Service Improvement



	Word 1	Word 2	Word 3	…	Word m-1	Word m	Rating
Review 1	1	2	0	3	4	0	5
Review 2	-	-	-	-	-	-	5
Review 3	-	-	-	-	-	-	4
…	-	-	-	-	-	-	3
…	-	-	-	-	-	-	4
…	-	-	-	-	-	-	1
…	-	-	-	-	-	-	4
…	-	-	-	-	-	-	5
…	-	-	-	-	-	-	4
…	-	-	-	-	-	-	3
Review n-1	-	-	-	-	-	-	2
Review n	-	-	-	-	-	-	4

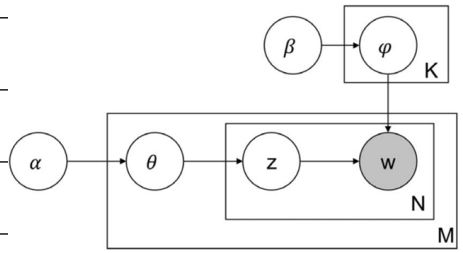
	Feature 1	Feature 2	Feature 3	…	Feature k-1	Feature k	Rating
Review 1	?	?	?	?	?	?	5
Review 2	?	?	?	?	?	?	5
Review 3	?	?	?	?	?	?	4
…	?	?	?	?	?	?	3
…	?	?	?	?	?	?	4
…	?	?	?	?	?	?	1
…	?	?	?	?	?	?	4
…	?	?	?	?	?	?	5
…	?	?	?	?	?	?	4
…	?	?	?	?	?	?	3
Review n-1	?	?	?	?	?	?	2
Review n	?	?	?	?	?	?	4

Word Vectorization and Service Feature Engineering

	Word 1	Word 2	Word 3	…	Word m-1	Word m	Rating
Review 1	1	2	0	3	4	0	5
Review 2	-	-	-	-	-	-	5
Review 3	-					-	4
…	-					-	3
…	-					-	4
…	-					-	1
…	-					-	4
…	-					-	5
…	-					-	4
…	-	-	-	-	-	-	3
Review n-1	-	-	-	-	-	-	2
Review n	-	-	-	-	-	-	4

Step 1: Choose $\theta_i \backsim \mathrm{Dir}(\alpha)$, where i $\in \{1, \ldots, M\}$
Step 2: Choose $\varphi_k \backsim \mathrm{Dir}(\beta)$, where k $\in \{1, \ldots, K\}$
Step 3: For each word position i, j, where $i \in \{1, \ldots, M\}$ and $j \in \{1, \ldots, N_i\}$
Choose a topic $z_{ij} \backsim$ Multinomial (θ_i)
Choose a word $w \backsim$ Multinomial $(\varphi_{z_{ij}})$

P1=P(topic k / document D)
P2=P(word w / topic k)



Graphical model representation of LDA

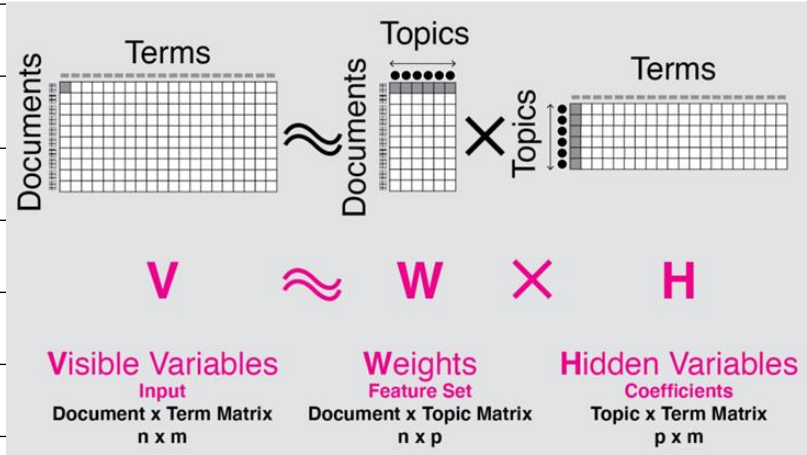
M = number of customer reviews
N = number of words in a review
K = number of topics
α = parameter of the Dirichlet prior on the per-review topic distribution
β = parameter of the Dirichlet prior on the per-topic word distribution
θ_i = topic distribution for review i (the sum of θ_i is 1)
φ_k = word distribution for topic k
z_{ij} = topic for the j^{th} word in review i
w = specific word

Word Vectorization and Service Feature Engineering

$$tf\text{-}idf\ value\ after\ normalization, when\ tf\text{-}idf(t,d) = tf(t,d) \times (log\frac{1+n_d}{1+df(d,f)} + 1)$$

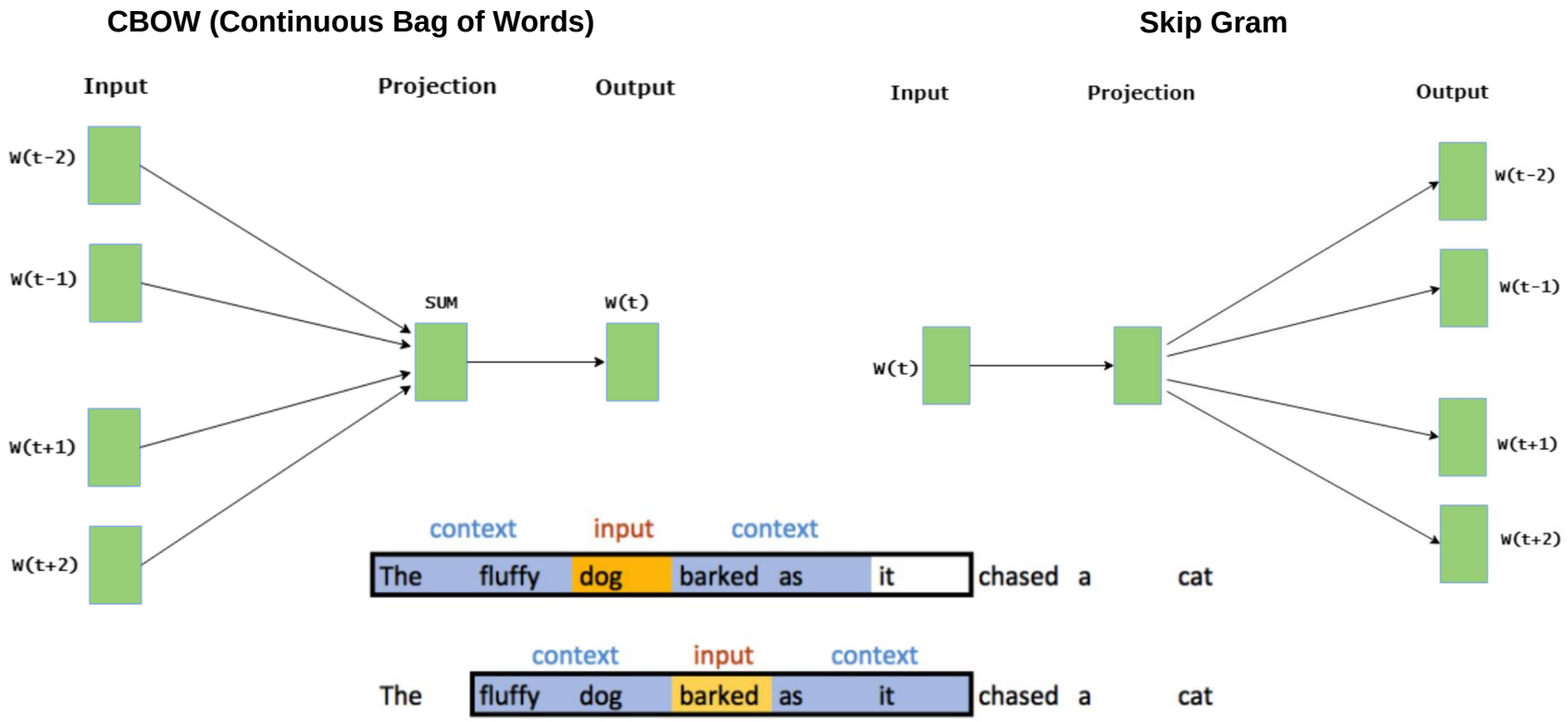
	Word 1	Word 2	Word 3	…	Word m-1	Word m	Rating
Review 1	0.04	0.18	0	0.23	0.10	0	5
Review 2	-	-	-	-	-	-	5
Review 3	-					-	4
…	-					-	3
…	-					-	4
…	-					-	1
…	-					-	4
…	-					-	5
…	-					-	4
…	-					-	3
Review n-1	-	-	-	-	-	-	2
Review n	-	-	-	-	-	-	4

$$Minimize\ ||V - WH||, W, H \geq 0$$



Word Vectorization and Service Feature Engineering

- Word2vec (Mikolov et al., 2013)
  - Word2Vec uses shallow two layer neural networks having one input layer, one hidden layer and one output layer



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Sentiment Analysis for Service Feature Engineering

	f_1	f_2	…	f_9
1	**Location** was great	Awesome **view**	…	Terrible **internet** speed
2		City **view** was not good	…	
3			…	
…	…	…	…	…
32044			…	

Sentiment intensity score from VADER sentiment analyzer
'Location': 0.6249
'View': 0.6249, -0.3412
'Internet', -0.4767

$$S_{im} = \begin{cases} 4, \ if \ 0.525 \leq \text{Sentiment intensity} \leq 1 \\ 3, \ if \ 0.05 \leq \text{Sentiment intensity} < 0.525 \\ 0, \ if \ -0.05 < \text{Sentiment intensity} < 0.05 \\ 2, \ if \ -0.525 < \text{Sentiment intensity} \leq -0.05 \\ 1, \ if \ -1 \leq \text{Sentiment intensity} \leq -0.525 \end{cases}$$

Encoding for input variable

	f_1	f_2	…	f_9	Star ratings
1	4	4	…	2	0
2	0	2	…	0	0
3	0	0	…	0	1
…	…	…	…	…	…
32044	0	0	…	0	1

→ Negative label (1, 2, 3 ratings)

→ Positive label (4, 5 ratings)

Input variables

Output variables

Prediction Modeling on Customer Satisfaction

- Logit model
  - $y = 0.227 \cdot location + 0.085 \cdot view + 0.095 \cdot breakfast + 0.009 \cdot sleep\ quality + 0.119 \cdot bathroom + 0.328 \cdot service + 0.01 \cdot check + 0.087 \cdot value + 0.04 \cdot internet$

$$Y_i = \beta_0 + \beta_1 A_1 + \beta_2 A_2 + \cdots \beta_i A_i$$

	f_1	f_2	…	f_9	Star ratings
1	5	5	…	2	0
2	0	2	…	0	0
3	0	0	…	0	1
…	…	…	…	…	…
32044	0	0	…	0	1

→ Negative label (1, 2, 3 ratings)

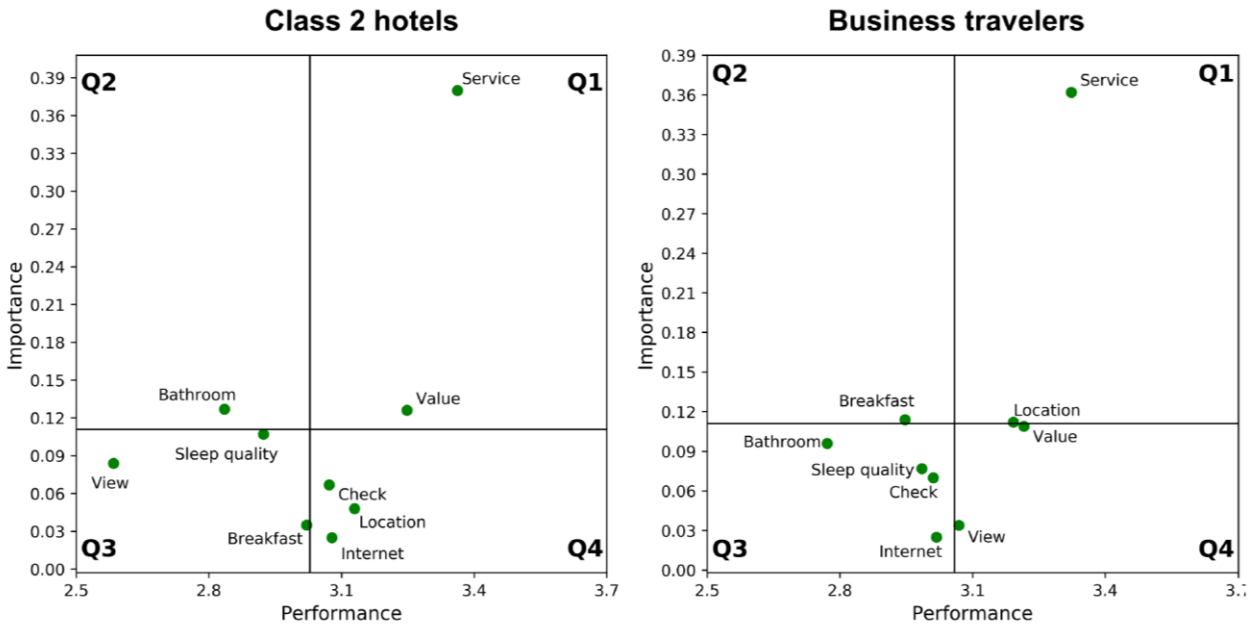
→ Positive label (4, 5 ratings)

Input variables

Output variables

Service Improvement Implications from Online Review Mining

- Importance-Performance Analysis (IPA) for service improvement
  - Q1: “Keep up the good work” : major strengths
  - Q2: “Concentrate here” : immediate action for improvement
  - Q3: “Low priority” : minor weaknesses
  - Q4: Possible overkill” : minor strengths



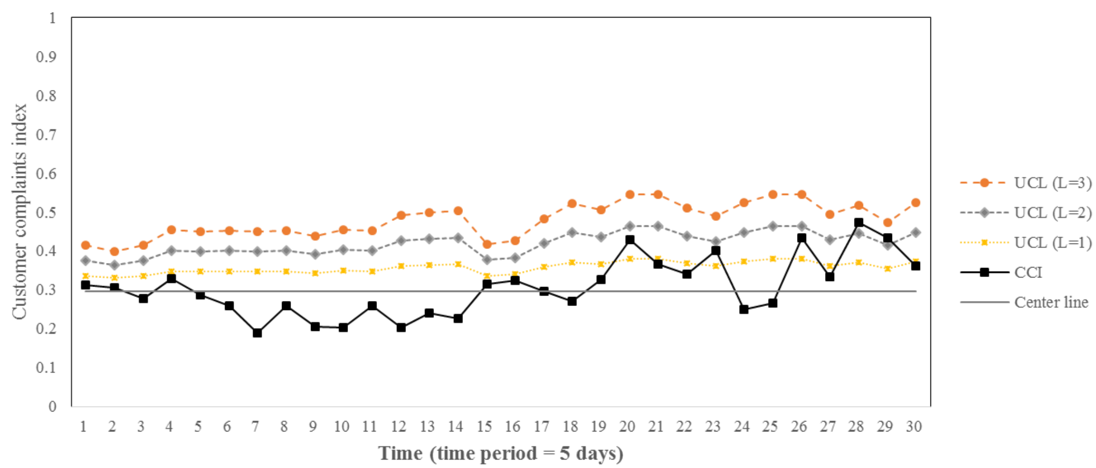
On the Time Dynamics of Customer Review – Service Feature

	Feature 1	Feature 2	Feature 3	…	Feature m-1	Feature m	Rating
Review 1	…	…	…	…	…	…	5
Review 2	…	…	…	…	…	…	5
Review 3	…	…	…	…	…	…	4
…	…	…	…	…	…	…	3
…	…	…	…	…	…	…	4
…	…	…	…	…	…	…	1
…	…	…	…	…	…	…	4
…	…	…	…	…	…	…	5
…	…	…	…	…	…	…	4
…	…	…	…	…	…	…	3
Review n-1	…	…	…	…	…	…	2
Review n	…	…	…	…	…	…	4

	Feature 1	Feature 2	Feature 3	…	Feature m-1	Feature m	Rating
Review 1	…	…	…	…	…	…	5
Review 2	…	…	…	…	…	…	5
Review 3	…	…	…	…	…	…	4
…	…	…	…	…	…	…	3
…	…	…	…	…	…	…	4
…	…	…	…	…	…	…	1
…	…	…	…	…	…	…	4
…	…	…	…	…	…	…	5
…	…	…	…	…	…	…	4
…	…	…	…	…	…	…	3
Review n-1	…	…	…	…	…	…	2
Review n	…	…	…	…	…	…	4

	Feature 1	Feature 2	Feature 3	…	Feature m-1	Feature m	Rating
Review 1	…	…	…	…	…	…	5
Review 2	…	…	…	…	…	…	5
Review 3	…	…	…	…	…	…	4
…	…	…	…	…	…	…	3
…	…	…	…	…	…	…	4
…	…	…	…	…	…	…	1
…	…	…	…	…	…	…	4
…	…	…	…	…	…	…	5
…	…	…	…	…	…	…	4
…	…	…	…	…	…	…	3
Review n-1	…	…	…	…	…	…	2
Review n	…	…	…	…	…	…	4

Time



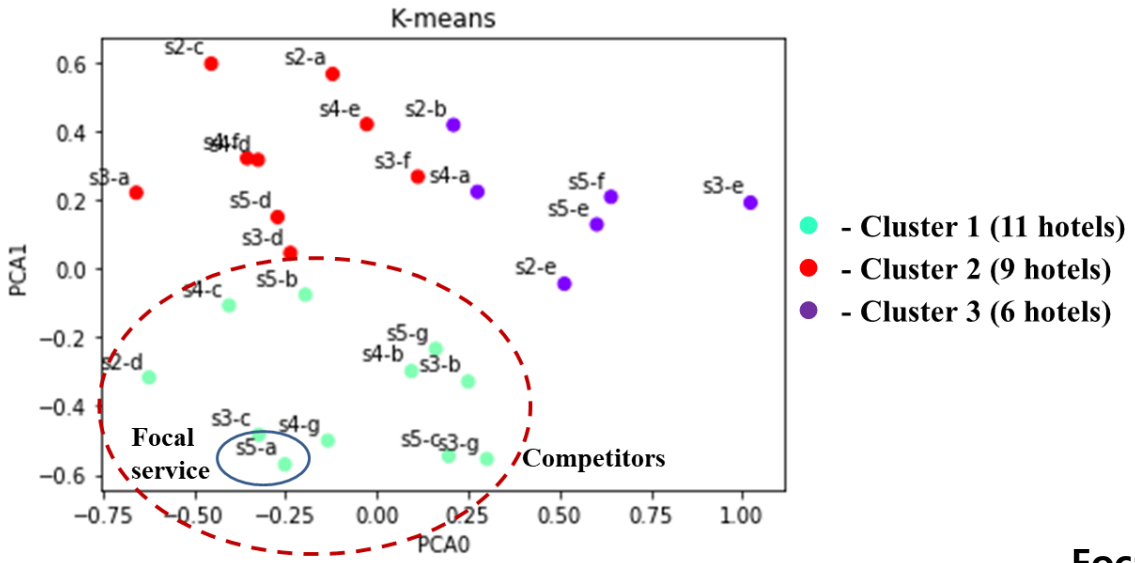
Customer-oriented Benchmarking of Service Firms

- Measurement of firm's service feature importance and performance

Hotel	Coefficient values of the service features								
	Food	Service	Room	Facility	Location	Cleanliness	Value	Wi-Fi	Security
S2-a	0.309	0.634	0.383	0.000	0.234	0.618	0.274	1.000	0.571
S2-b	0.369	0.655	0.670	0.000	0.284	0.813	0.437	1.000	0.168
S2-c	0.301	0.483	0.608	0.171	0.000	0.531	0.192	0.726	1.000
S2-d	0.105	0.033	0.120	0.097	0.000	1.000	0.292	0.274	0.551
S2-e	0.000	0.788	0.567	0.805	0.020	1.000	0.792	0.591	0.021
S3-a	0.175	0.235	0.667	0.363	0.124	0.787	0.000	0.389	1.000
…	…	…	…	…	…	…	…	…	…
S5-a	0.075	0.328	0.211	0.213	0.000	1.000	0.332	0.035	0.200
S5-b	0.227	0.587	0.502	0.150	0.000	1.000	0.199	0.425	0.338
S5-c	0.346	0.523	0.533	0.321	0.081	1.000	0.550	0.020	0.000
S5-d	0.154	0.436	0.785	0.313	0.000	1.000	0.286	0.531	0.566
S5-e	0.516	0.812	0.694	0.612	0.373	1.000	0.556	0.774	0.000
S5-f	0.268	1.000	0.405	0.584	0.138	0.000	0.773	0.341	0.324
S5-g	0.320	0.504	0.521	0.275	0.159	1.000	0.425	0.428	0.000
Average	0.261	0.571	0.504	0.289	0.147	0.840	0.384	0.483	0.388

Customer-oriented Benchmarking of Service Firms

- Identification of the competitors and best practices as benchmark
  - Identifying the **competitors** via *K*-means clustering
    - Conducting the *k*-means clustering algorithm to identify competitor groups
    - Identified groups for 26 hotels in Bangkok



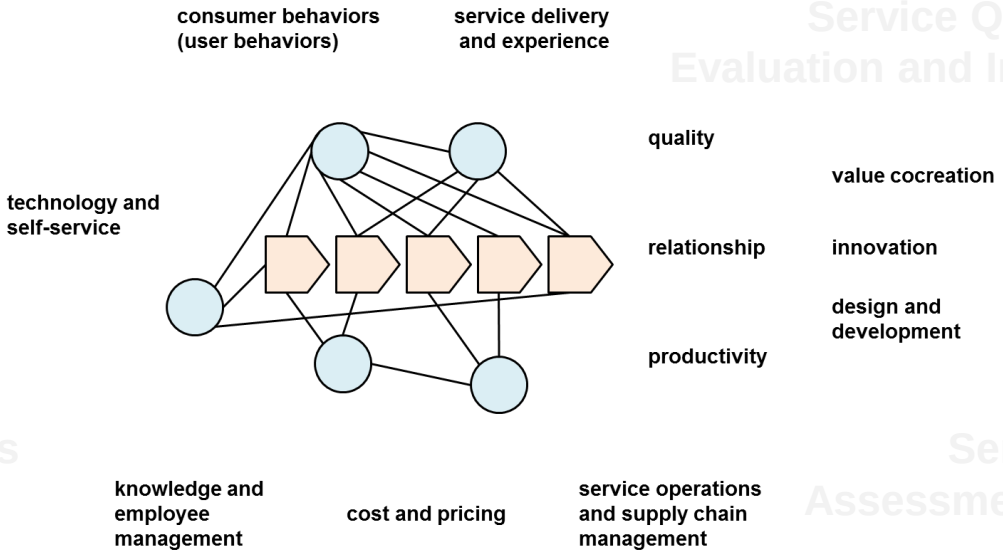
Focal hotel

Hotel	S2-d	S3-b	S3-c	**S3-g**	S4-b	S4-c	**S4-g**	S5-a	**S5-b**	S5-c	S5-g
Performance	0.45	0.459	0.445	0.839	0.426	0.543	0.724	0.604	0.623	0.492	0.564
Ranking	9	8	10	1	11	6	2	4	3	7	5

Assignment 4 (by 10.7 11:59 pm)

- By yourself, (1) complete the construction of the review-feature dataset on service quality of hotels in Singapore based on the practice demonstrated by the TA. Then, (2) using the review-feature matrix you constructed, develop a service quality prediction model for the hotels in Singapore (i.e., predict the customer's quality evaluation with review data). Do it all by yourself, and describe the analysis process and outcome in detail. Interpret the outcome (e.g., name the service features you identified, interpret the coefficient/importance values of service features to the quality ratings).
- (3) What other interesting machines can be developed using the review-feature matrix dataset you constructed? Describe your ideas in detail (e.g., describe the learning objective and process). Try to think your own creative, unique ideas! You have completed the basic review mining activities (tasks 1 and 2) as well as your own idea generation (task 3). Then, (4) describe how you can use your machine(s) to automate the monitoring, evaluation, and improvement of hotel service quality? Imagine you are working for a real hotel.
- Using a similar approach that you have practiced so far, (5) what other services can be improved using review mining machines or another intelligent machine that learns other types of raw data traces of service quality (e.g., customer behavior data)? Assume that you actually manage the quality of service in question. (6) How would you conduct this job in your own creative, unique way? What kinds of data and methods are you going to collect, analyze, and learn? Describe your service intelligence development plan in detail. If possible, visualize your plan clearly (e.g., draw an image, construct a mathematical model).
- Upload your code and a several paragraph essay on the tasks (1)~(6) in the Blackboard.

