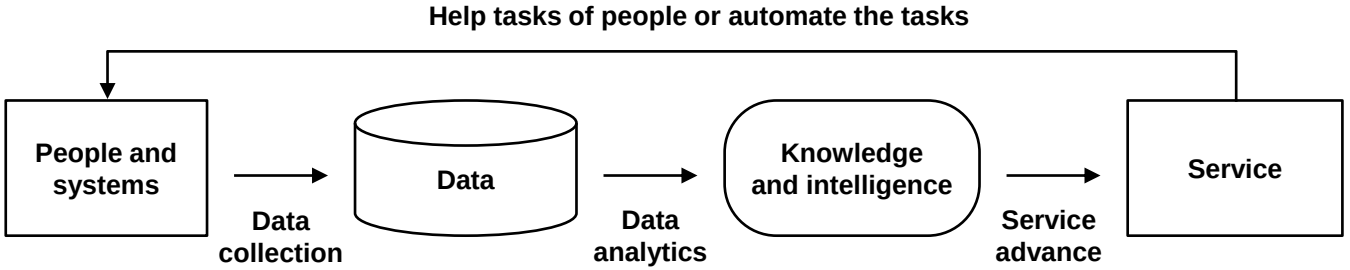
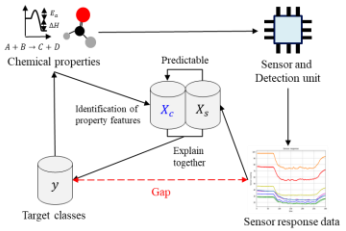
Understanding Service Tasks and Domains

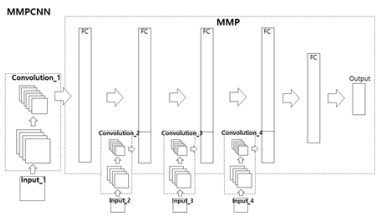
Chiehyeon Lim

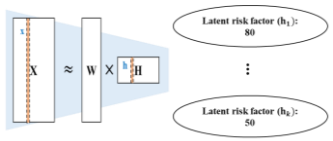
2022. 08. 31

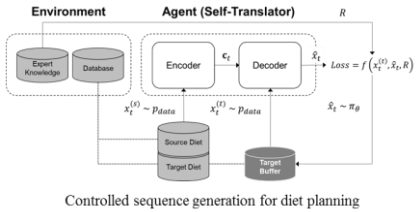
A Framework of Service Intelligence











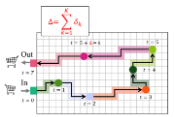
Controlled sequence generation for diet planning

knowledge discovery and intelligence development

health care

mobility

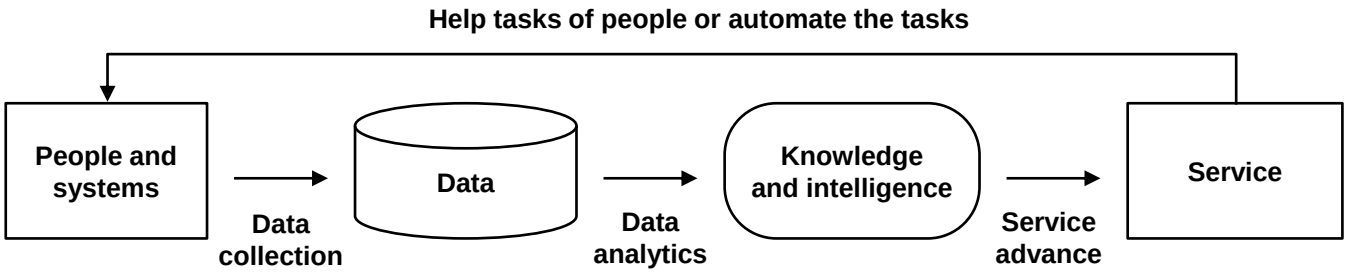
hospitality



retail services

for advancing services in industry and society

Learning Tasks and Service Tasks



Learning tasks

- Classification
- Regression
- Clustering
- Generation
- Control
- Representation
- …