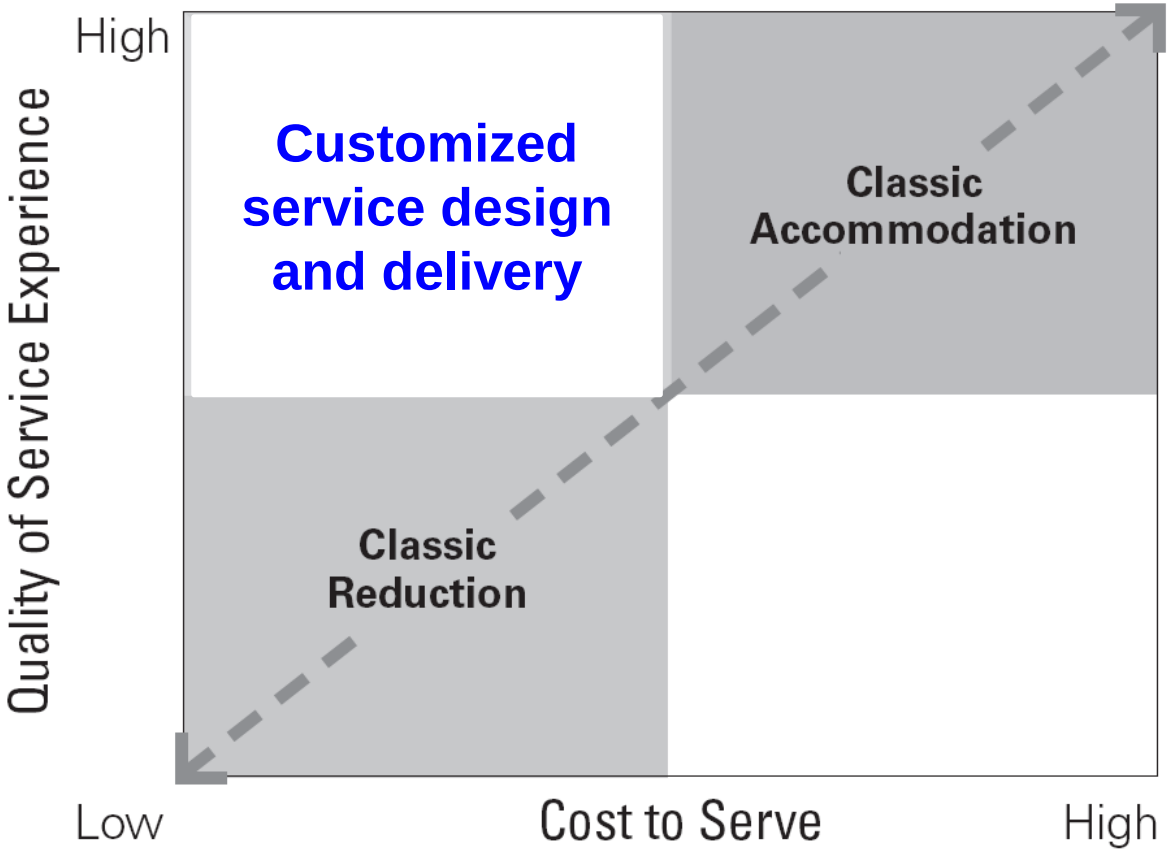
Topics of the Service Intelligence Course



Customer Segmentation and Service Customization

Customization is the Essence in Service Design and Delivery

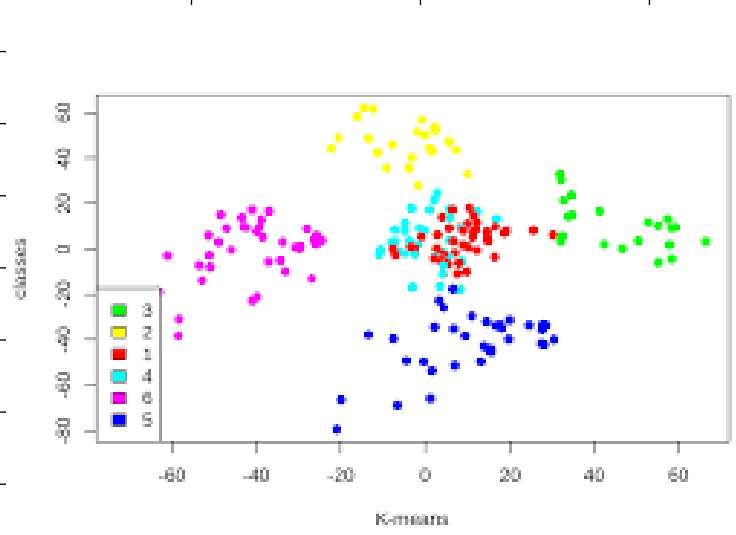
- Service customization should aim to accommodate and control customer variability at the same time



Customer Segmentation: A Dataset Perspective

- Customer-feature matrix

	Feature 1	Feature 2	Feature 3	…	Feature m-1	Feature m
Customer 1	…	…	…	…	…	…
Customer 2	…	…	…	…	…	…
Customer 3	…					…
…	…					…
…	…					…
…	…					…
…	…					…
…	…					…
…	…					…
…	…					…
Customer n-1	…	…	…	…	…	…
Customer n	…	…	…	…	…	…



Customer Segmentation: Students Clustering for Counseling/Advising

489 respondents from the 5 universities

	질문	1차설문	2차설문
1	너의 취미가 뭐야?	o	o
2	너에게 중요한 관계는 누구야?	o	o
3	그러면 너가 일 또는 공부를 하고 있는 혹은 일하게 될 공간에서 동료와의 관계는 어땠으면 좋겠어?	o	o
4	너가 설계하는 미래의 커리어가 있을까?	o	o
5	이번에는 좀 더 넓게, 너가 꿈꾸는 삶은 어떤 삶이야? 흔히 라이프스타일이라고들 하지!	o	o
6	그러면 너가 현재 어떤 것을 잘 하는지 궁금해 지는데, 혹시 난 이걸 좀 잘하는 거 같아 하는게 있을까?	o	o

What are the Main Difficulties in Students' Task Completion??

12	그러면 일을 처리할 때 너의 패턴이 있을거잖아, 일할 때 습관이라던지.. 그 중에 일을 잘 할수 있게 해 주는 요소가 있을까?	o	o
13	이번엔 해야 할 일을 미루게 하거나, 못하게 하는 요소는 어떤 게 있을까?	o	o
14	어떤 마음이, 어떤 성격이 해야할 일(활동)을 하는데 방해가 되는 거 같아?	o	o
15	일을 처리할 때의 너의 습관 중에서 일을 방해하는 요소가 있을 텐데 그게 뭐야?	o	x
16	너의 삶에서 가치있는 것들 3가지만 말해볼래?	o	o
17	그러면 이 가치들을 실현하기 위한 너의 삶의 목표를 세워서 말해줘!	o	x
18	[목표를 모두 수행했을 경우] 많이 힘들었을텐데, 모두 잘 이행했구나! 이렇게 잘 이행할 수 있었던 이유가 뭔거 같아?	o	x
19	[목표를 절반만 수행했을 때] 열심히 수행하려고 노력했는데, 맘대로 되지 않을 때도 있지 ㅠㅠ 모든 목표를 다 수행하지 못한 이유가 있을까?	o	x
20	[목표를 하나도 수행하지 못했을 때] 혹시 오늘 하루 힘든 일이 있는거야...? ㅠㅠ 가끔은 이렇게 쉬어가도 괜찮지만, 혹시 무슨일이 있는지 걱정	o	o
21	삶에서 이루고 싶은 것을 두가지 정도만 말해줄래?	x	o
22	위 목표를 이루기 위한 1년 후 이루고 싶은 목표를 세워보자!	x	o
23	그럼 한달 안에 이룰 수 있는 목표를 2가지만 말해줄래?	x	o
24	그러면 위 목표를 이루기 위해 내일까지 뭘 해야할까? 목표를 구체적으로 2가지 이상 적어줘!	x	o

Customer Segmentation: Students Clustering for Counseling/Advising

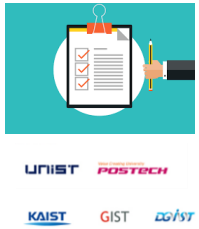
- Customer-feature matrix

	Word feature 1	Word feature 2	Word feature 3	…	Word feature m-1	Word feature m
Customer 1	…	…	…	…	…	…
Customer 2	…	…	…	…	…	…
Customer 3	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
…	…	…	…	…	…	…
Customer n-1	…	…	…	…	…	…
Customer n	…	…	…	…	…	…

Customer Segmentation: Students Clustering for Counseling/Advising

1. Collection of text data on the topic in question
2. Semi-automatic semantic identification of significant word-features
3. Unsupervised learning of the data with selected word-features
4. Interpretation

1



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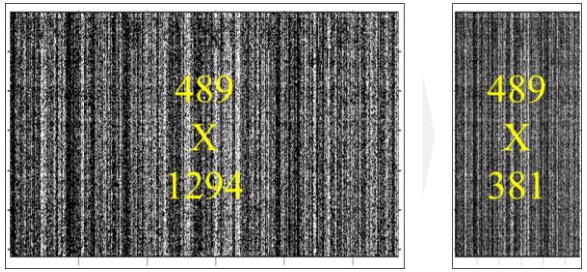
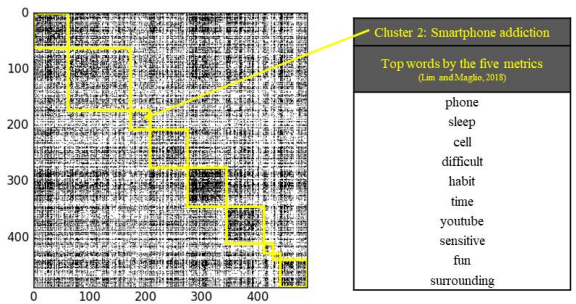


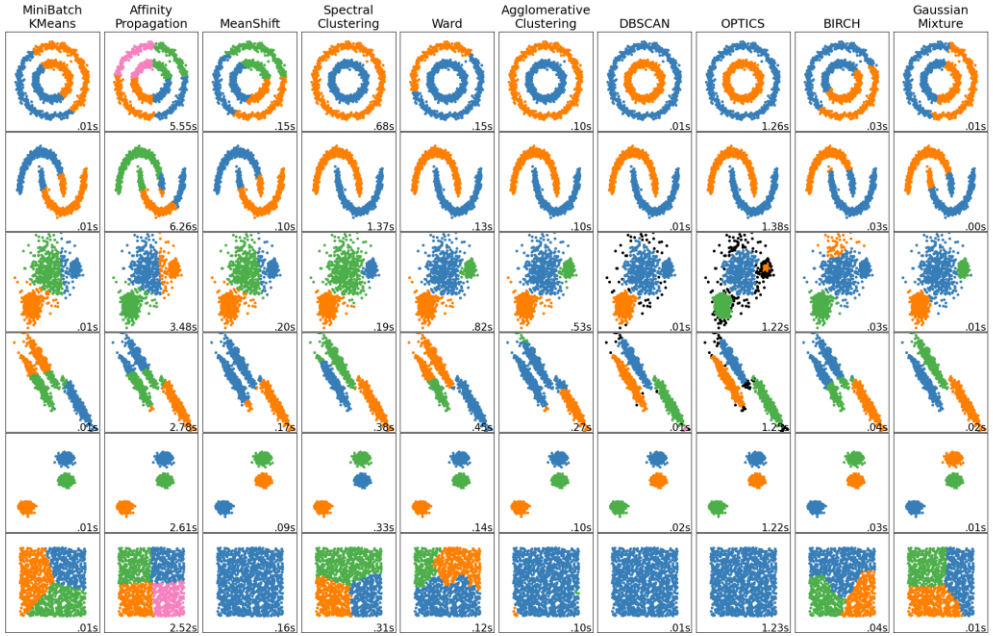
4

- 스트레스 (Stress)
- 완벽주의 (Perfectionism)
- 스마트폰 (Smartphone)
- 너무피곤 (Tiredness)
- 인간관계 (Relationship)
- 놀고싶어 (WantPlay)
- 귀차니즘 (Laziness)
- 자기안심 (Self-justification)
- 일이많음 (TooManyWorks)

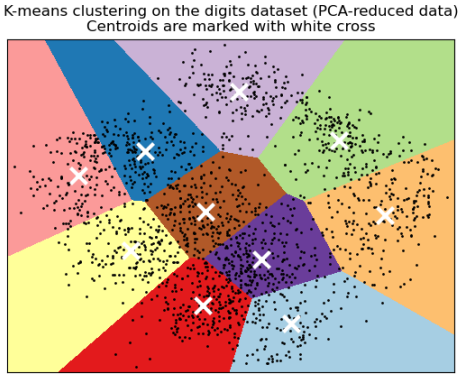
3

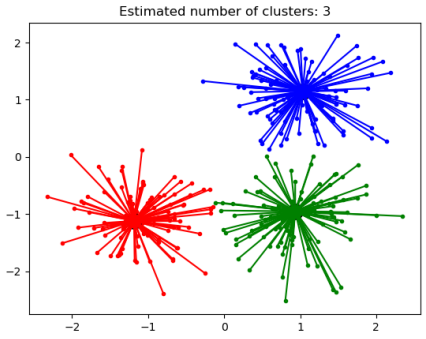


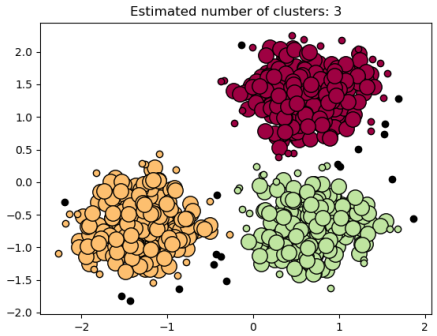
Customer Segmentation: Students Clustering for Counseling/Advising

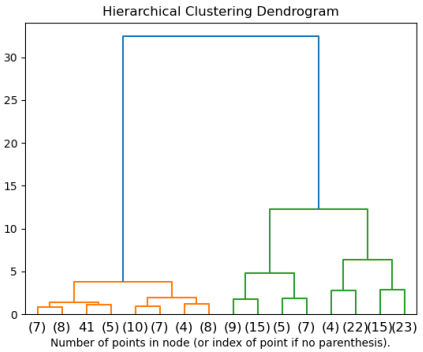


$$\sum_{i=0}^{n} \min_{\mu_j \in C} (||x_i - \mu_j||^2)$$



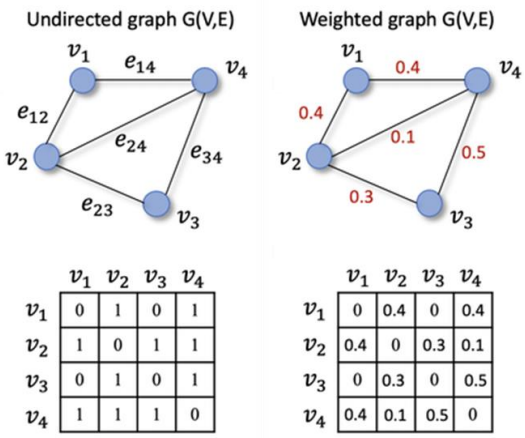


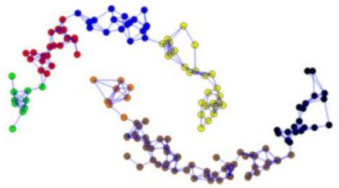


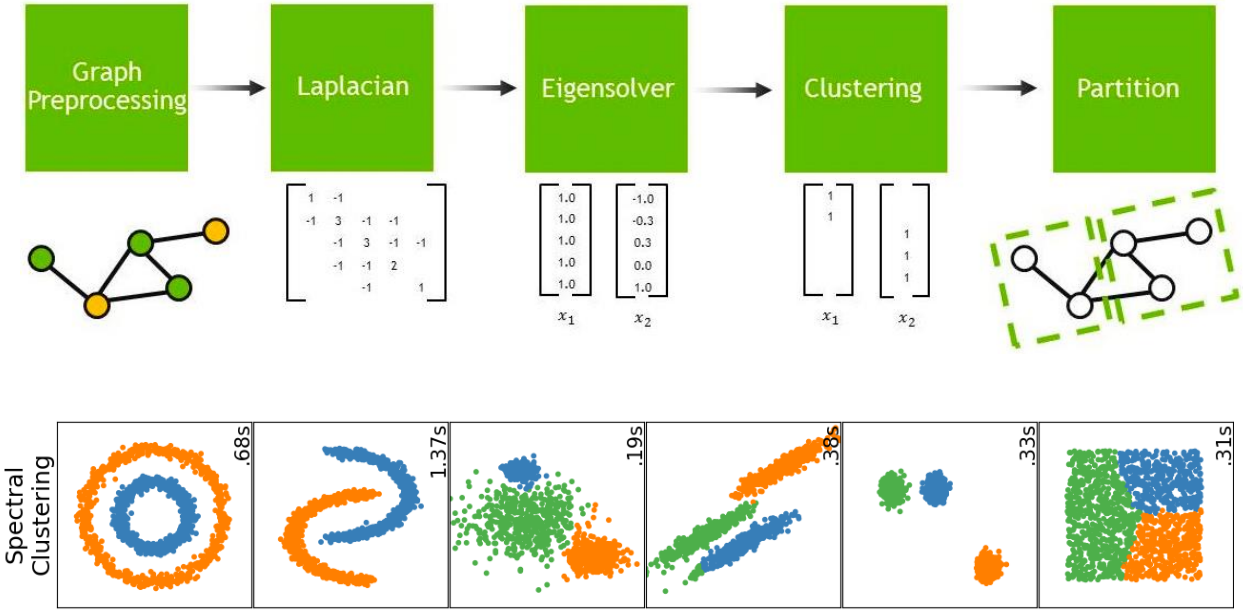


Reference: https://scikit-learn.org/stable/modules/clustering.html#hierarchical-clustering

Customer Segmentation: Students Clustering for Counseling/Advising







- Euclidean distance
- Cosine similarity
- Jaccard coefficient
- Pearson correlation coefficient
- …

$$\mathrm{Sim}(u_a, u_b) = \frac{\sum_{i=1}^{i'} (r_{u_{a,i}})(r_{u_{b,i}})}{\sqrt{\sum_{i=1}^{n} (r_{u_{a,i}})}\sqrt{\sum_{i=1}^{n} (r_{u_{b,i}})}}$$

$$\mathrm{Sim}(u_a, u_b) = \frac{|I_{u_a}| \cap |I_{u_b}|}{|I_{u_a}| \cup |I_{u_b}|}$$

$$\mathrm{Sim}(u_a, u_b) = \frac{\sum_{i=1}^{i'} (r_{u_{a,i}} - r_{\overline{u_a}})(r_{u_{b,i}} - r_{\overline{u_b}})}{\sqrt{\sum_{i=1}^{i'} (r_{u_{a,i}} - r_{\overline{u_a}})^2} \cdot \sqrt{\sum_{i=1}^{i'} (r_{\overline{u_{b,i}}} - r_{\overline{u_b}})^2}}$$

Customer Segmentation: Students Clustering for Counseling/Advising

Cluster 0. 스트레스 (Stress)

Cluster 1. 완벽주의 (Perfectionism)

Cluster 2. 스마트폰 (Smartphone)

Cluster 3. 너무피곤 (Tiredness)

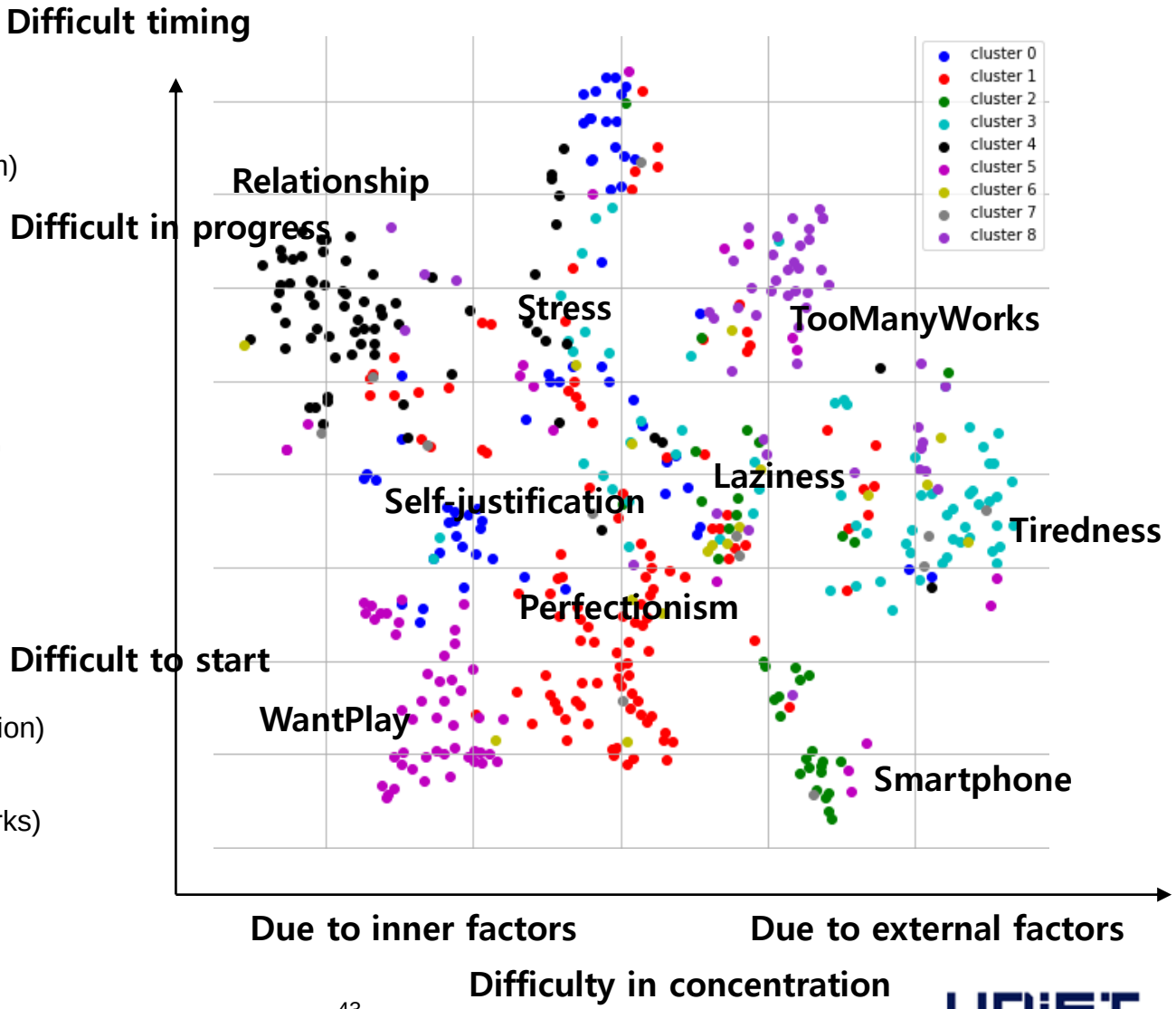
Cluster 4. 인간관계 (Relationship)

Cluster 5. 놀고싶어 (WantPlay)

Cluster 6. 귀차니즘 (Laziness)

Cluster 7. 자기안심 (Self-justification)

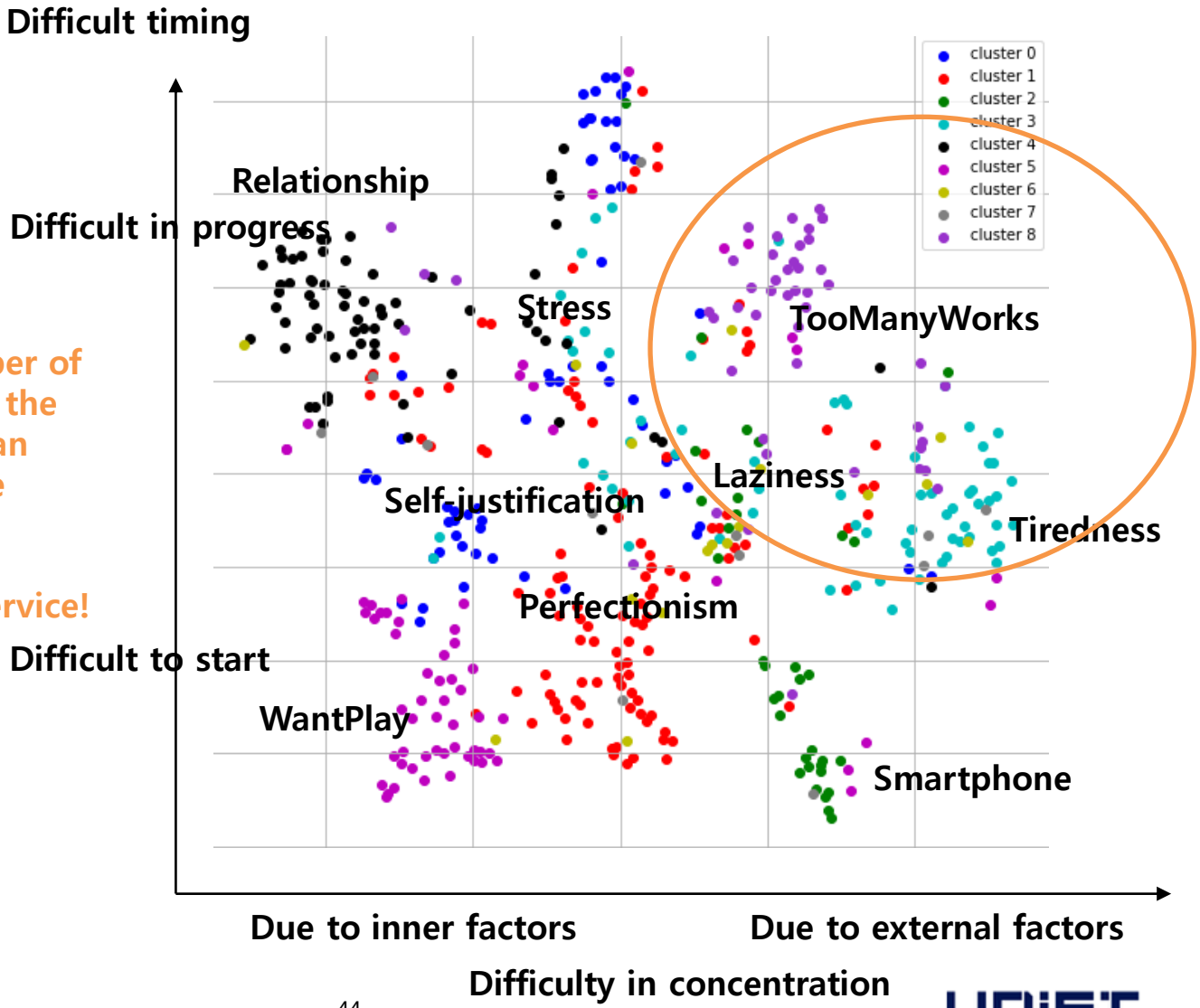
Cluster 8. 일이많음 (TooManyWorks)



Advising Service Customization to Student Segments

I would try to advise the student to reduce the number of his/her tasks by prioritizing the tasks, so that the student can focus fewer items and make some more time to focus.

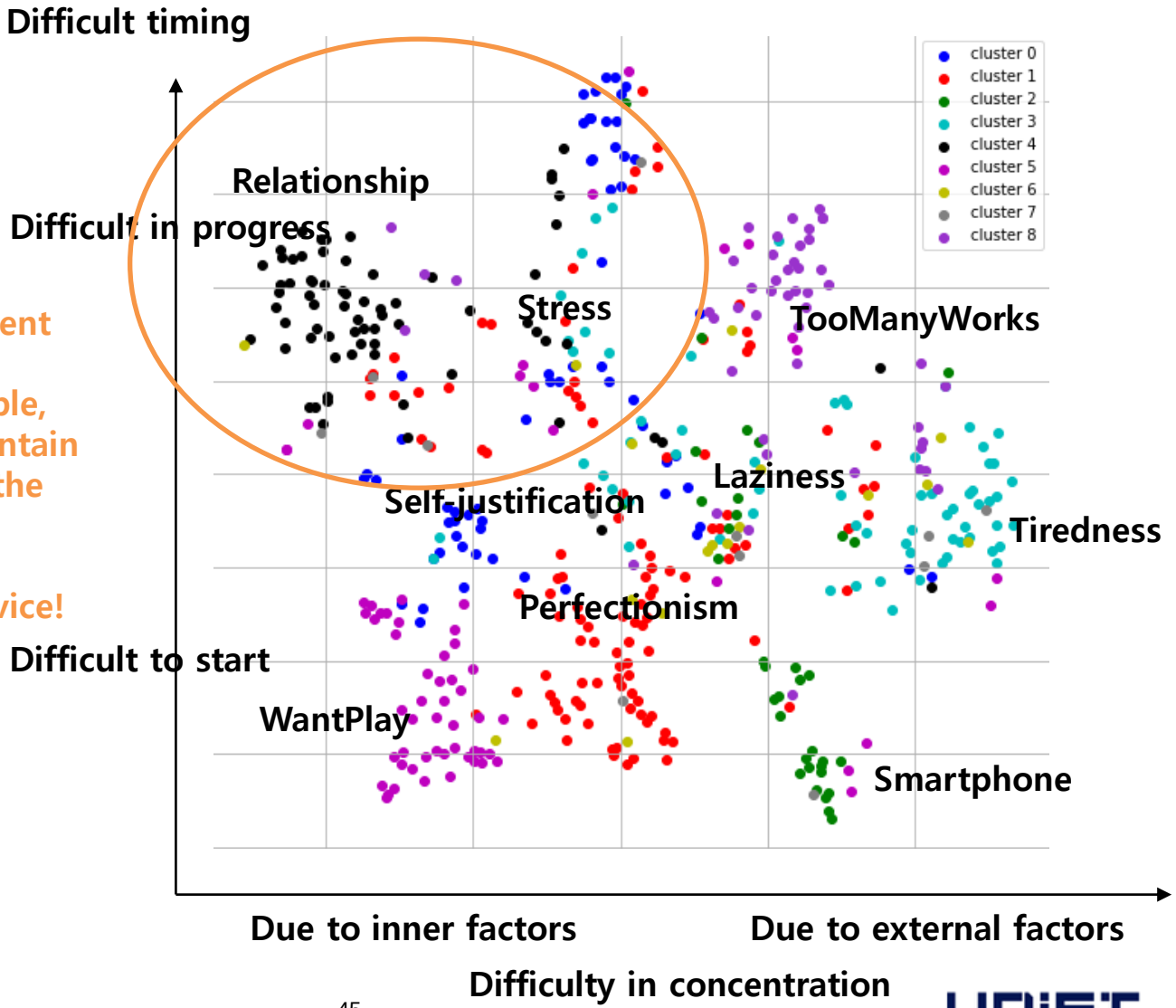
→ Prioritization coaching service!



Advising Service Customization to Student Segments

I would try to help the student become robust to the relationship with other people, so that the student can maintain his/her focus regardless of the relationship status.

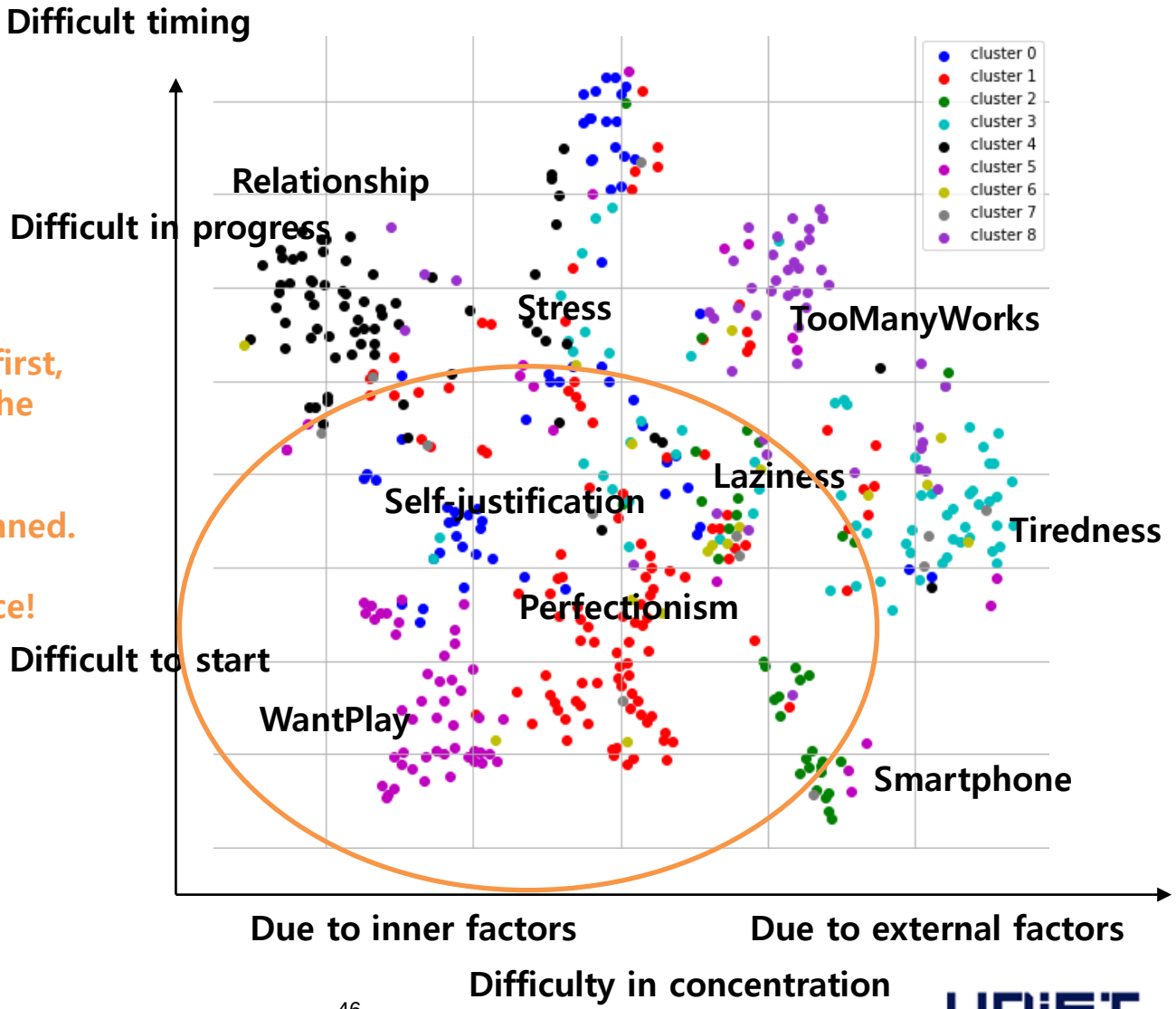
→ Robustness coaching service!



Advising Service Customization to Student Segments

I would try to advise the student to just start a task first, and then think later. Once the task is started, the task completion process can be properly estimated and planned.

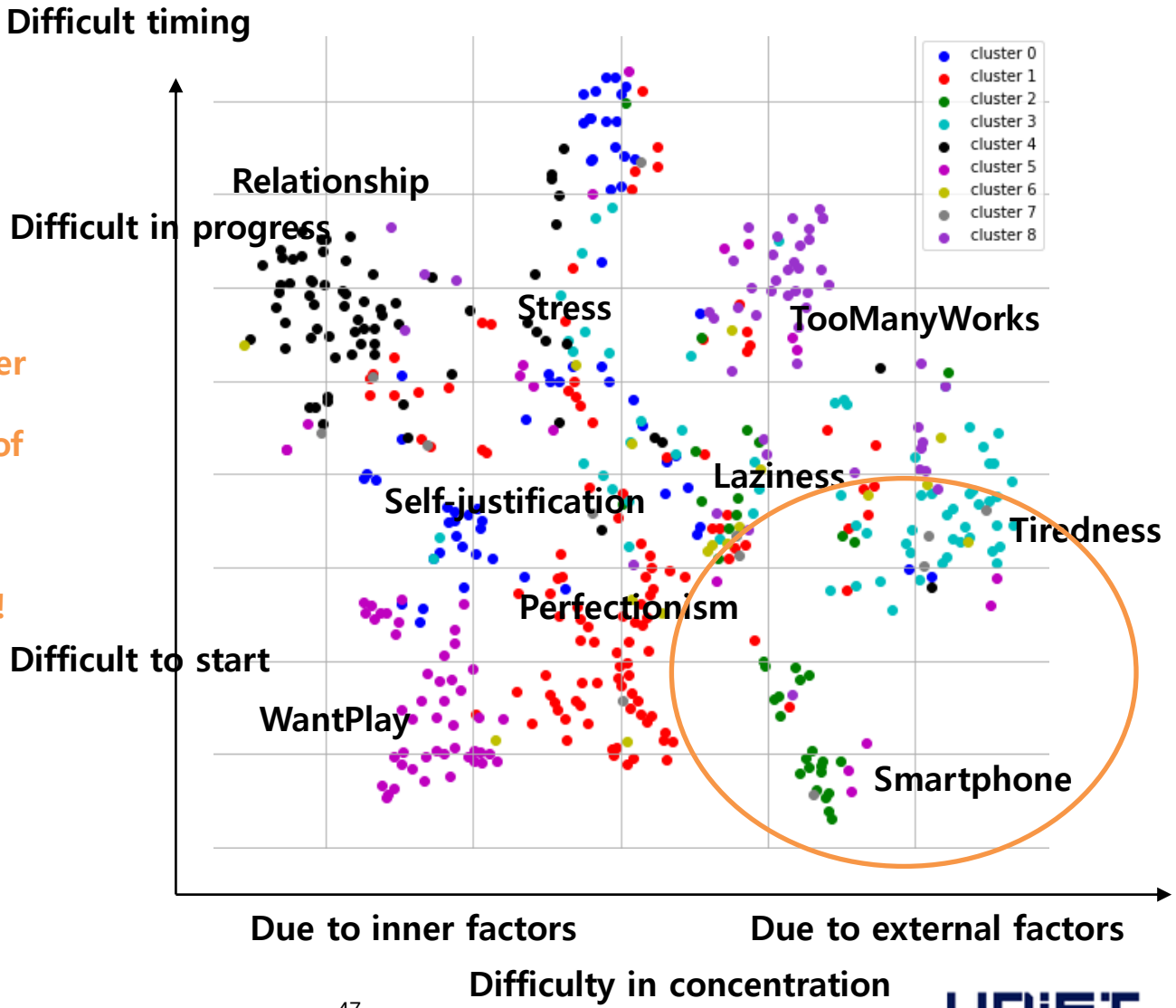
→ Just-do-it coaching service!



Advising Service Customization to Student Segments

I would try to advise the student to search for another routine to escape from the addiction and habitual use of smartphone or other digital devices/services.

→ Routine coaching service!



Assignment 5 (This is a practice with no due date and evaluation)

- (1) Based on the lab demonstration by TA Jung, apply clustering algorithms to the provided dataset of LG Electronics System Air Conditional customers. Evaluate and compare the clustering results (e.g., using the Silhouette coefficient), and select the most accurate and interpretable result of clustering. You should describe the analytics process in detail.
- (2) You may have identified multiple clusters. Focus on the most clear and interesting clusters. Design MORE THAN THREE customized services to address the customer clusters. For example, when there are school-related customer clusters identified, you may want to design an Air Conditioning service specialized to schools. For another example, when there will be a customer cluster with specific maintenance issues frequently occur, you may want to offer an Air Conditioner Maintenance service specialized to this customer. You should describe in detail your services customized for your focal customer segments.
- (3) Assume you actually need to use your outcomes of customer segmentation and service customization for LG Electronics. Starting from your analytics outcomes and designed services, think how to further develop and operate your designed services. What kinds of data are further required to completely develop and operate your services? What kinds of intelligent machines can be further used to improve the efficiency and performance of your services? Describe your service development and implementation plan in detail.
- (4) Select one of the datasets you used or constructed in your previous assignments (e.g., item purchase data and customer review data), and apply clustering algorithms to the dataset. Evaluate and compare the clustering results (e.g., using the Silhouette coefficient), and select the most accurate and interpretable result of clustering. Finally, similar to the above practice, design and describe at least three options of service customization to your customer segments.
- (5) Think about your concerned or interested service around UNIST, in Ulsan, in your hometown, or any other interested service that require further customer segmentation and service customization. If you would actually conduct a study on customer segmentation and service customization, how would you conduct the research in your own creative, unique way? What kinds of data are you going to collect, analyze, and learn? What analytics methods are you going to use? Describe your service customization and 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)~(5) in the Blackboard, IF YOU WANT.