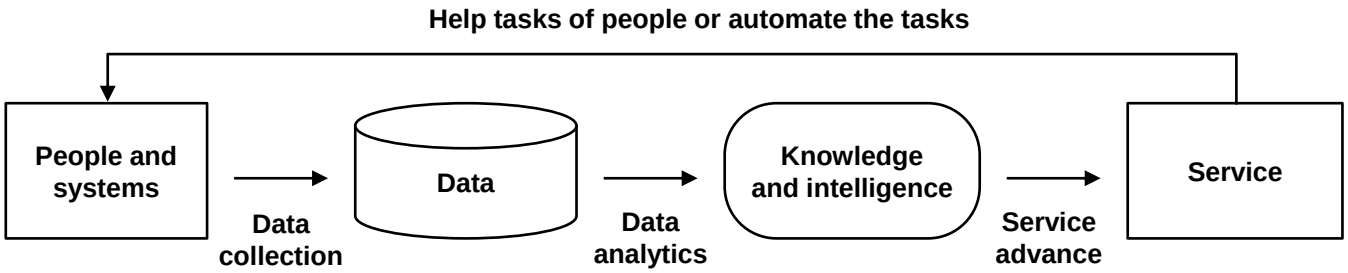
Service tasks

- Customized delivery
- Professional tasks
- Service design and quality
- …

Reference: Lim, C. and Lyons, K., "Toward service intelligence: On the gaps between artificial intelligence and service research," *Journal of Service Management*, Invited, 2022.

Learning Tasks and Service Tasks

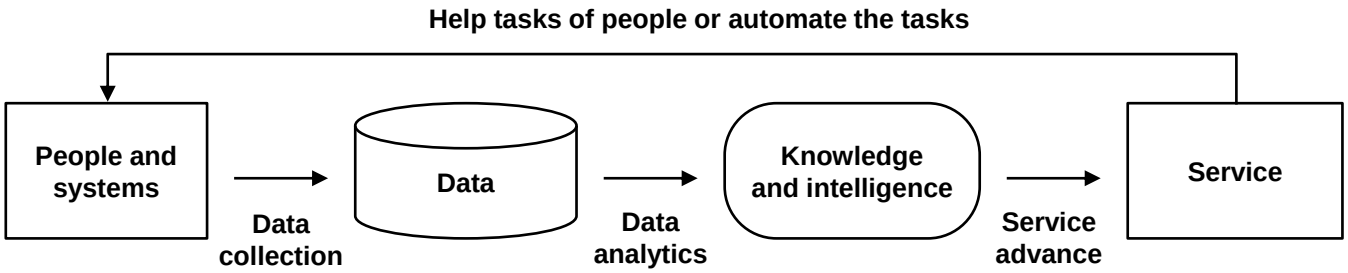
There are gaps (e.g., scope, data gaps) between the learning tasks and service tasks



Learning tasks		Service tasks
• Classification • Regression • Clustering • Generation • Control • Representation • …	← gaps →	• Customized delivery • Professional tasks • Service design and quality • …

Learning Tasks and Service Tasks

To fill the gaps, service intelligence development requires the knowledge on both tasks



Learning tasks

- Classification
- Regression
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- …

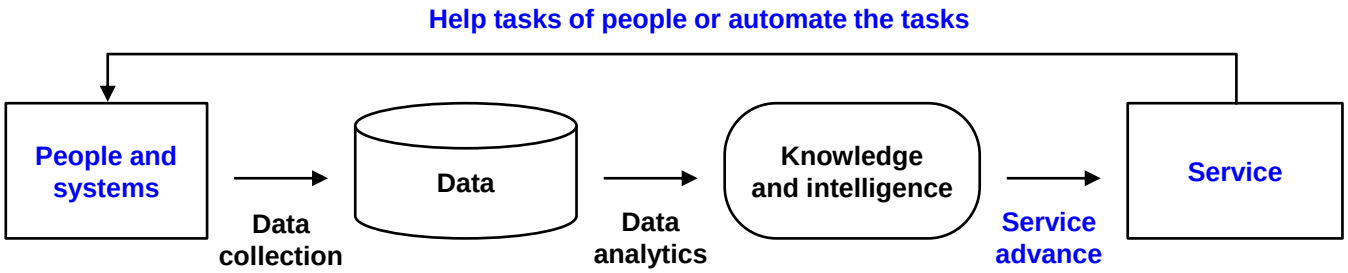
→ gaps ←

Service tasks

- Customized delivery
- Professional tasks
- Service design and quality
- …

Learning Tasks and Service Tasks

We should first need understand service tasks and domains, the problem area



Learning tasks		Service tasks
• Classification • Regression • Clustering • Generation • Control • Representation • …	→ gaps ←	• Customized delivery • Professional tasks • Service design and quality • …

What is a service? How can we define it?

Service??