Topics of the Service Intelligence Course

Service Review Mining

Recommender Systems Development

Service Quality Evaluation and Improvement

All Weeks

Customer Segmentation and Service Customization

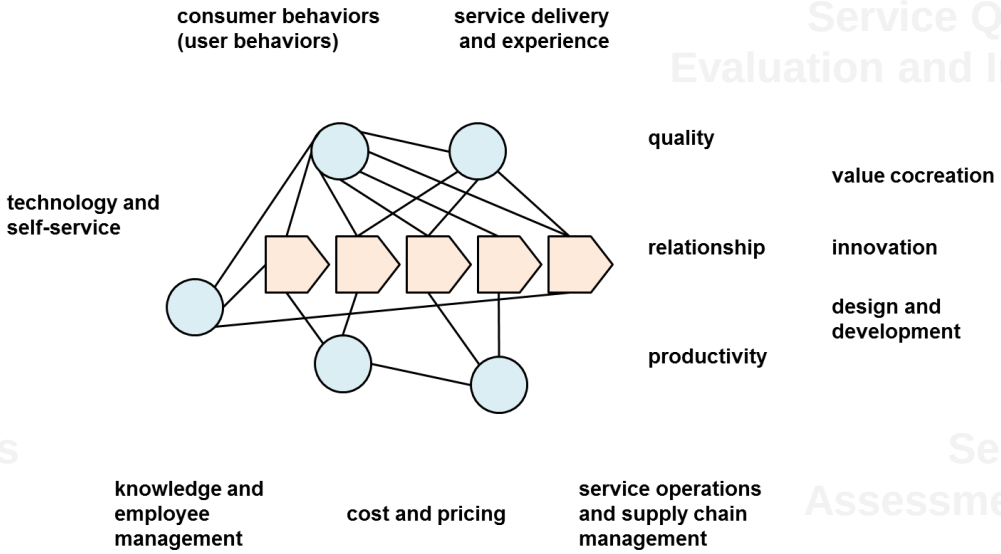
Special Lectures on Service Intelligence

Service Process Assessment and Improvement

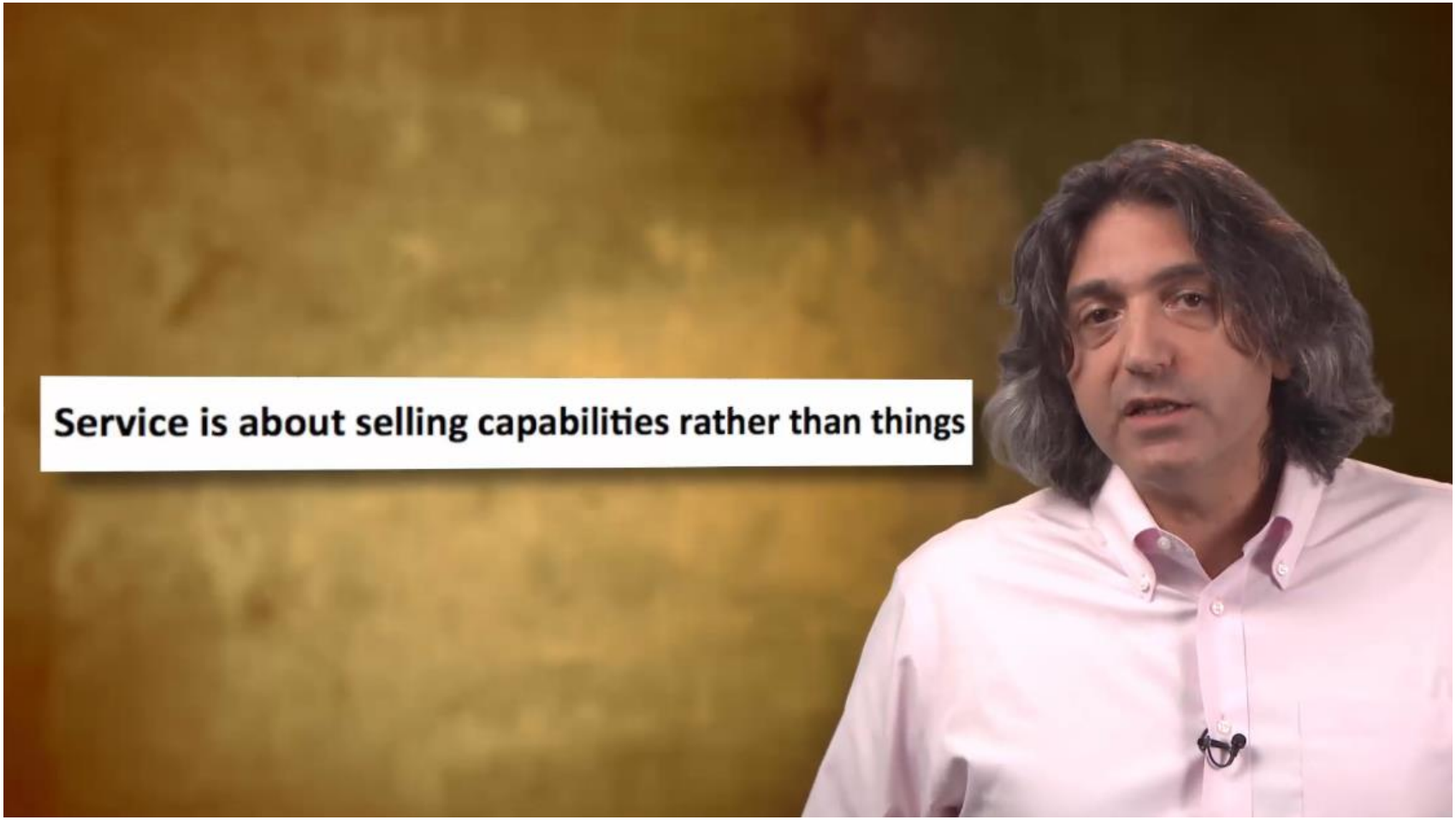
Service Optimization

Industrial Service Intelligence

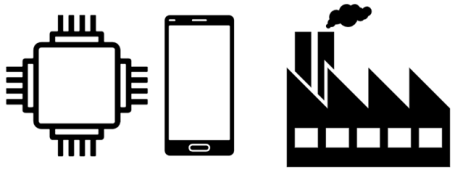
Behavioral Data Mining



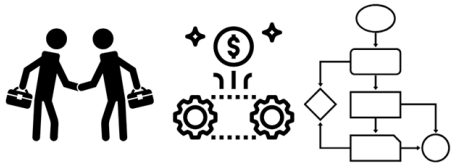
Service is Simply to Serve Customers: Help Tasks or to Do the Tasks



Tasks in Industry and Society: A Process Viewpoint



Manufacturing Process



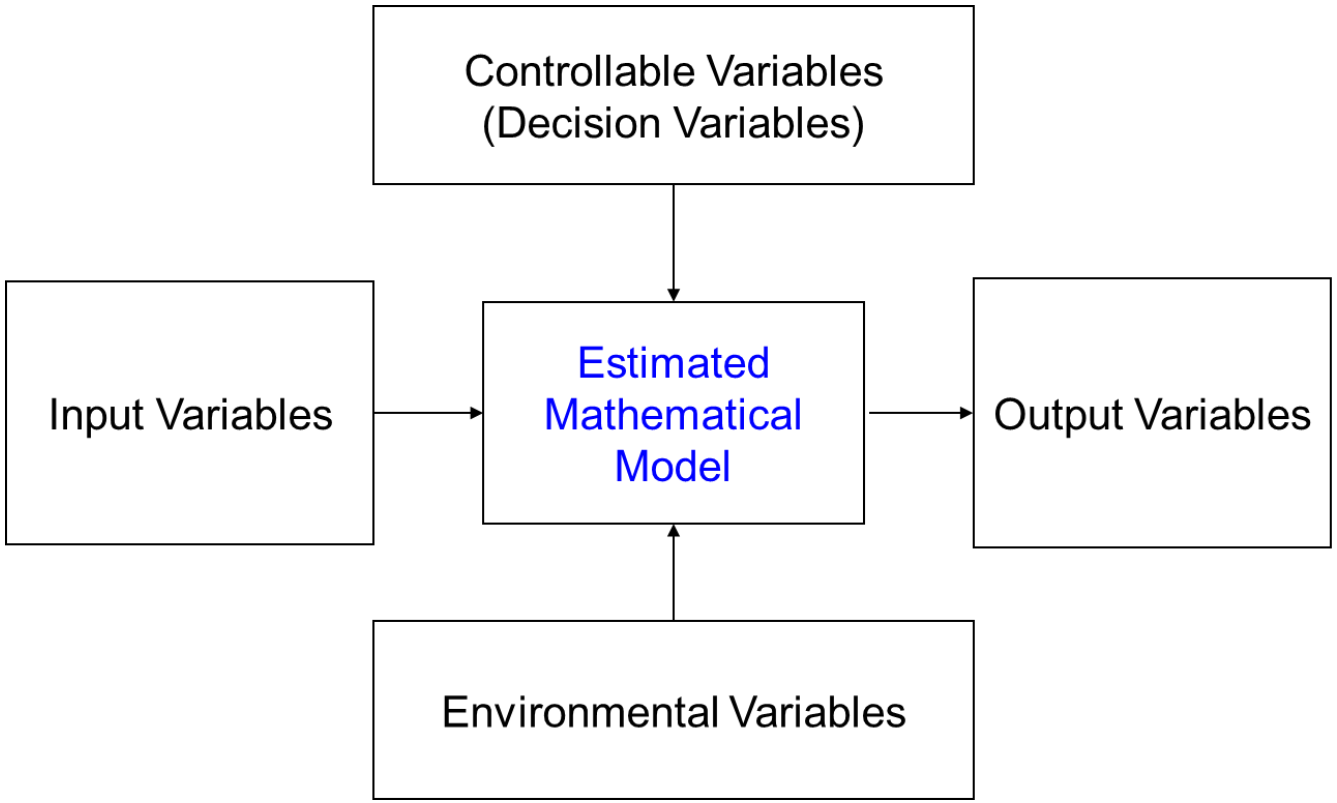
Business Process

Personal Process

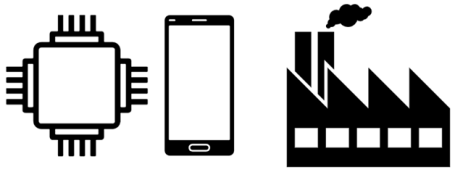
Conceptual Framework of Data-driven Process Management

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

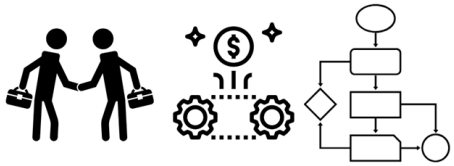
$$y = f(\mathbf{x}, \boldsymbol{\theta}) + \varepsilon \quad \rightarrow \quad \hat{y}(\mathbf{x}) \quad \rightarrow \quad \underset{\mathbf{x} \in \Omega}{\text{optimize}} \ \hat{y}(\mathbf{x})$$



Tasks in Industry and Society: A Process Viewpoint



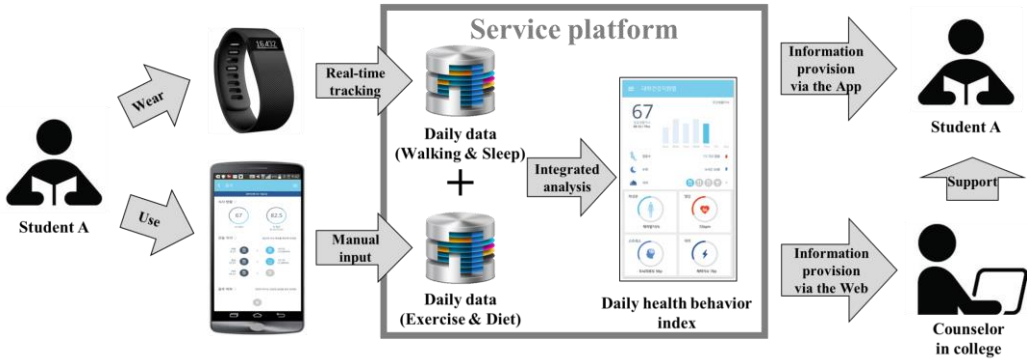
Manufacturing Process

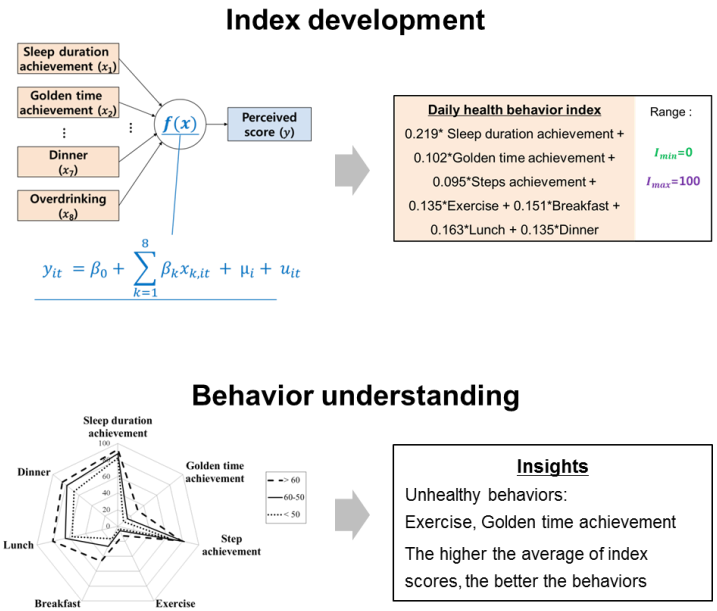


Business Process

Personal Process

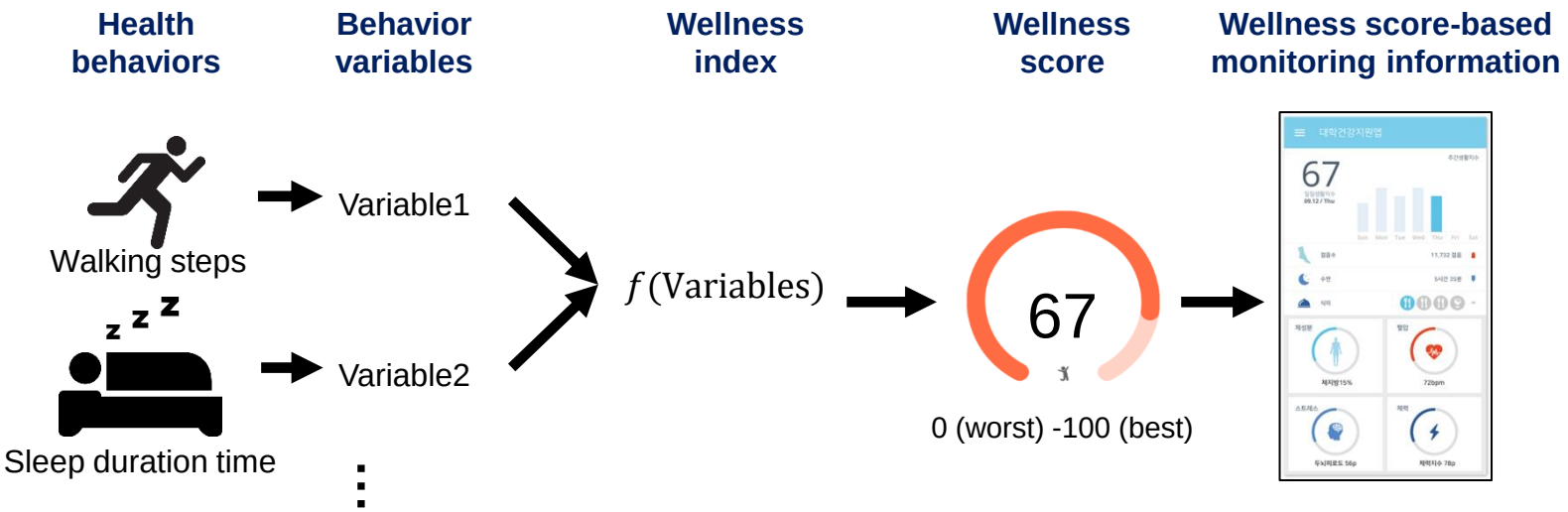
Personal Process Management in the Context of Healthcare Support

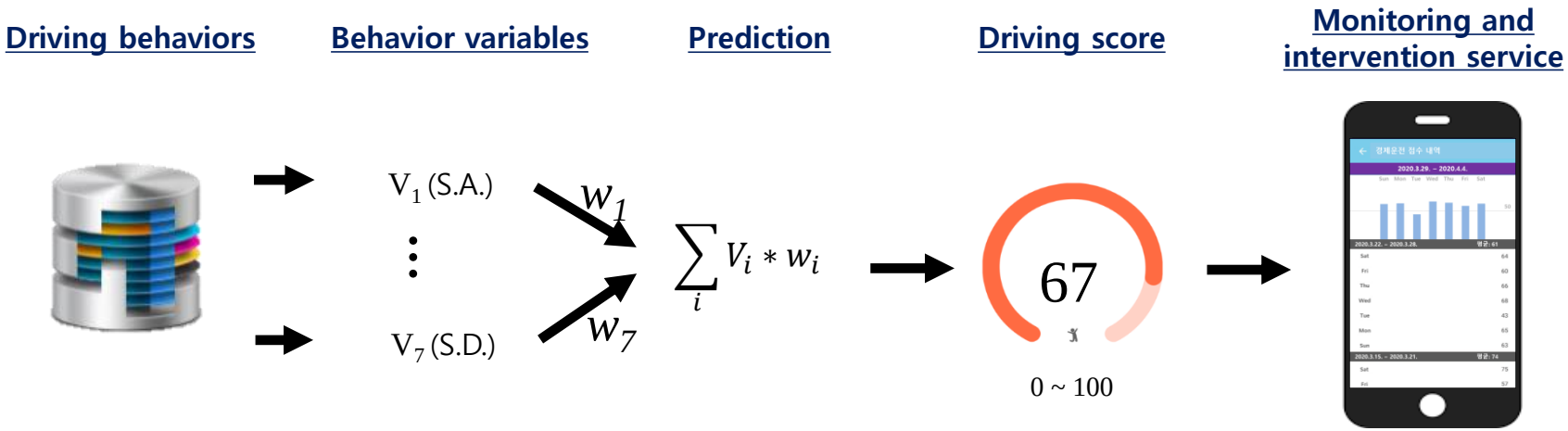




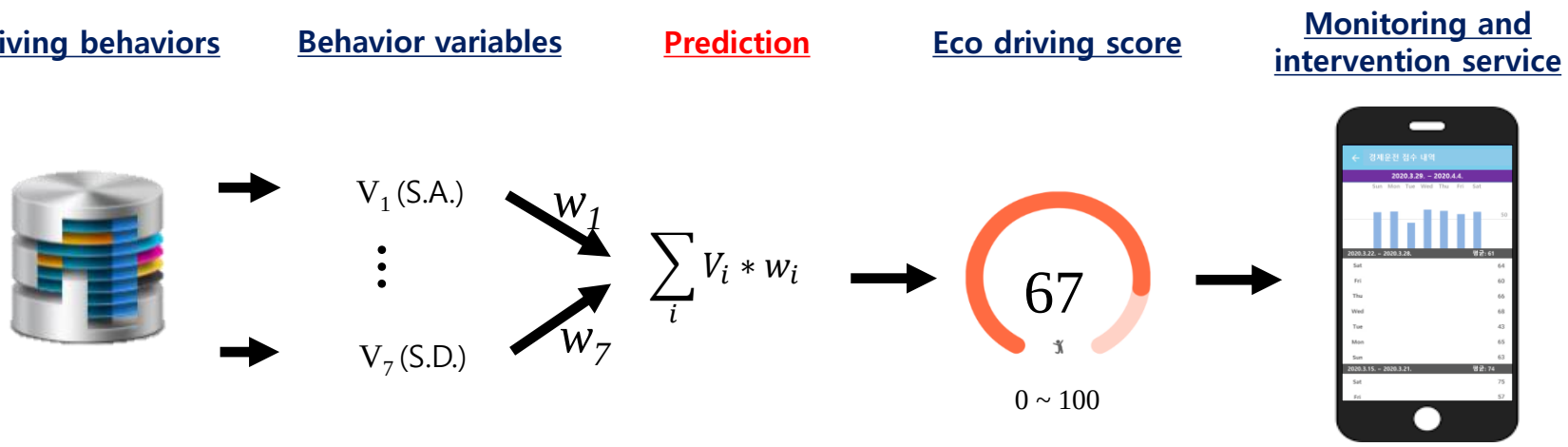
Source: Kim, K., Kim, K., Lim, C., and Heo, J., "Development of a Lifelogs-based Daily Wellness Score to Advance a Smart Wellness Service," *Service Science*, Vol. 10, No. 4, 408–422, 2018.

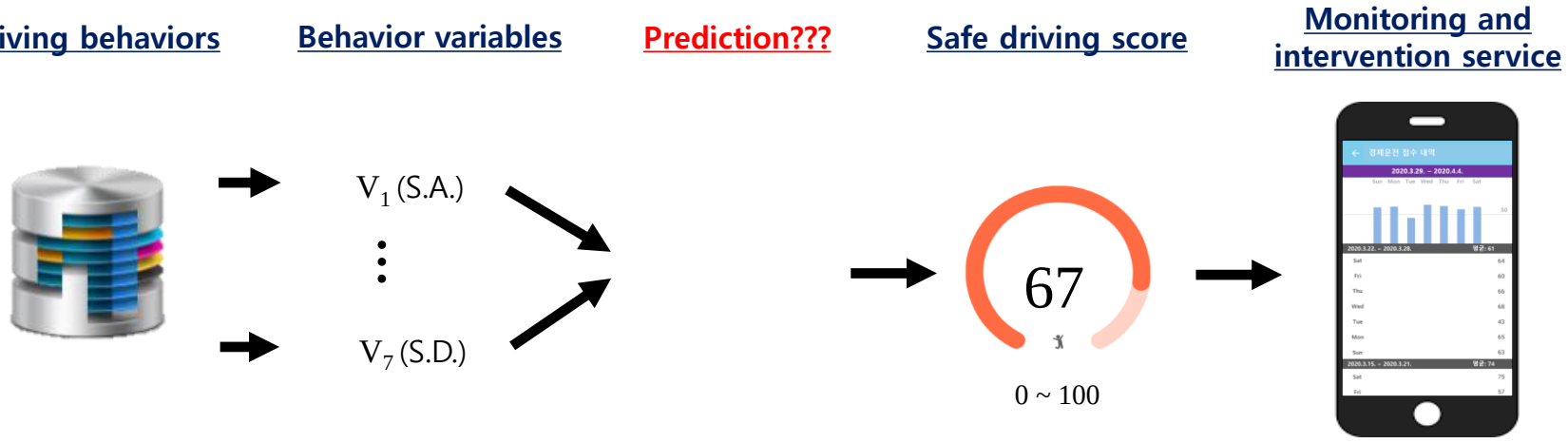
Personal Process Management in the Context of Eco Driving Context



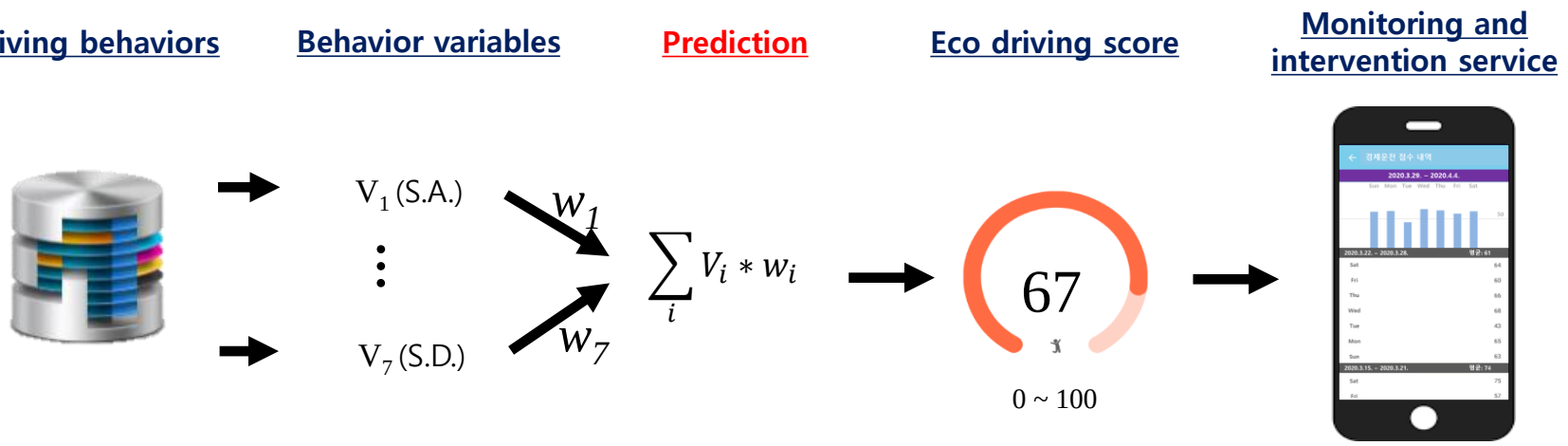


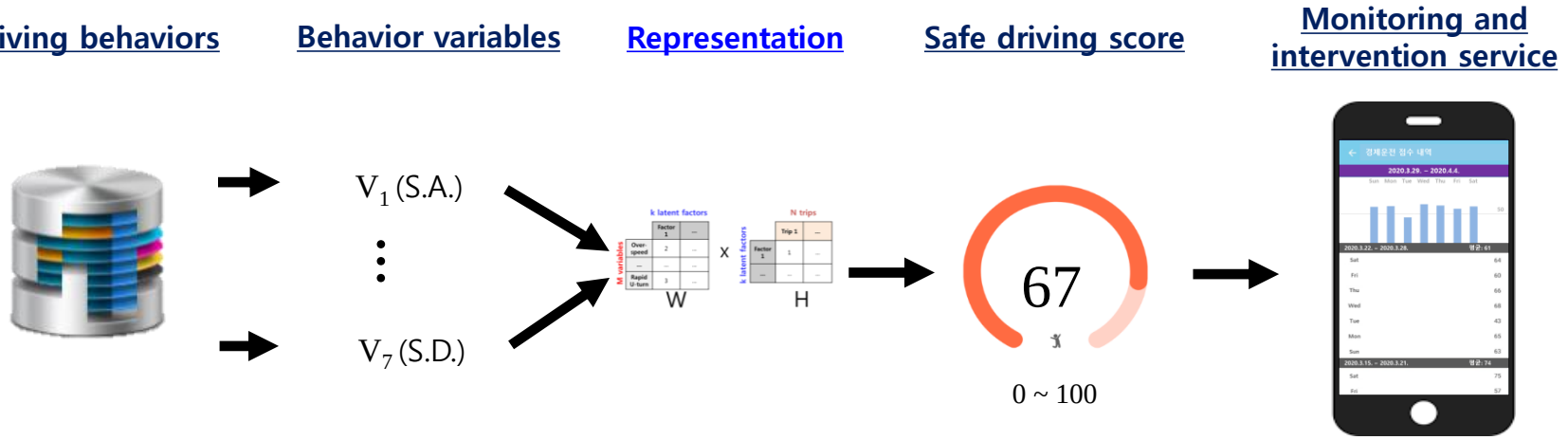
Existence vs. Nonexistence of the Labels



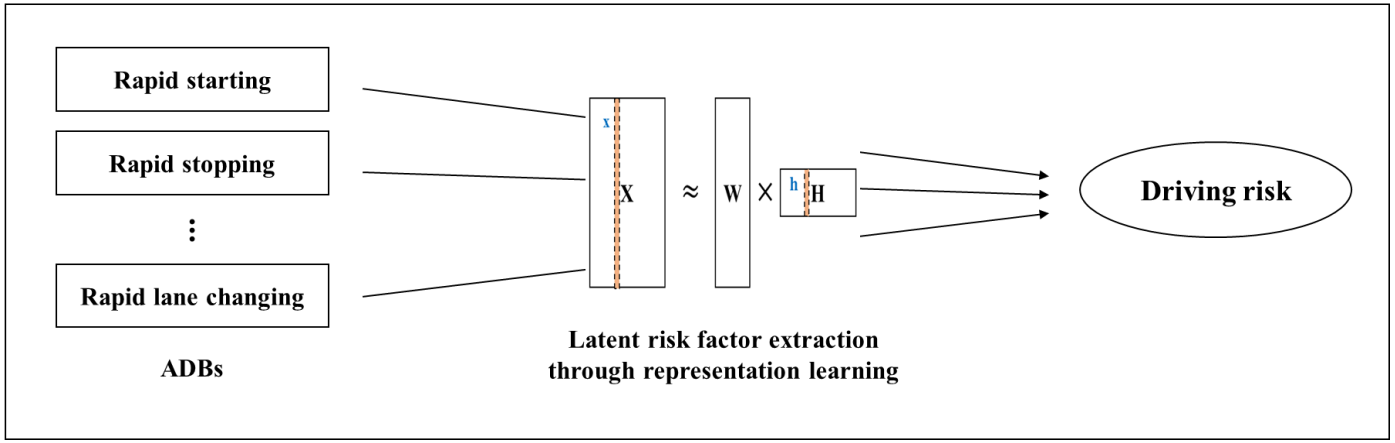


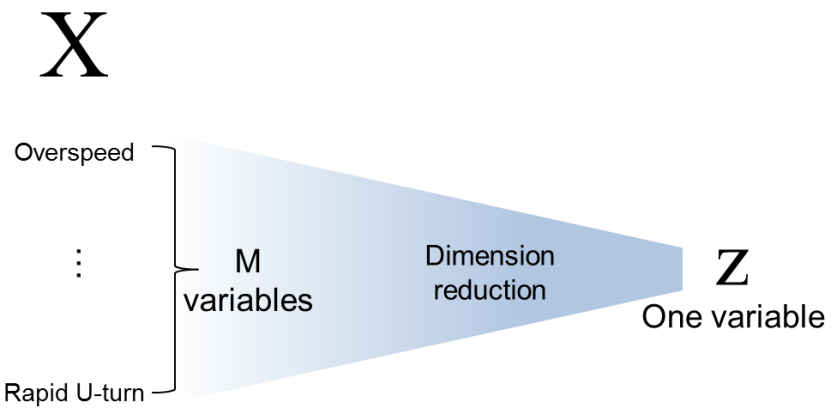
Existence vs. Nonexistence of the Labels

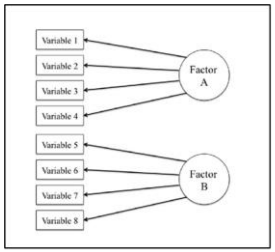


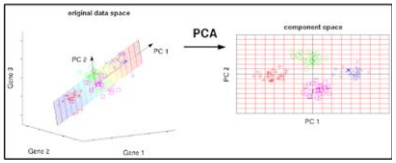


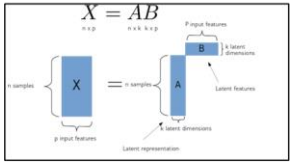
Personal Process Management in the Context of Safe Driving Context

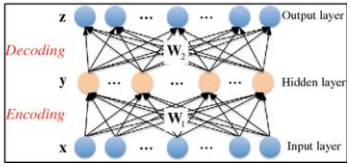




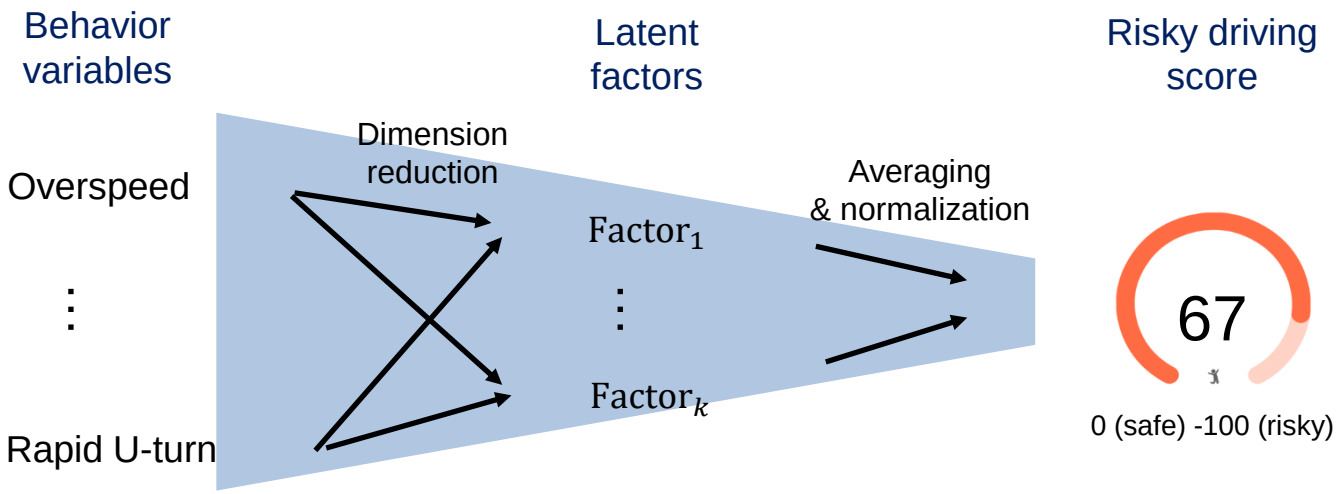


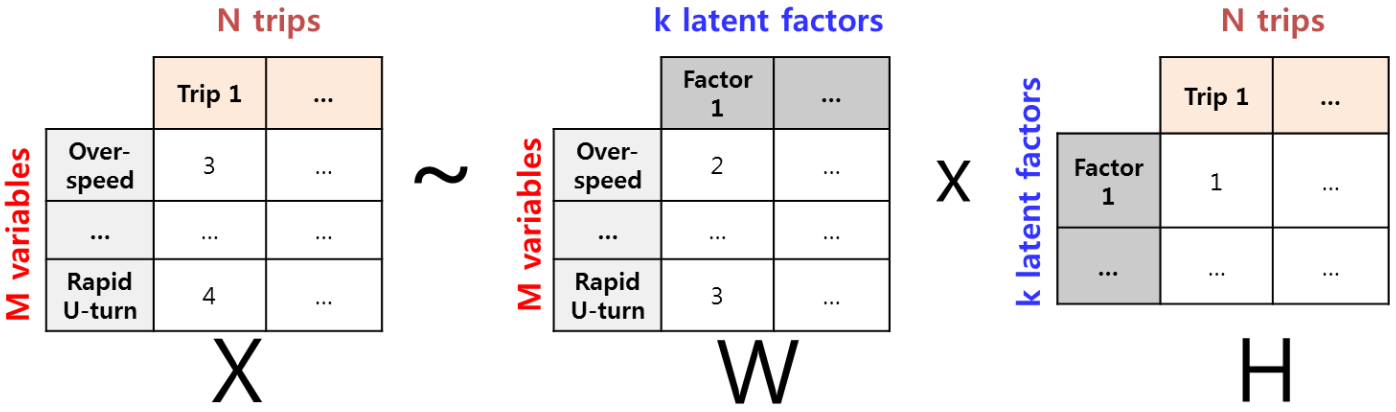




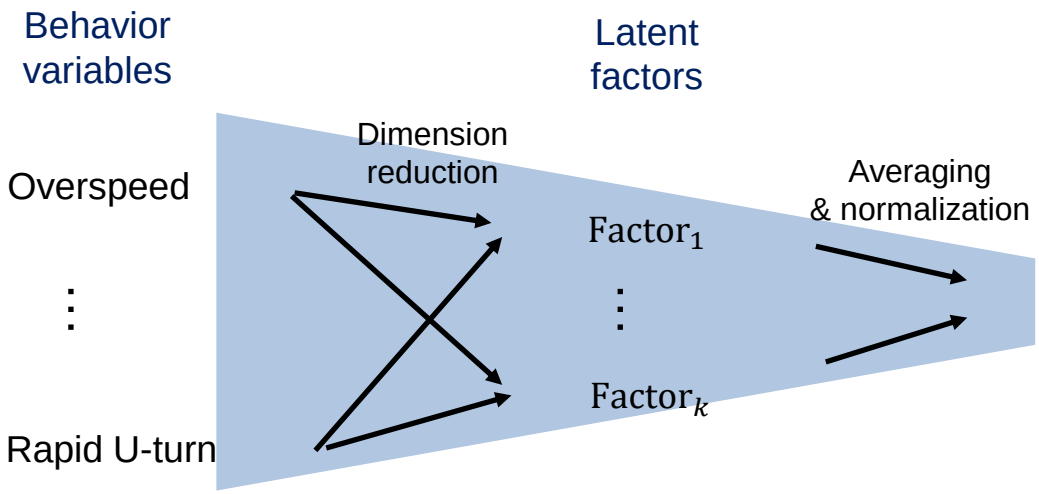


Personal Process Management in the Context of Safe Driving Context





Personal Process Management in the Context of Safe Driving Context



	Trip 1	...
Overspeed	3	...
Rapid stopping	5	...
Rapid U-turn	4	...

	Trip 1	...
Factor 1	1	...
Factor 2	2.5	...

	Trip 1	...
Score	67	...

Existence vs. Nonexistence of the Labels

	Behavioral feature 1	Behavioral feature 2	Behavioral feature 3	…	Behavioral feature m	Outcome label
Customer 1	…	…	…	…	…	…
Customer 2						
Customer 3						
…						
…						
…						
…						
…						
…						
…						
Customer n-1	…	…	…	…	…	…
Customer n	…	…	…	…	…	…

Input Data
(Pre-processed)

Data \ Type	Variable (x_t)	Time window
Behavior data	Behavior 1	$S1_t, S1_{t-1}, \ldots$
	Behavior 2	$S2_t, S2_{t-1}, \ldots$
	…	$S3_t, S3_{t-1}, \ldots$
	Behavior 1	$Sk_t, Sk_{t-1}, \ldots$
	Data smoothing	
	$Mean(\sum_{i=0}^{n} x_{t-i})$	

Model

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

neural networks

Nonlinearity consideration

Decision trees

Rule-based explanation

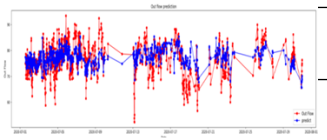
Regression

Linear coefficient estimation

Result

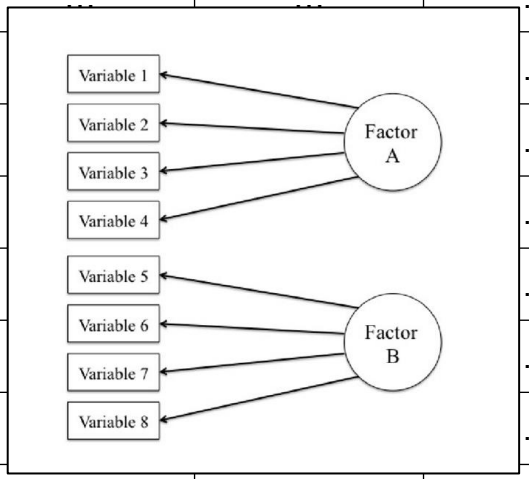
$$\hat{y}(\mathbf{x})$$

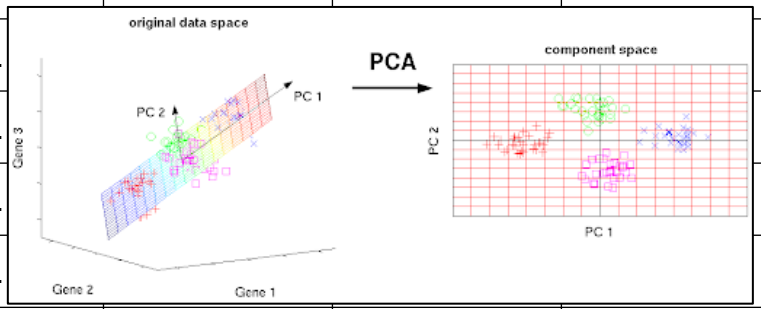
Behavioral outcomes

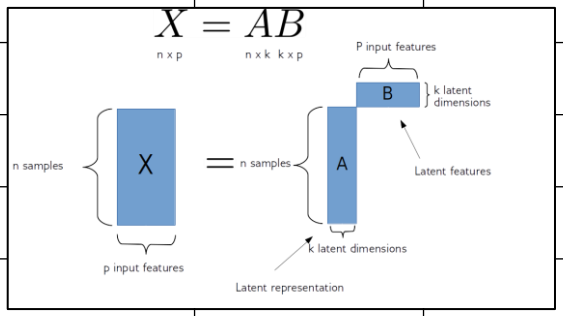


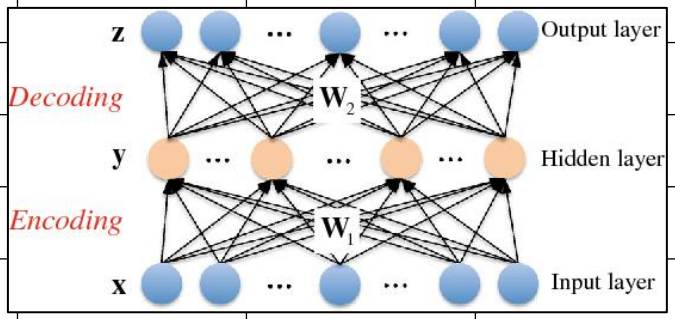
Existence vs. Nonexistence of the Labels

	Behavioral feature 1	Behavioral feature 2	Behavioral feature 3	…	Behavioral feature m	Outcome label
Customer 1	…	…	…	…	…	…
Customer 2			…	…	…	…
Customer 3			…			
…			…			
…			…			
…			…			
…			…	…	…	…
…						
…						
…						
Customer n-1						
Customer n						





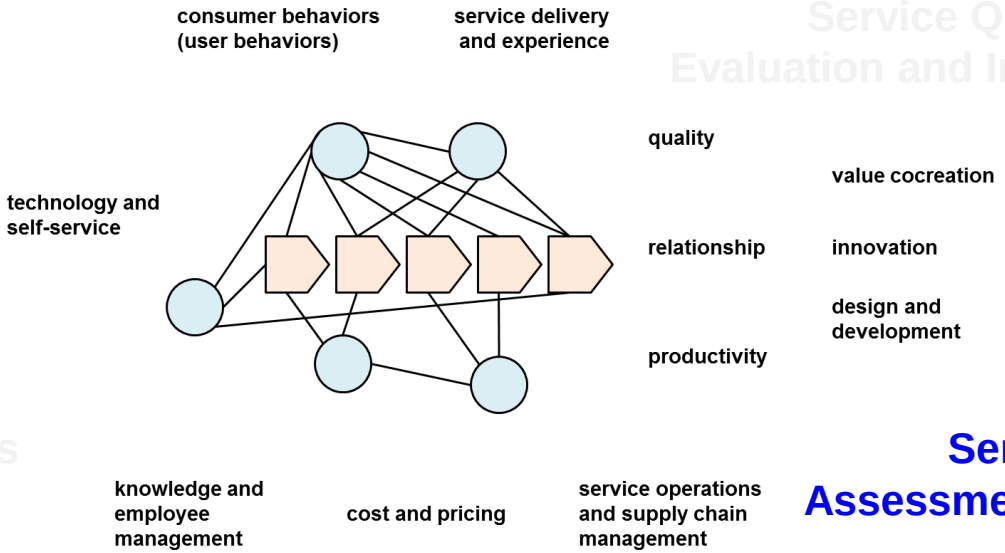




Assignment 5 (by 10.28 11:59 pm)

- Based on the practice demonstration from TA Jung, (1) complete the construction of the behavior feature – outcome label matrix in the context of eco-driving by yourself. You should select significant behavior features (variables) based on your own descriptive analysis and eco-driving domain knowledge study.
- Then, (2) using the behavior feature – outcome label matrix you constructed, develop an eco driving score prediction model. Do it all by yourself, and describe the analysis process and outcome in detail. Interpret the outcome (e.g., describe the behavior features you identified significant, interpret the coefficient/importance values of behavior features to the FPK label).
- (3) Assume you need to use your machine for real-world driving support service (e.g., T map service or Hyundai blueLink service). How can you improve your machine to be used for the service effectively? For example, what kinds of data should you collect and use further to develop a complete driving support service? How would you design a method for using/learning the data? Think beyond these examples in your own creative, unique way!
- (4) You must have your own interested or favorite service WITHOUT a machine for data-driven personal process management (e.g., traditional services that do utilize customers' behavioral data yet). Discuss the requirements of personal process management for the service in detail.
- (5) If you would conduct a study on developing a machine for data-driven personal process management for the 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 related to the service you are interested or concerned.
- Upload your code and a several paragraph essay on the tasks (1)~(5) in the Blackboard.

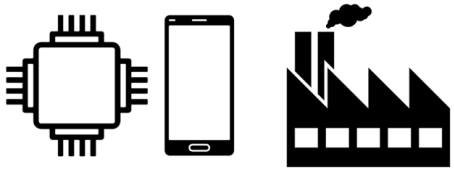
Topics of the Service Intelligence Course



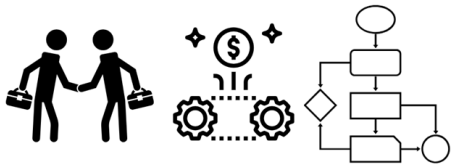
Service Process Assessment and Improvement