Restaurant Service

Health Care Service

taskrabbit UBER

Location-based Mediation Service

E-learning Service

Amusement Park Service

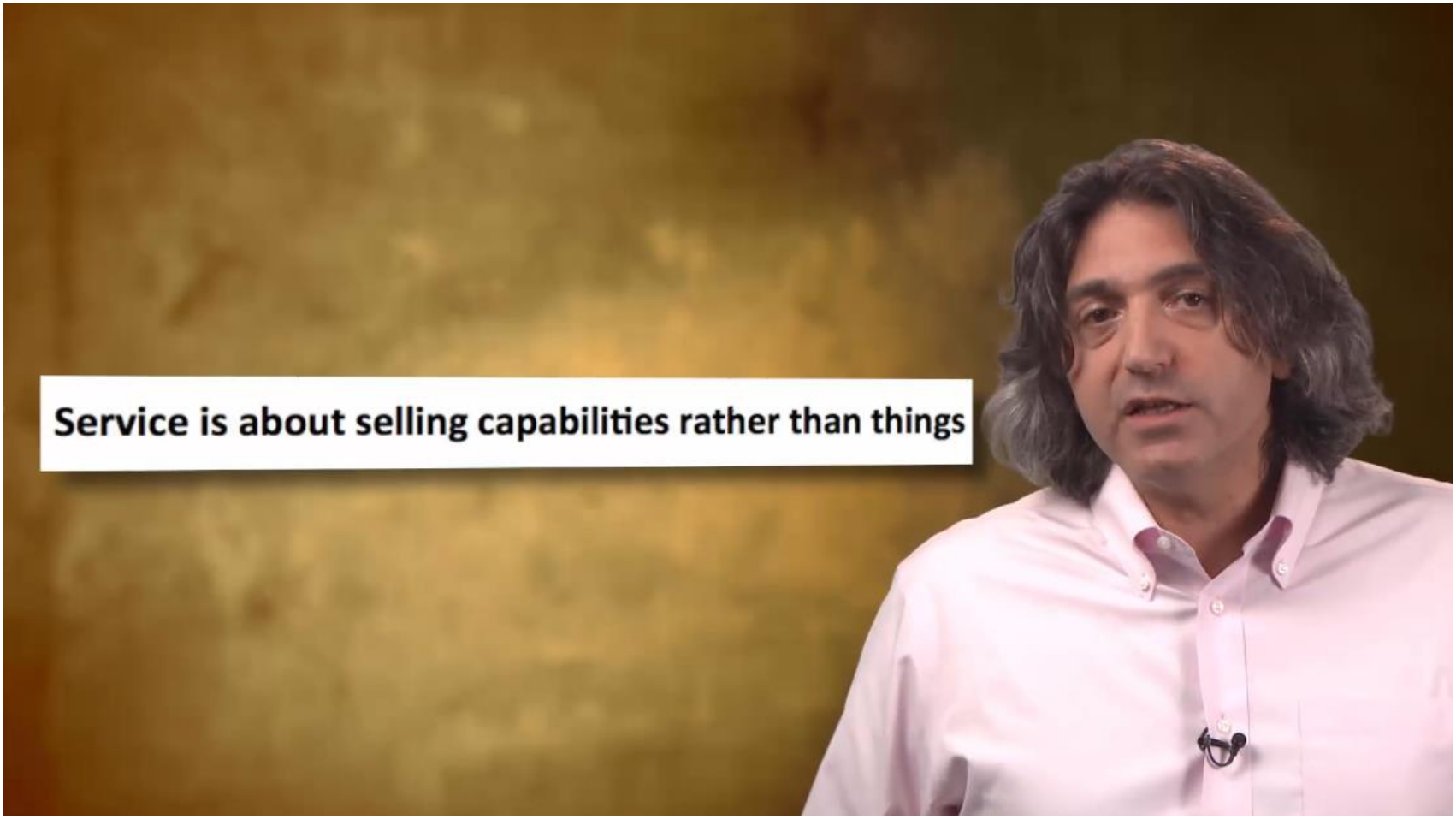
Ingredients Delivery Service

Car Sharing Service

Leisure Service

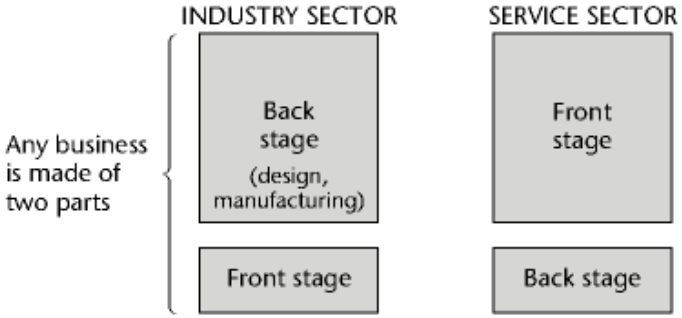
Mobile Game Service

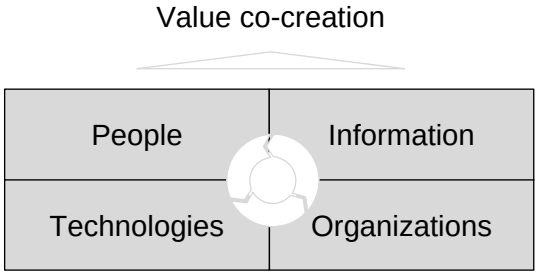
Service is Simply to Serve Customers: Help Tasks or to Do the Tasks