Industrial Service Intelligence

Tasks in Industry and Society: A Process Viewpoint



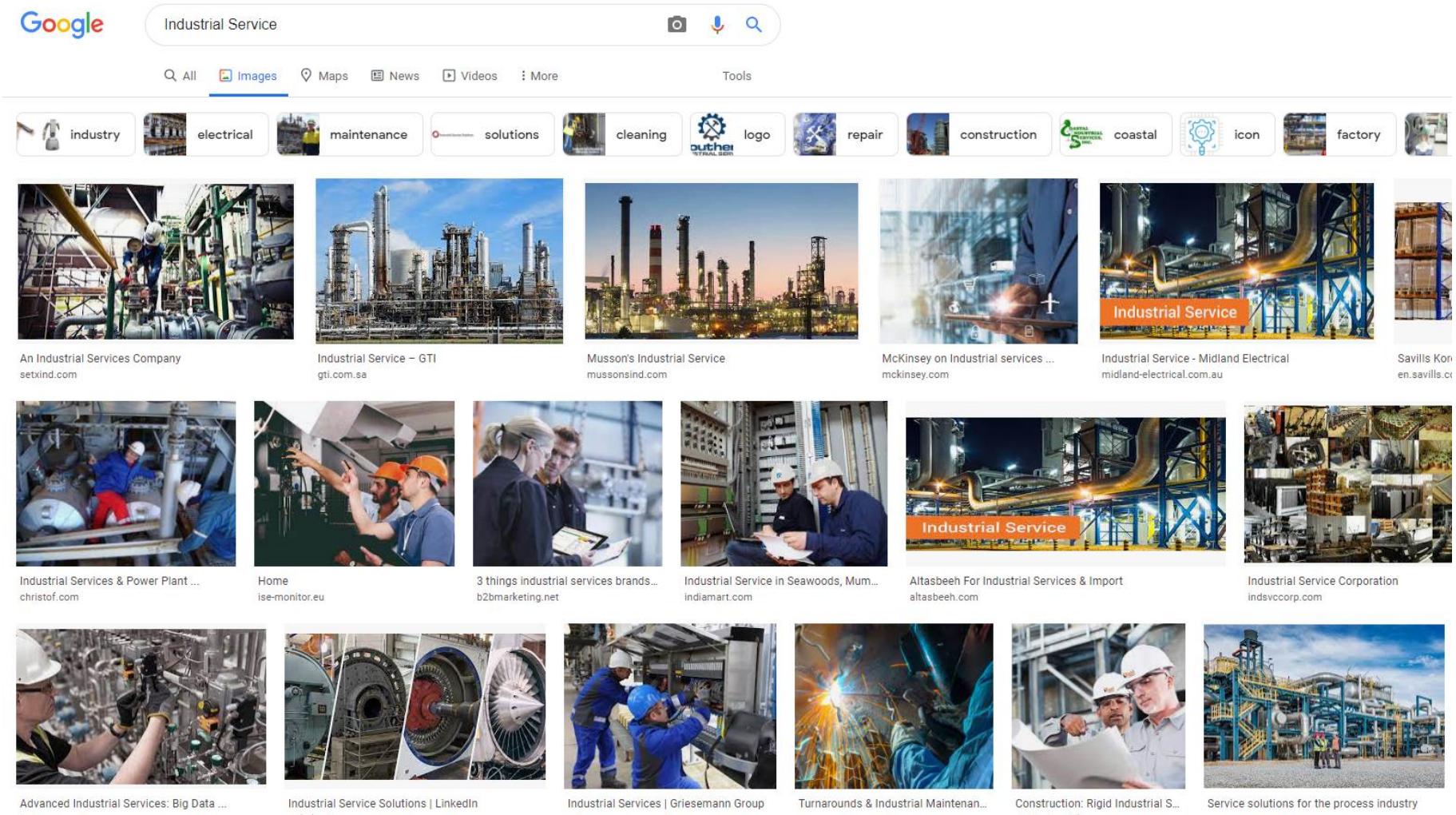
Manufacturing Process



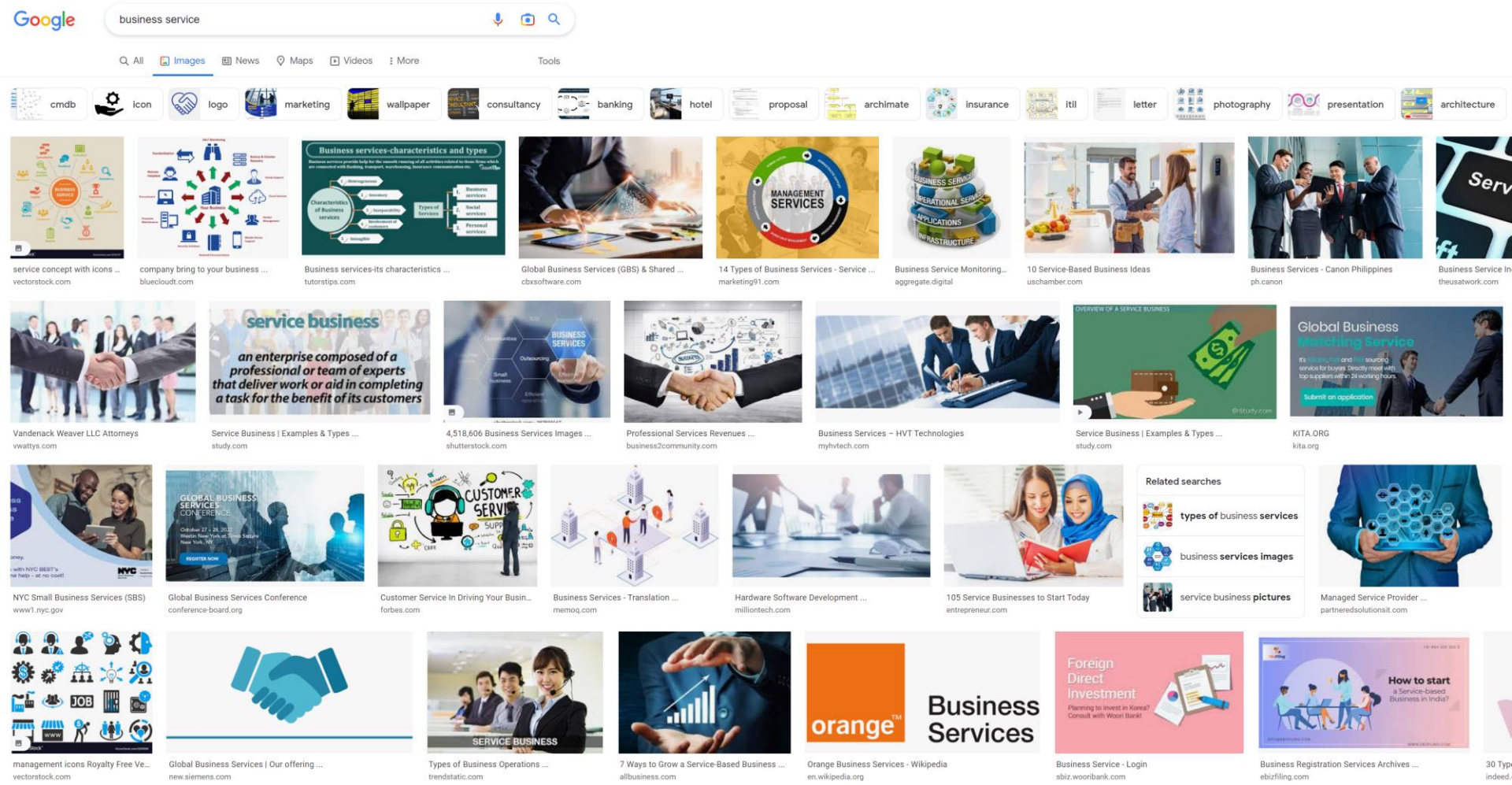
Business Process

Personal Process

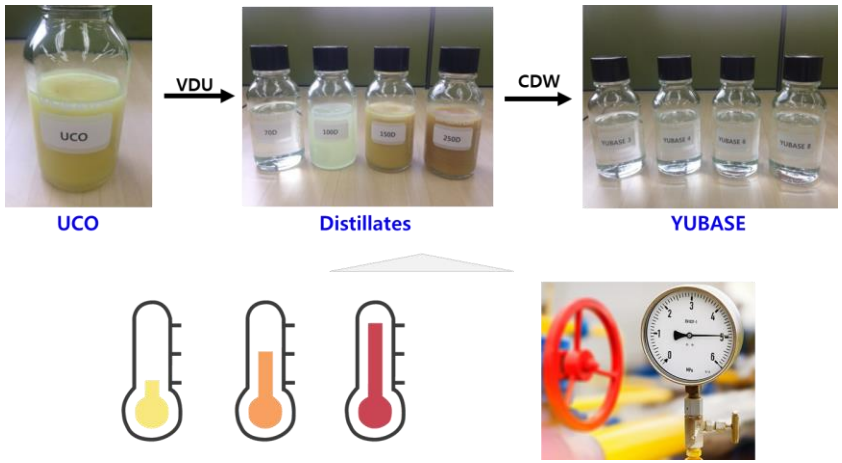
Industrial “B2B” Services

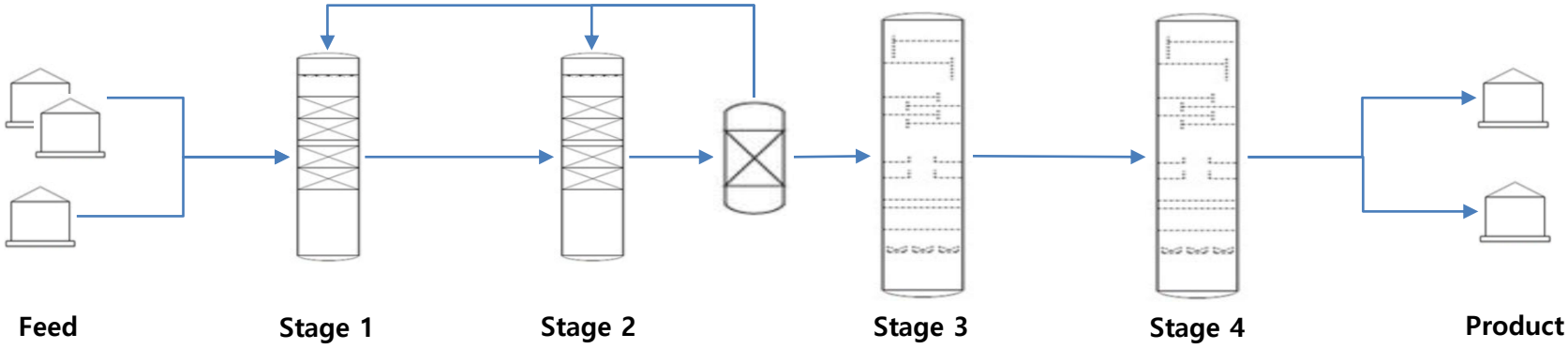


Other “B2B” Services in General

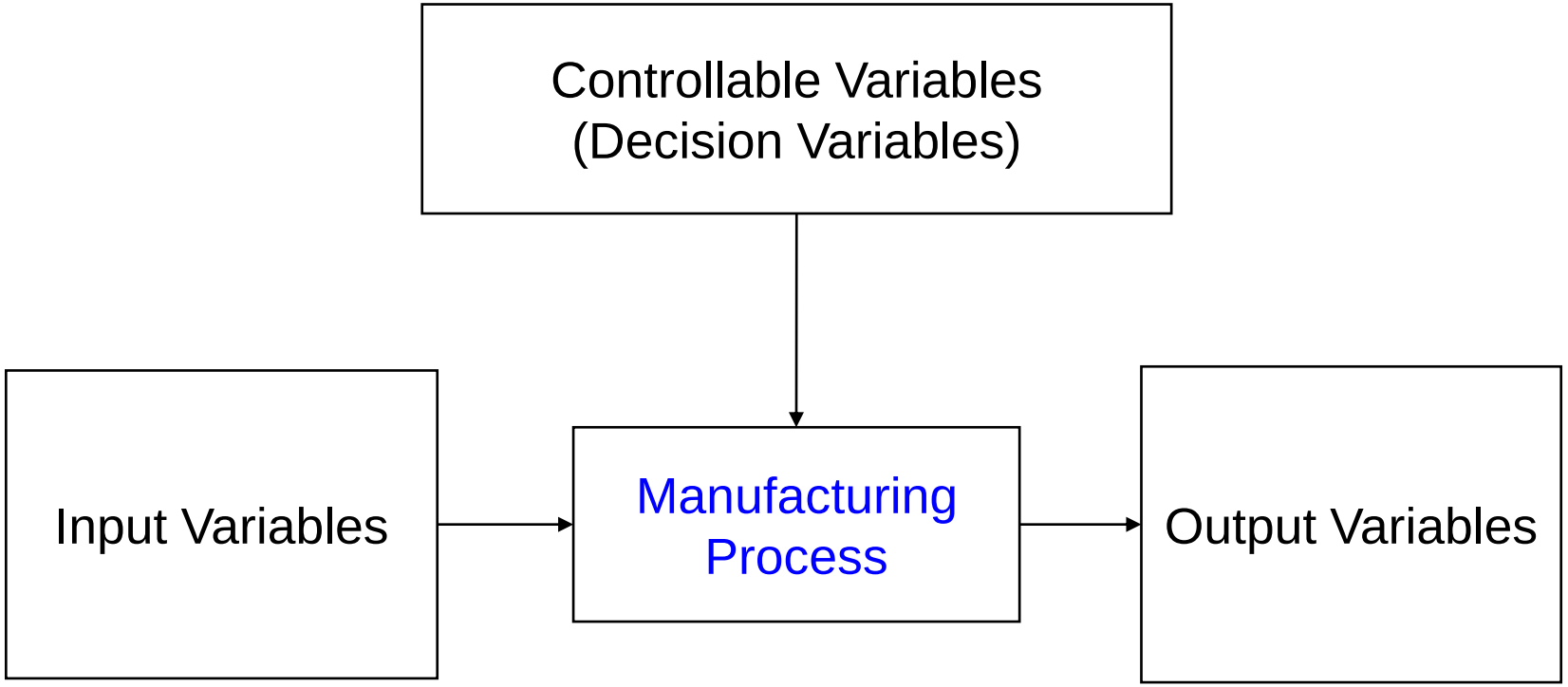


Difficulty of “Professional” Tasks of Manufacturing

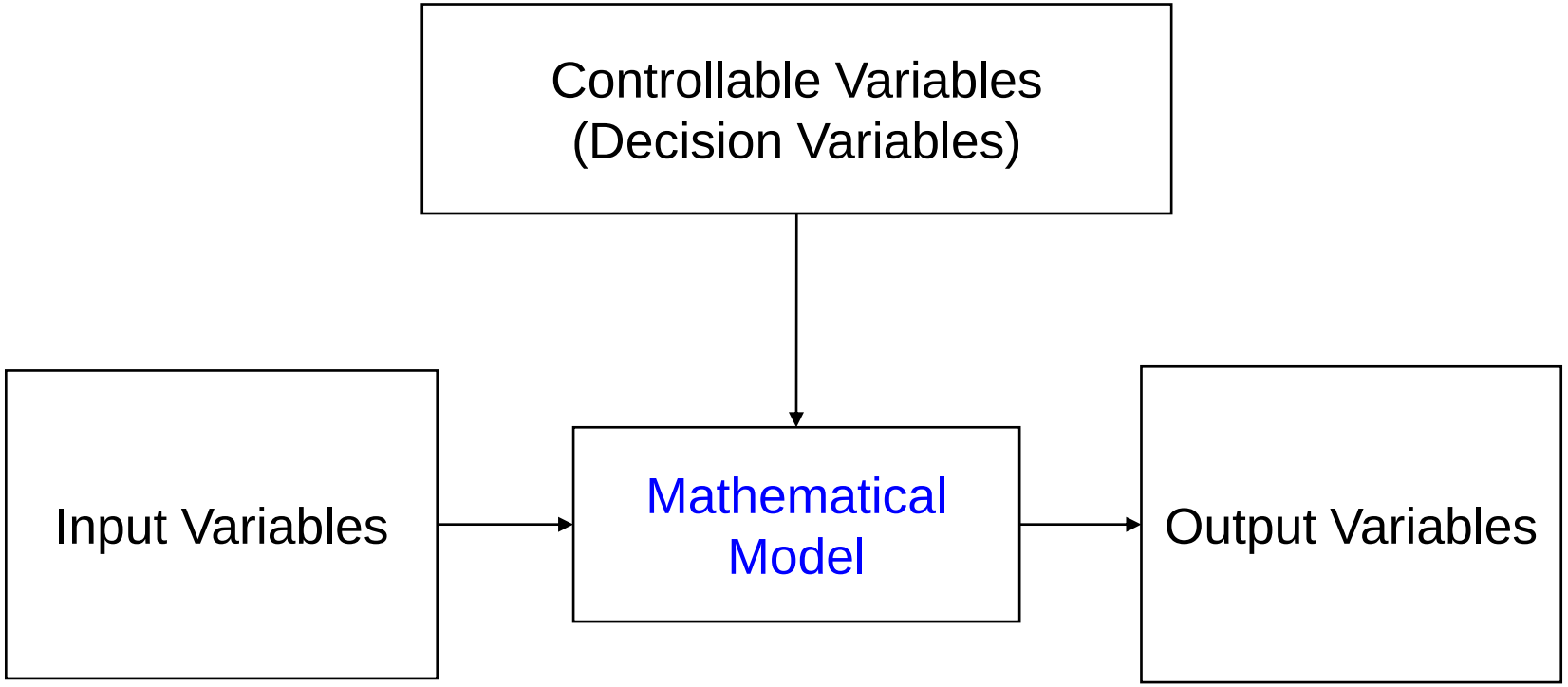




Manufacturing Process Management with Service Intelligence



Manufacturing Process Management with Service Intelligence



Prediction Model Development

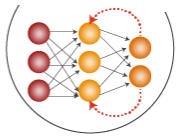
Input Data
(Pre-processed)

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

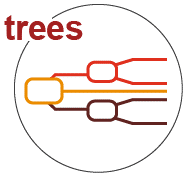
$$y = f(\mathbf{x}, \boldsymbol{\theta}) + \varepsilon$$

neural networks



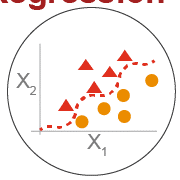
Process-based explanation (Skipped NN)

Decision trees



Rule-based explanation (XGBoost)

Regression



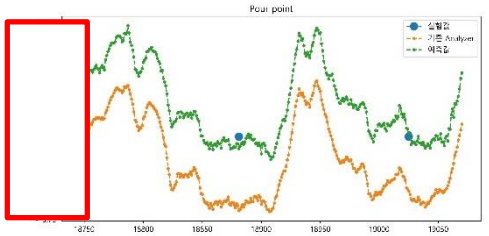
Linear coefficient calculation (LR Bagging)

Result

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

Pour point

NOACK



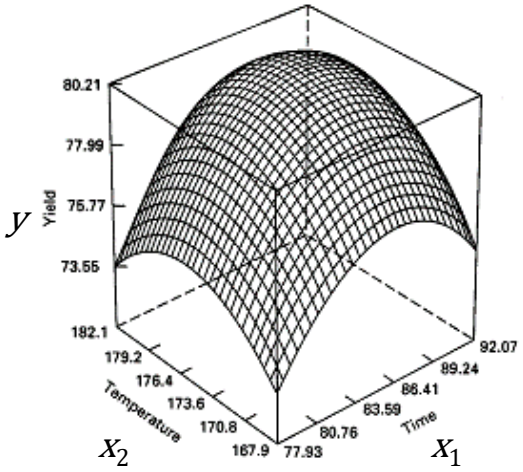
Process Control Optimization

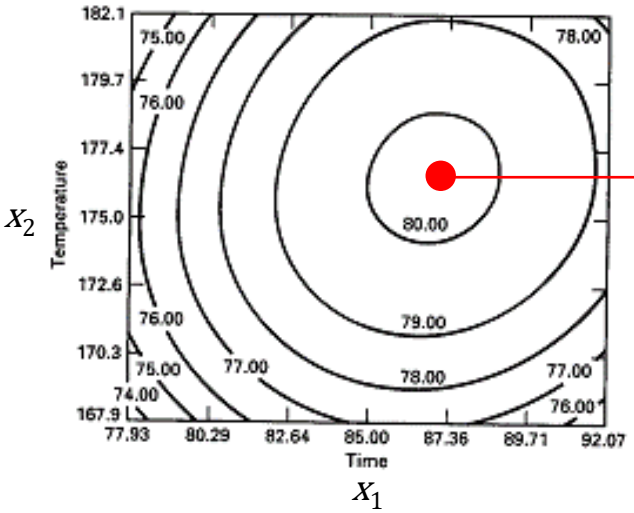
"Model building" "Search optimal setting for **x**"

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

Example*

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

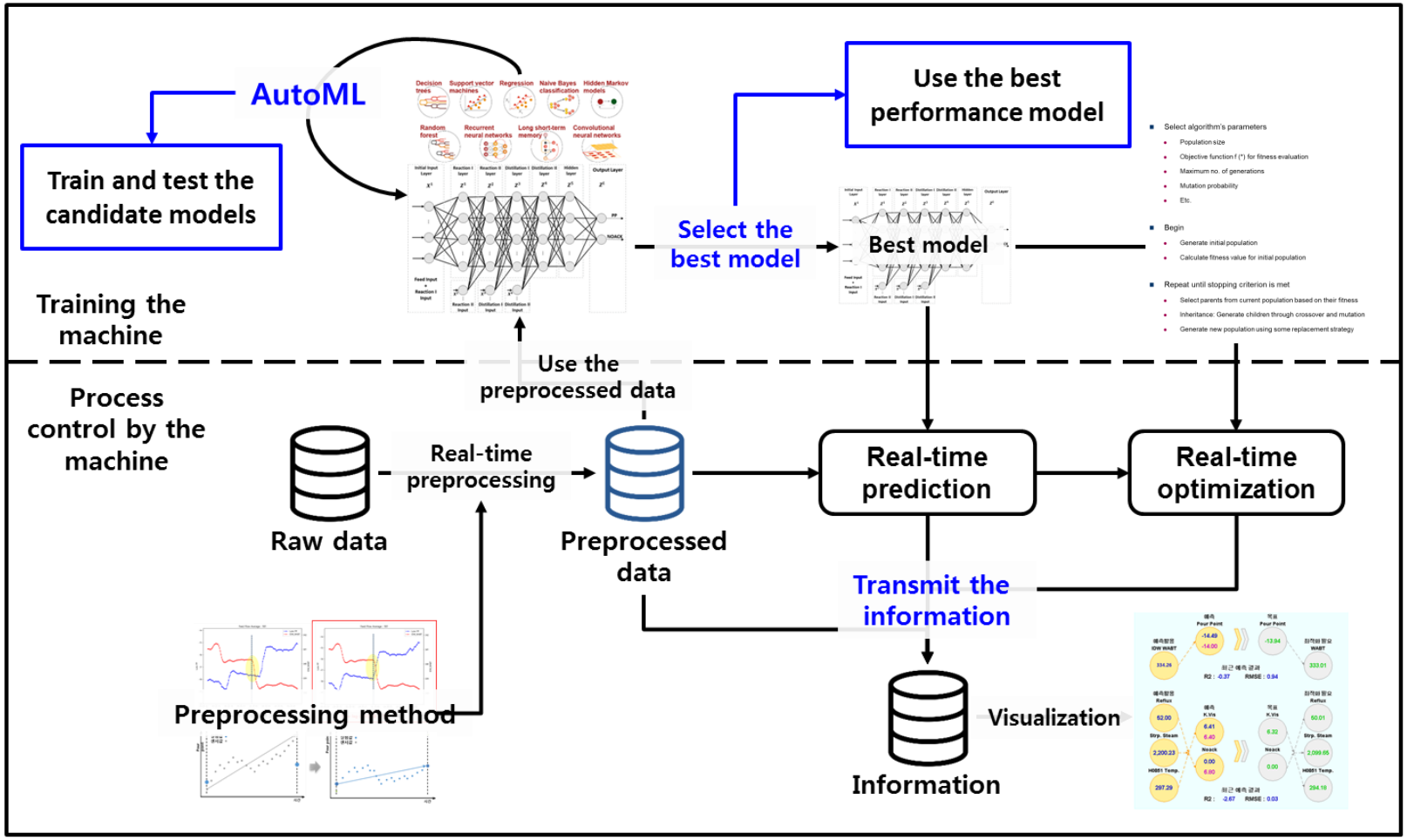




$\hat{y}_1^* = 80.21$ at $\mathbf{x}^* = (87.0, 176.5)$

Service Solution Development

Service solution implementation



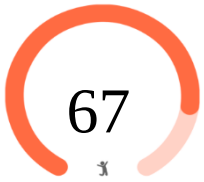
➡ Service solution should be automated to support real-time task support

Safety Monitoring with Service Intelligence

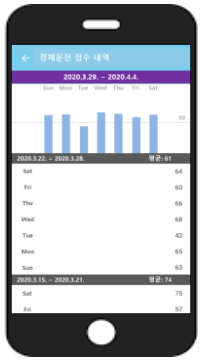
Dangerous behaviors → **Behavior variables** → **Representation** → **Safety score** → **Monitoring and intervention service**

V_1 (S.A.)

V_7 (S.D.)



0 ~ 100



Samyang, the Sugar Manufacturer

samyang
삼양사

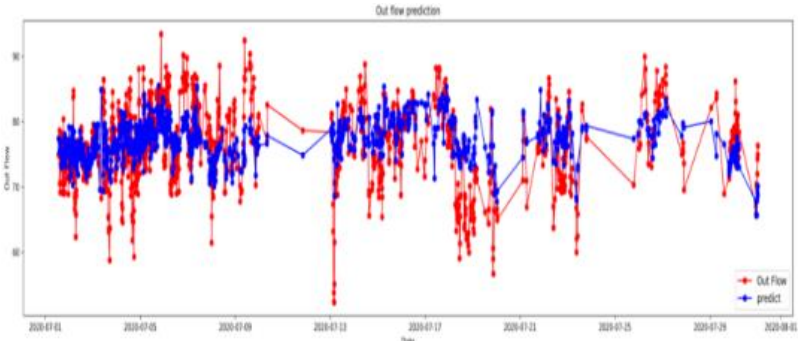
큐원

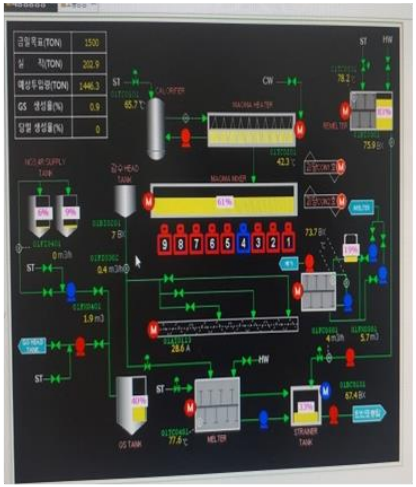
- 1924. 10 삼양사 창립
- 1955. 12 울산제당공장(50 MT/Day)준공
- 1967. 7 한국산업규격표시(KS)인증 취득
- 1992. 8 정제공정자동화
- 2000. 3 ISO 9001, 14001 인증 취득
- 2003. 5 HACCP 인증 취득
- 2007. 6 설탕생산 천만 톤 달성
- 2007. 9 OHSAS 18001 인증 취득
- 2007. 10 ISO 22000 인증 취득
- 2009. 1 정제당시설 1,450MT/Day 증설
- 2009. 3 온실가스배출 감축실적 인증서
- 2010. 5 탄소 성적표지 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

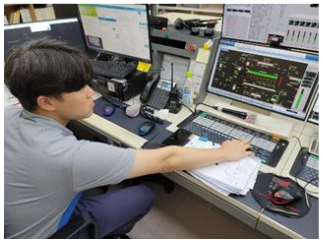
"Model building" "Search optimal setting for **x**"

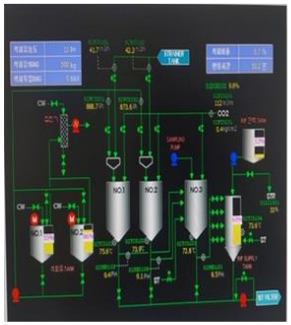
$$y = f(\mathbf{x}, \boldsymbol{\theta}) + \varepsilon \quad \rightarrow \quad \hat{y}(\mathbf{x}) \quad \rightarrow \quad \underset{\mathbf{x} \in \Omega}{\text{optimize}} \ \hat{y}(\mathbf{x})$$

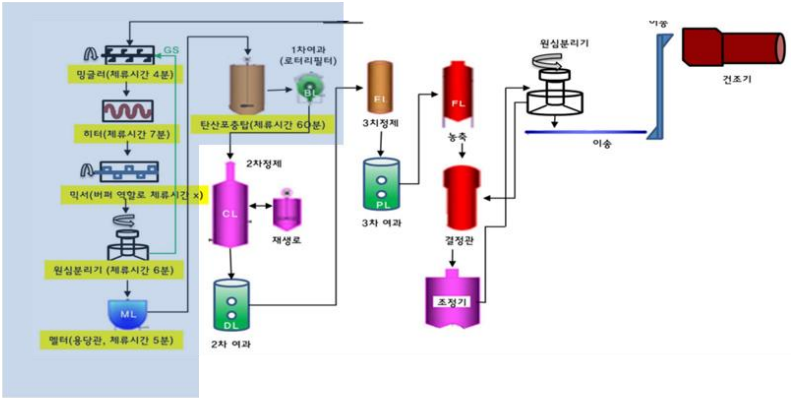




Samyang, the Sugar Manufacturer

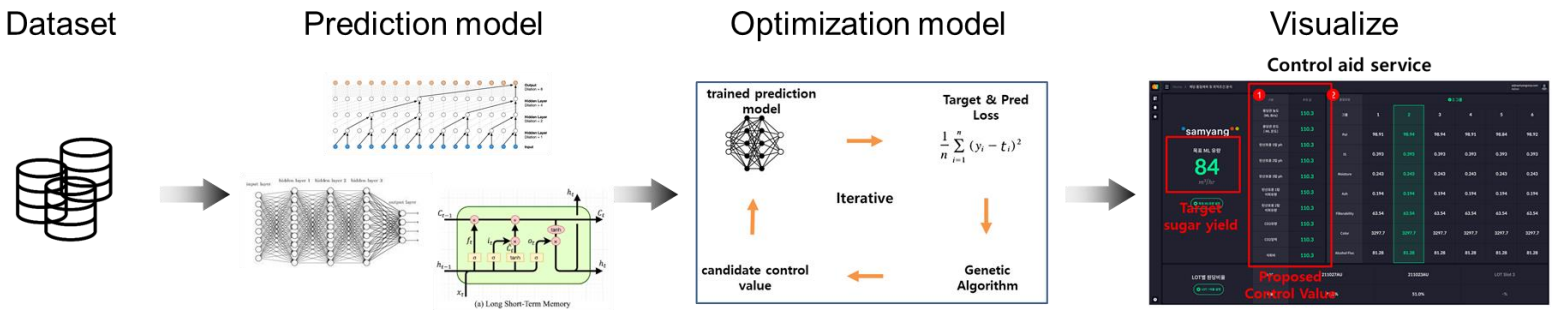






- Problem
  - Operator manually control manufacturing process to optimize sugar yield
  - **Difficult to control complex manufacturing process** to keep sugar yield **stable**
- Service objective
  - **Manufacturing process control aid service** that help operators to keep sugar yield stable

Samyang, the Sugar Manufacturer



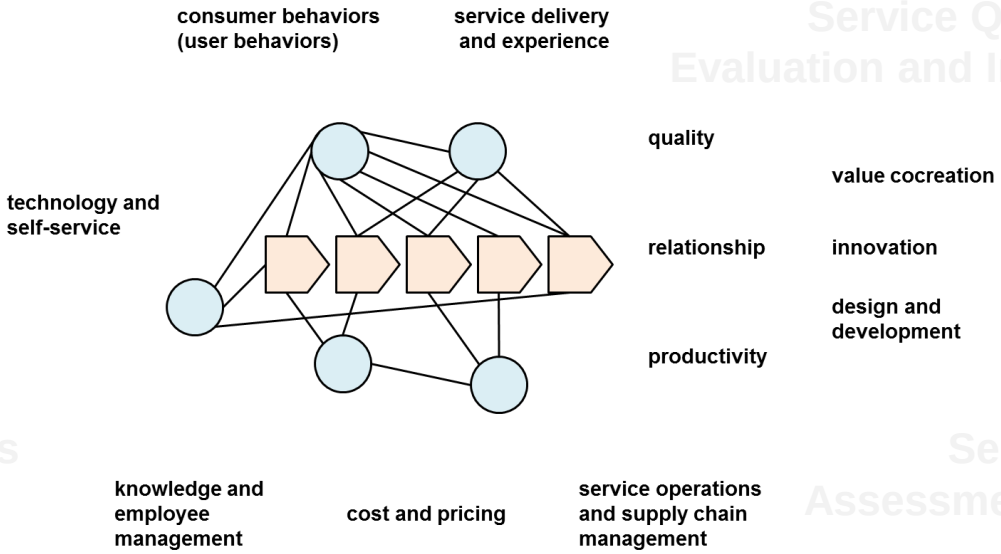
- Real-world application in SAMYANG
  - Need to develop high-performance prediction model

    ➔ time-series pattern, multistage manufacturing property, data characteristics …
  - Consider optimization results that operator can trust ➔ constraints, ranges …
  - Manage real-time prediction & optimization ➔ data collection & storing (DB), preprocessing, model retraining …
  - Visualize (Front end) ➔ connection with back end, user needs …

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.

Topics of the Service Intelligence Course



Service Optimization

Service-related Optimization Problems

- Traveling Salesman Problem
- Vehicle Routing Problem
- Set Covering Problem
- Knapsack Problem
- Bin Packing Problem
- Facility Location Problem
- Scheduling Problem
- Etc.

Heuristics

psychology | algorithm | problem solving | availability | representativeness | decision making | design | usability | evaluation | bias | nielsen | affect

Heuristics and Cognitive Biases
verywellmind.com

Availability Heuristic Affecting Your ...
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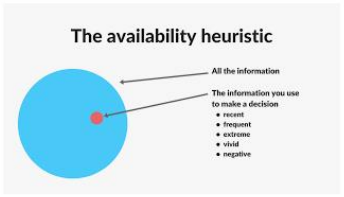

The availability heuristic: Why your ...
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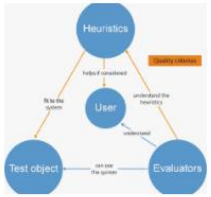

Quality model of heuristic evalu...
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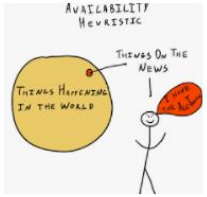

Availability Heuristic - Biases ...
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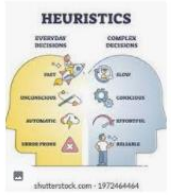
Applying Heuristic Evaluation ...
designorate.com



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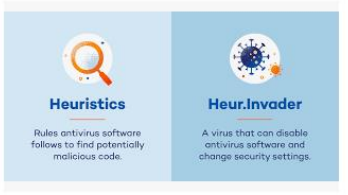
Heuristics Definition | DeepAI
deepai.org



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Reducing Consumer Decision Friction ...
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Using Heuristic Problem-Solving Methods ...
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Create a heuristic evaluation and ...
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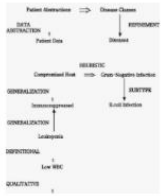
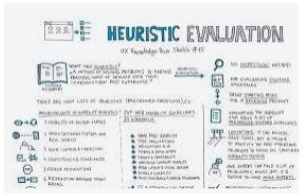

Heuristic Classification
aistudy.co.kr


What Is Heuristic Evaluation? Simple ...
adamfard.com



Heuristic Evaluation. UX Knowledge Base ...
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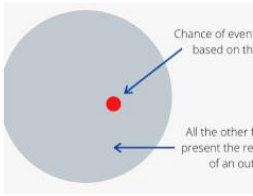

Availability Heuristic (Definition and ...
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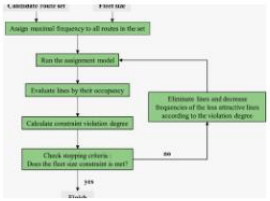
Heuristics

flowchart | singhal | diagram | problem | mystery | simple | classification | ppt | neh | tree | architecture | clustering | scheduling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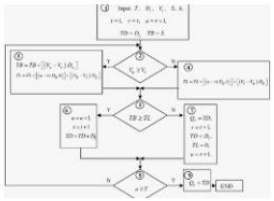
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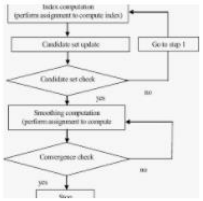
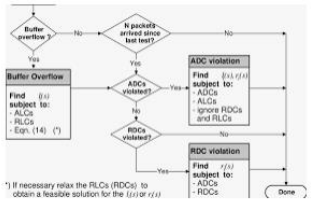
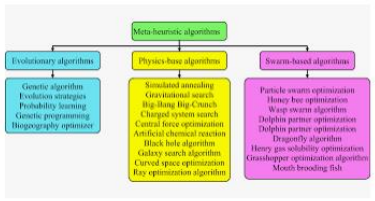
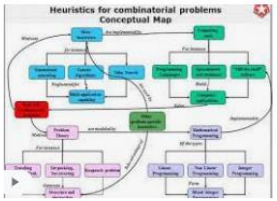
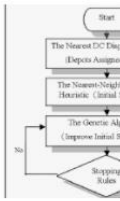
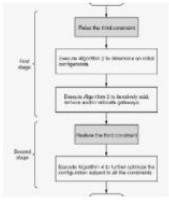

rule based heuristic algorithm...
researchgate.net

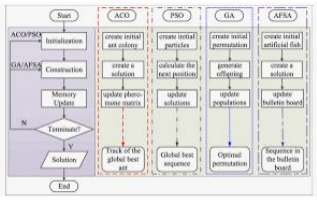

Outline of the Heuristic Algorithm ...
researchgate.net


A novel nature-inspired meta-heuristic ...
link.springer.com

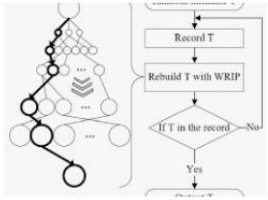

Heuristic Algorithms introduction - YouTube
youtube.com


The hybrid heuristic
researchgate.net

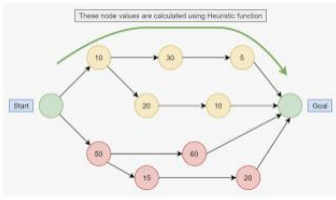

Heuristic Algorithm - an ...
sciencedirect.com


framework of meta-heuristic algorithms ...
researchgate.net

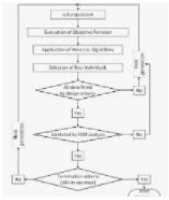

your algorithms from your heuristics ...
dataphilos.com

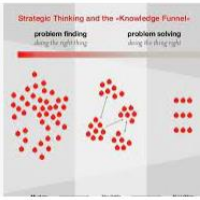


A Heuristic Algorithm Based on Tour ...
semanticscholar.org

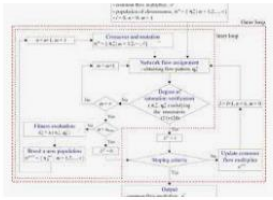


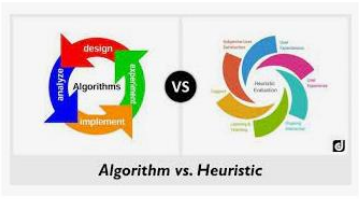
Greedy Vs. Heuristic Algorithm ...
baeldung.com


optimization of heuristic ...
researchgate.net

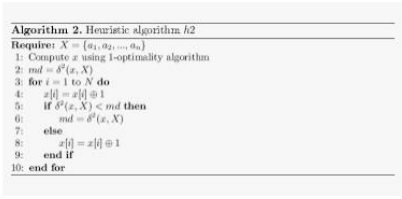


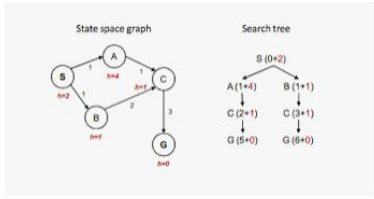
Mystery Heuristic Algorithm ...
in.pinterest.com


Procedure of the heuristic algorithm ...
researchgate.net

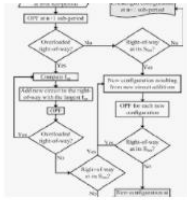


Heuristics Definition | DeepAI
deepai.org


Algorithm 2. Heuristic algorithm $h2$
Require: $X = \{a_1, a_2, ..., a_n\}$
Compute x using 1-optimality algorithm
$md = \delta^2(x, X)$
for $i = 1$ to N **do**
  $x[i] = x[i] \oplus 1$
  if $\delta^2(x, X) < md$ **then**
    $md = \delta^2(x, X)$
  else
    $x[i] = x[i] \oplus 1$
  end if
end for
Heuristic Algorithms for 2-Optimality ...
link.springer.com



heuristic function H is not monotonic ...
stackoverflow.com


Heuristic algorithm embedd...
researchgate.net

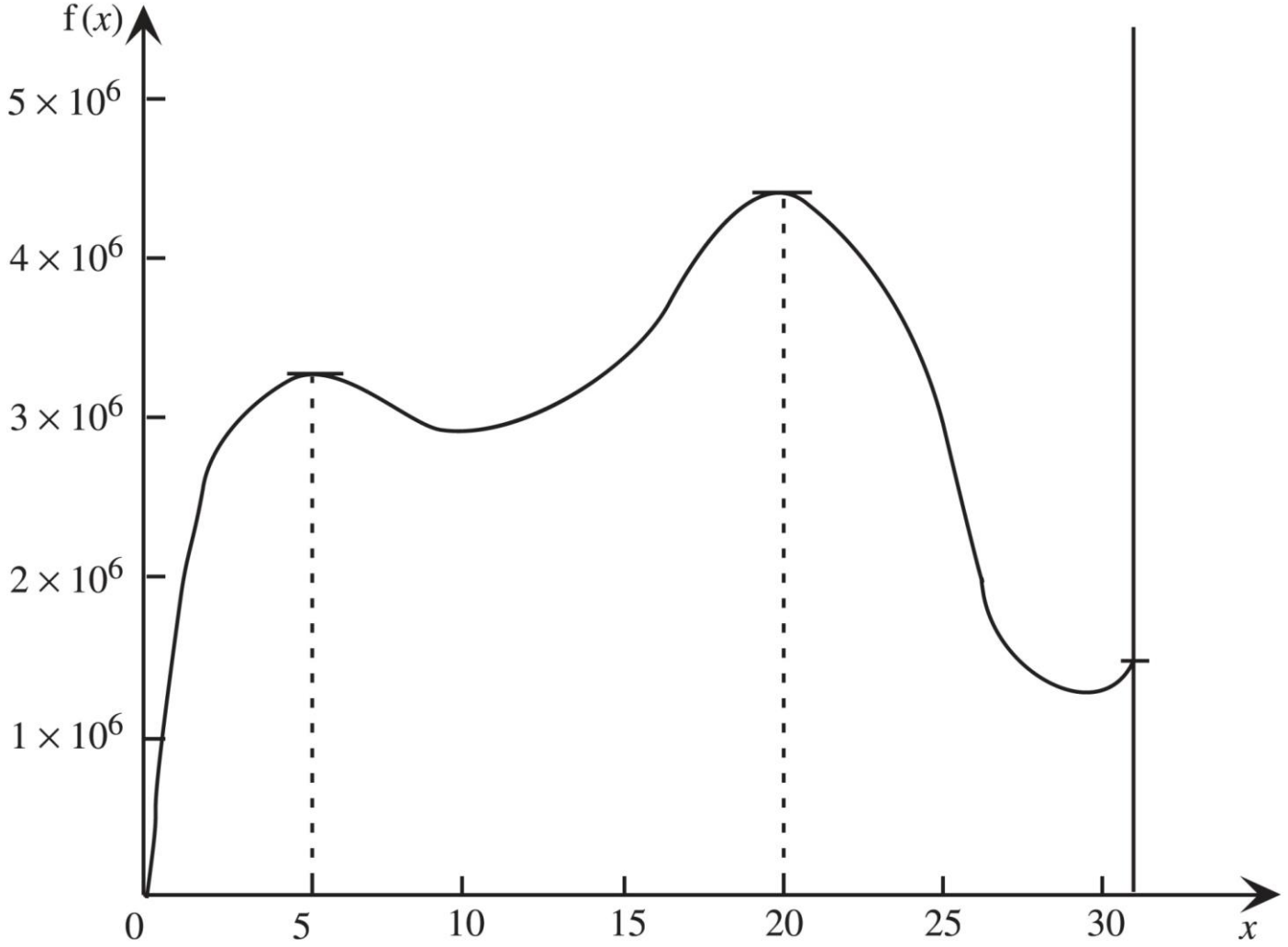
Sookshum: Heuristic Algorithm
sookshum.blogspot.com

Some TSP Construction Heuristics

- Random Search
- Nearest Neighbor Heuristic
- Divide and Conquer
- Farthest Addition Heuristic
- Multi-fragment
- …

Source: R. L. Rardin, Optimization in Operations Research, Prentice Hall, 1998

Limitation of the Improving Search Heuristic Algorithm in General



Heuristics vs. Metaheuristics

- Metaheuristics
  - Some complex optimization problems may not be possible to solve with exact algorithms presented in the OR I and OR II lectures
  - A metaheuristic provides a general structure and strategy guidelines to develop a heuristic method to fit a particular type of problem
  - Metaheuristics can escape from a local optimum: Trial solutions that immediately follow a local optimum are allowed to be inferior
  - Metaheuristics are useful to deal with non-dominated solutions of complex problems

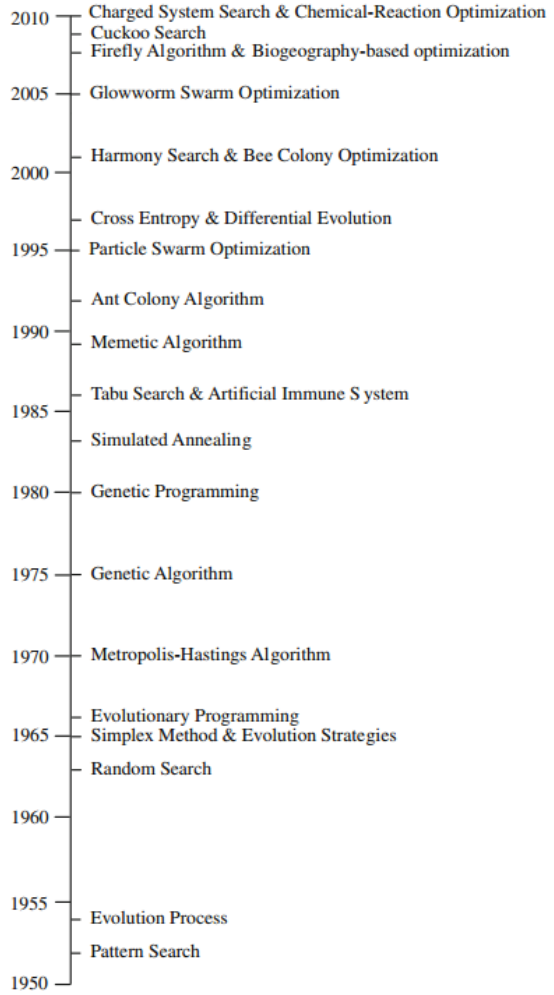
Concept of “Meta”

- Higher order thinking skills
  - Cognition about cognition
  - Thinking about thinking
  - Knowing about knowing
  - Algorithm of algorithms

Metaheuristics Algorithms (Computational Intelligence Algorithms)

- Higher-level procedure or heuristic designed to find a sufficiently good solution

- Often inspired from nature or society
  - Genetic Algorithm
  - Tabu Search
  - Simulated Annealing
  - Ant Colony Algorithm
  - Particle Swarm Optimization
  - Cuckoo Search Algorithm
  - …



GA Example

Member	Initial Population	Fitness (Distance)
1	1-2-4-6-5-3-7-1	64
2	1-2-3-5-4-6-7-1	65
3	1-7-5-6-4-2-3-1	65
4	1-2-4-6-5-3-7-1	64
5	1-3-7-5-6-4-2-1	66
6	1-2-4-6-5-3-7-1	64
7	1-7-6-4-5-3-2-1	65
8	1-3-7-6-5-4-2-1	69
9	1-7-6-4-5-3-2-1	65
10	1-2-4-6-5-3-7-1	64

Member	Parents	Children	Member	Fitness (Distance)
1	1-2-4-6-5-3-7-1	1-2-4-5-6-7-3-1	11	69
7	1-7-6-4-5-3-2-1	1-2-4-6-5-3-7-1	12	64
2	1-2-3-5-4-6-7-1	1-2-4-5-6-7-3-1	13	69
6	1-2-4-6-5-3-7-1	1-7-6-4-5-3-2-1	14	65
4	1-2-4-6-5-3-7-1	1-2-4-6-7-5-3-1	15'	63
5	1-3-7-5-6-4-2-1	1-3-7-5-6-4-2-1	16	66

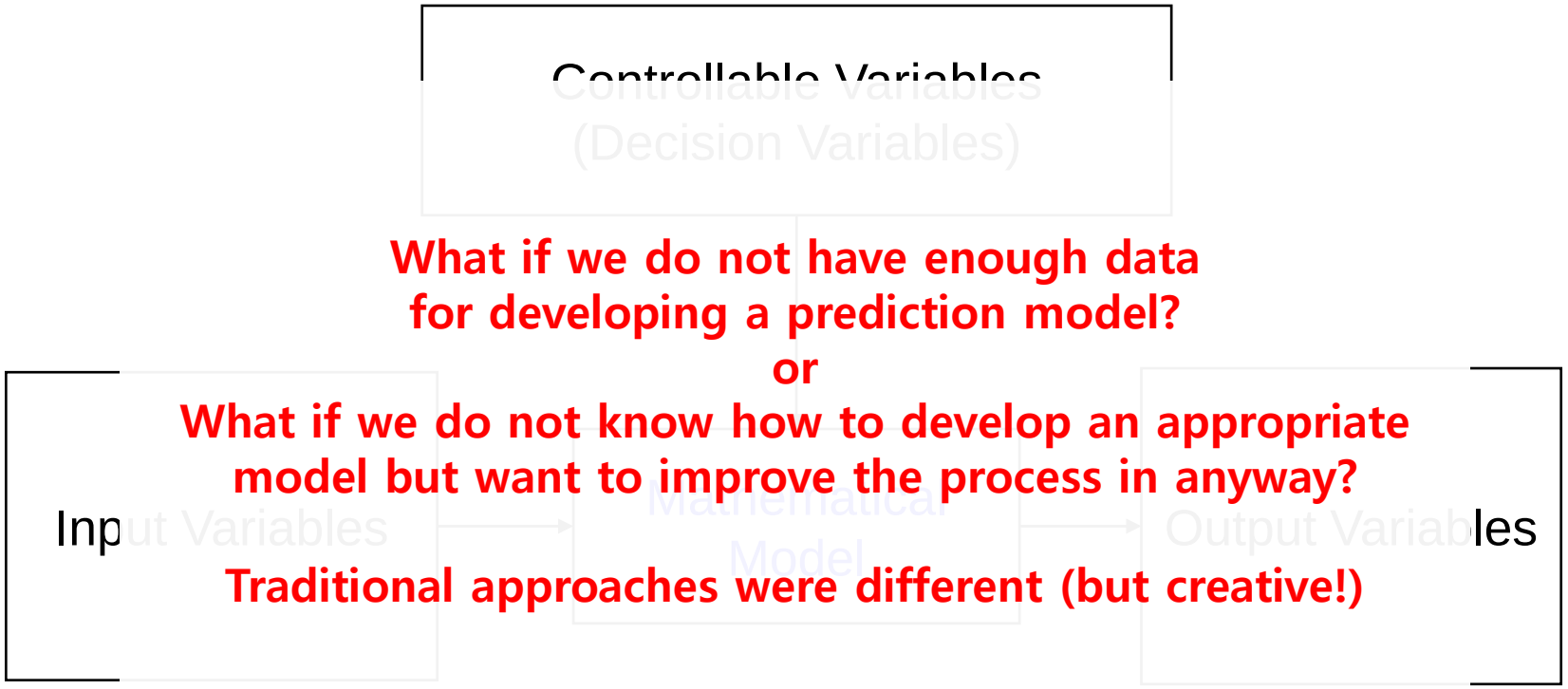
Think About

- Encoding method
- Initialization method
- Population size
- Fitness evaluation function
- Parents selection method
- Inheritance method
- Mutation method
- Parameters for the methods
- Homogeneity of population
- Etc.

Assignment 7 (by 11.18 11:59 pm)

- (0) Based on the practice demonstration by TA Yoon, complete the Assignment 6 (i.e., Optimize the production process and describe the results - identify 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.
- (1) Select more than 9 nodes in the UNIST map you would like to introduce to a visitor. Connect the nodes, estimate the distance between nodes, and represent the network similar to the case introduced in the class. Find the optimal route, using a genetic algorithm or your own heuristic.
- (2) Identify a real-world service optimization problem that you are interested or concerned, and develop a mathematical model of this problem, based on existing reference models and your own creativity. Describe the importance of your problem and model in detail.
- (3) Develop your own heuristic algorithm to solve this problem. Your algorithm should reflect a mechanism “how we, humans make decisions”. An idea level is fine. Try to think long and propose your new algorithm concisely. Describe in detail the algorithm in a format of flow chart, pseudocode, or your own visualization. If possible, try to identify and use a good mathematical model for your conceptual basis. For your reference, you may want to study a metaheuristic algorithm besides GA that is most interesting to you.

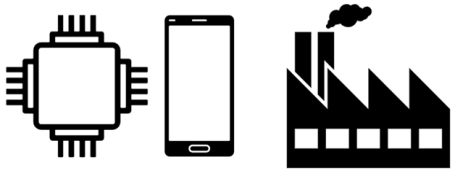
A Framework of Service Operations Management



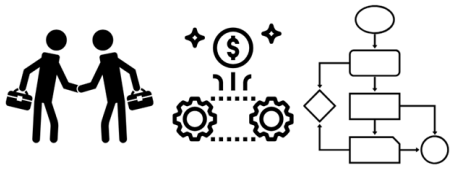
What if we do not have enough data for developing a prediction model?
or
What if we do not know how to develop an appropriate model but want to improve the process in anyway?

Traditional approaches were different (but creative!)

Processes around Us Involve Problems and Need Improvement



Manufacturing Process Management



Business Process Management

Personal Process Management

Process/ variables	Inputs				Outputs		
	I1	I2	I3	I4	O1	O2	O3
P2-a	…	…	…	…	…	…	…
P2-b	…	…	…	…	…	…	…
P2-c	…	…	…	…	…	…	…
P2-d	…	…	…	…	…	…	…
P2-e	…	…	…	…	…	…	…
P3-a	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…
P5-a	…	…	…	…	…	…	…
P5-b	…	…	…	…	…	…	…
P5-c	…	…	…	…	…	…	…
P5-d	…	…	…	…	…	…	…
P5-e	…	…	…	…	…	…	…
P5-f	…	…	…	…	…	…	…
P5-g	…	…	…	…	…	…	…

Data Envelopment Analysis: Concept

- Definition of the efficiency in DEA

$$\text{Efficiency} = \frac{\text{Weighted Sum of Outputs}}{\text{Weighted Sum of Inputs}}$$

$$\text{Efficiency of unit j} = \frac{u_1 y_{1j} + u_2 y_{2j} + \ldots}{v_1 x_{1j} + v_2 x_{2j} + \ldots}$$

where

u_1 = the weight given to output i

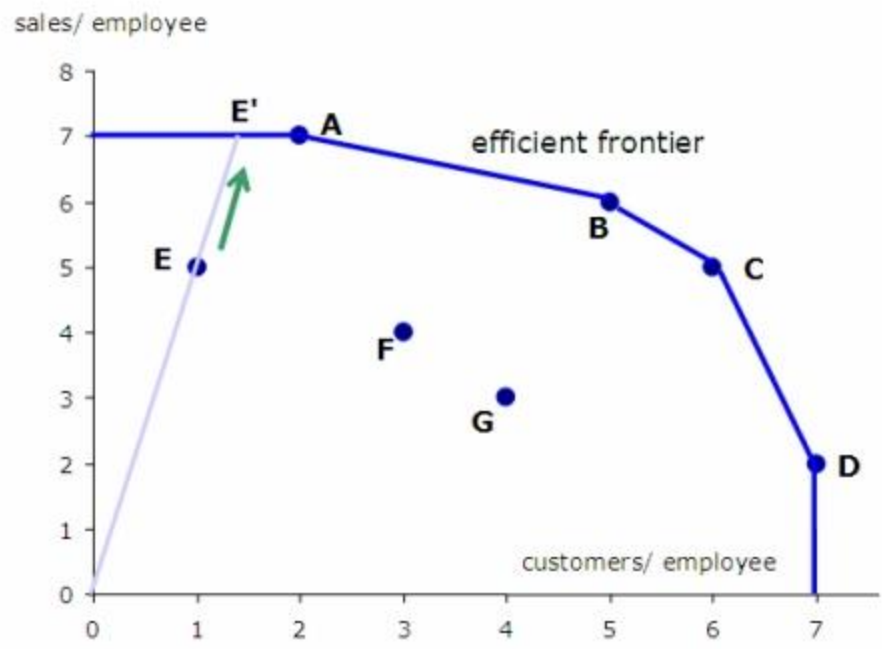
y_{1j} = amount of output 1 from unit j

v_1 = weight given to input 1

x_{1j} = amount of input 1 to unit j.

Data Envelopment Analysis: Visual Illustration of the Concept

- Efficient DMUs form a frontier and envelop the data



Source: http://blog.datumbox.com/data-envelopment-analysis-tutorial/

Term Project :

“Develop Your Own Service Intelligence”

Term Project Topics

Book recommender system

Musical review mining
Spotify review mining

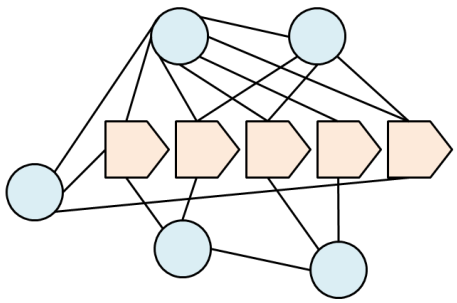
Beer recommender system

Skin care item recommendation

Music recommender system
Restaurant recommender system

Food recommender system

All Projects



Healthy diet planning for UNIST students

Banking app service advancement

Machine predictive maintenance for e-coating system
Anomaly detection for industrial services

Topics of the Service Intelligence Course

Service Review Mining

Behavioral Data Mining

Recommender Systems Development

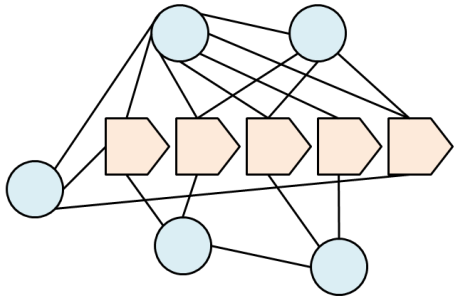
consumer behaviors (user behaviors)

service delivery and experience

Service Quality Evaluation and Improvement

All Weeks

technology and self-service



quality

value cocreation

relationship

innovation

design and development

productivity

Customer Segmentation and Service Customization

Special Lectures on Service Intelligence

knowledge and employee management

cost and pricing

service operations and supply chain management

Service Process Assessment and Improvement

Service Optimization

Industrial Service Intelligence

Implications from several previous term projects

Implications from several previous term projects

- Own creative “framework” of developing a novel service intelligence
- Performance evaluation of the intelligence developed
- Comparison of different methods
- Completeness of the “final solution” design
- Contribution of the term project outcome to the improvement of focal service

Implications from your assignment outcomes

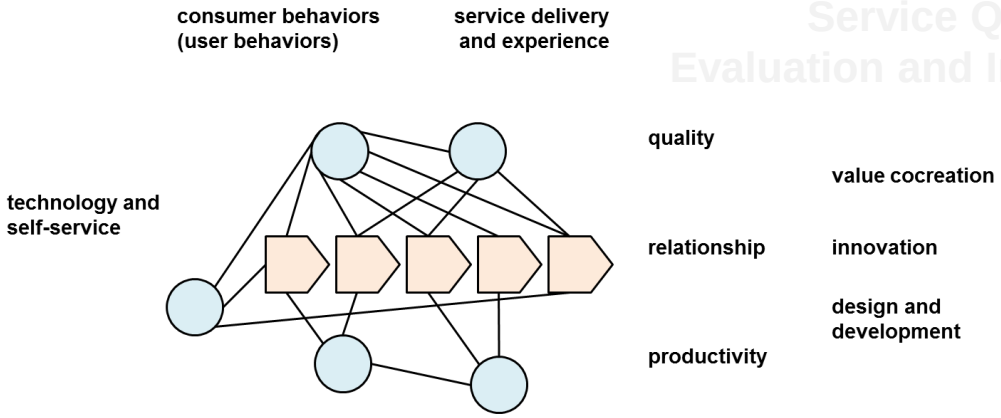
Implications from your assignment outcomes

- Collection, analysis, and learning of well-structured datasets are basic

- Identification of a significant problem based on the basic practice
- Identification of an idea to solve the problem
- Identification or design of service contents to be delivered to the customers/users

- Own creative “framework” of developing a novel service intelligence

Topics of the Service Intelligence Course



Special Lectures on Service Intelligence

Service Intelligence Special Lecture:

An Example of Successful Service Intelligence R&D Projects

Jongkyung Shin

2022. 11. 16

Dandelion Algorithm:

An Example of Successful Term Projects

Kihyuk Yoon

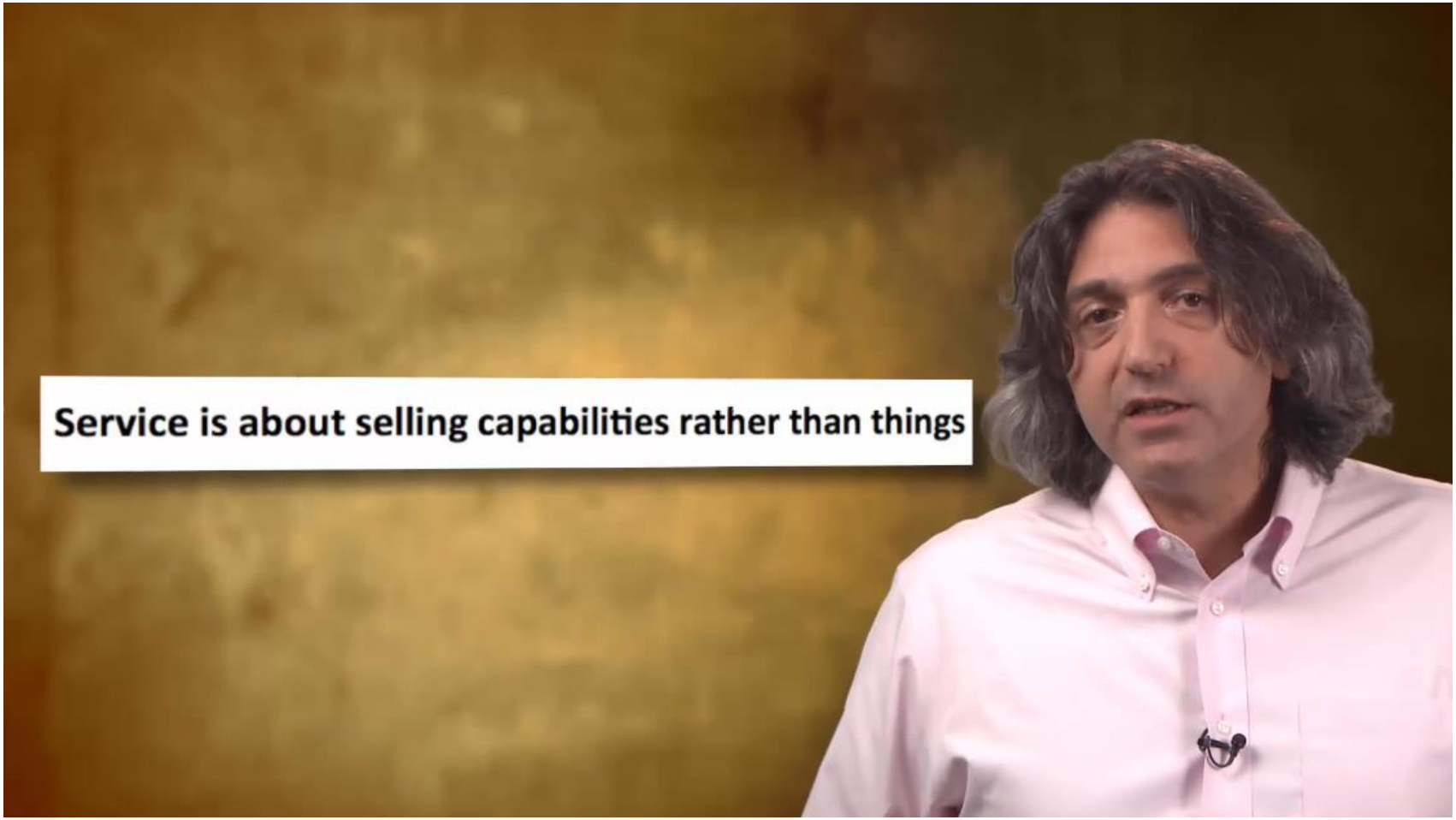
2022. 11. 16

Requirements and standards for your term projects

- Definition of a significant service problem and an idea to solve the problem (10)
- Identification or design of service contents to be delivered to the customers/users (10)
- Own creative “framework” of developing a novel service intelligence (30)
- Collection, analysis, and learning of well-structured datasets (20)
- Experiment: Performance verification of the intelligence developed (10)
- Experiment: Comparison with different methods of the intelligence development (10)
- Validity and completeness of the final service solution design (5)
- Contribution of your term project outcome to the improvement of focal service (5)

Concluding Remarks on Service Intelligence

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



Think About Learnable Tasks and Data in the Services You Care

Restaurant Service


Health Care Service

Location-based Mediation Service

E-learning Service

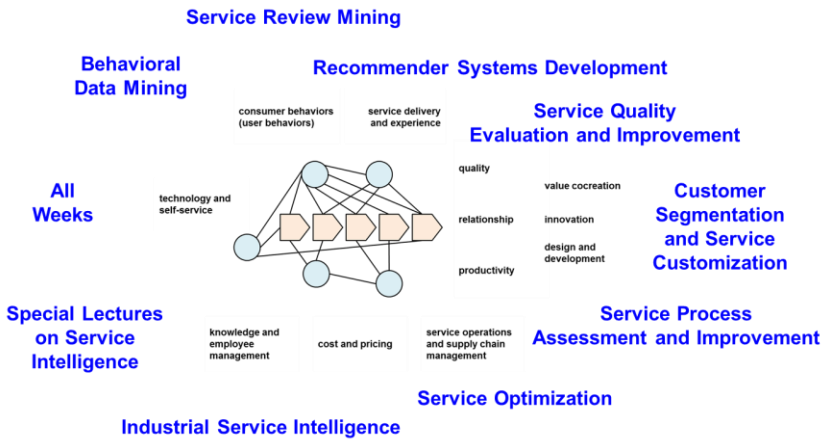

Amusement Park Service


Ingredients Delivery Service

Car Sharing Service


Leisure Service


Mobile Game Service



Scattered knowledge and raw data related to the important task of customers

A large gap exists. Why?
There is no knowledge base for decision making of the customers and service provider!

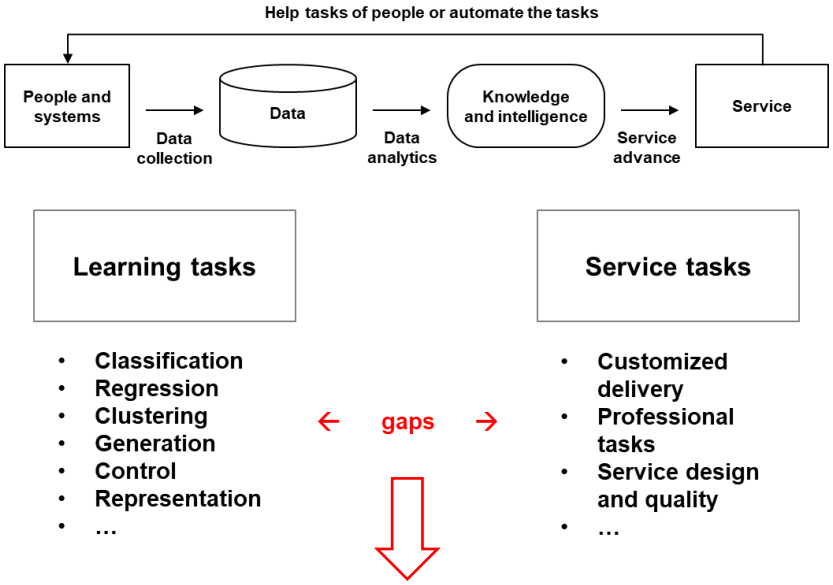
Efficient and effective execution of the tasks and value co-cretaion

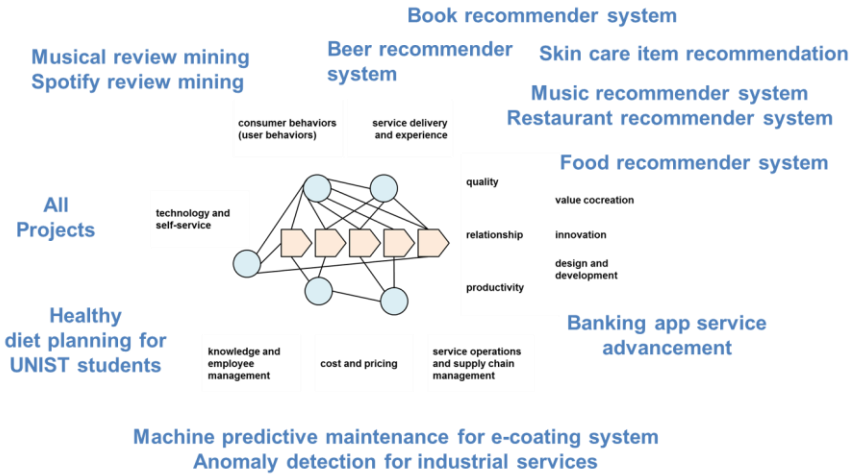
Prepare a dataset regarding the task and preprocess the dataset for learning

Service intelligence trained for the task's learning and control objectives

Semi-automated efficient and effective execution of the tasks and value co-cretaion

The Gaps in Solving Real-World Service Problems with Intelligence





① machine capabilities – service requirements, the task scope gap

② learning infrastructure – machine requirements, the learning operations gap

③ intelligence contents – customer acceptance, the intelligence delivery gap

④ human employees – artificial intelligence, the collaborative intelligence gap

⑤ non-AI professionals – AI professionals, the organizational knowledge gap

Remaining Schedule for Term Project Presentation & Paper Submission

- Finally, the remaining schedule of the term project is as follows
  - Final presentations on December 7

    (each team has 5 minutes in total for presentation and 2 minutes for Q&A)
  - Final paper submission due by December 23

    (maximum 8 pages for the main article and unlimited pages for the appendix; use the template)
- 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