Traditional Descriptive Definitions of Service

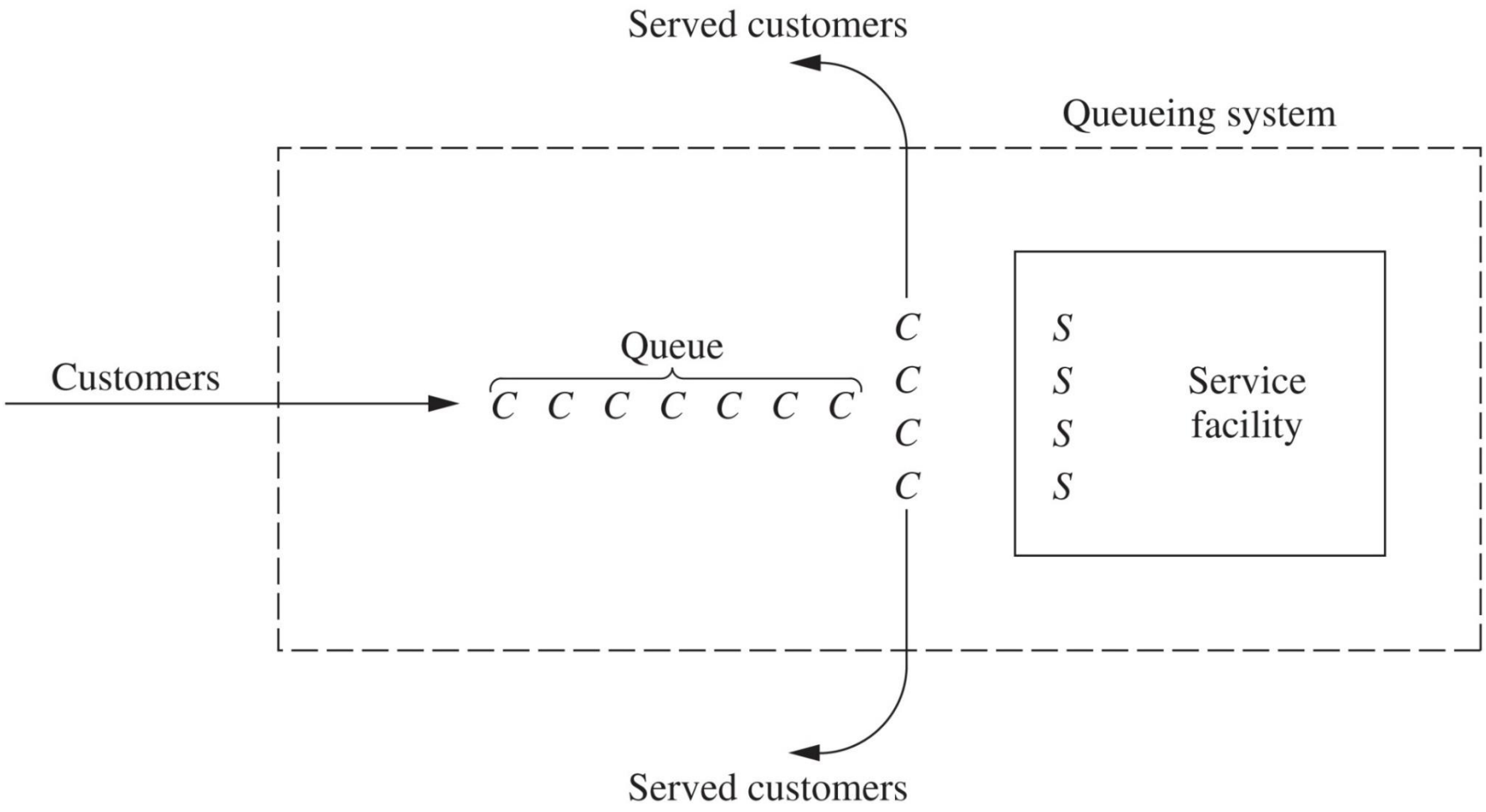
Viewpoint	Think about
Services are neither agriculture nor manufacturing	Think about services based on the separation of sectors (e.g., heavy equipment vs. hotel)
Services are front-stage activities that involve a performance given by one party for another	Think about services based on the separation between the front and back stages (e.g., fast food vs. counseling)
Services are systems of people, information, organizations, and technologies that operate together for a mutually valued outcome	Think about services as a system by decomposing the systems into several elements that collaborate for "value creation" (e.g., how education creates value? how do you create value with others? try to capture opportunities around you)





Reference: Service is Front Stage (Teboul, 2006);
On value and value co-creation: A service systems and service logic perspective (Vargo et al., 2008)

Service is a stochastic system



Service is a stochastic system

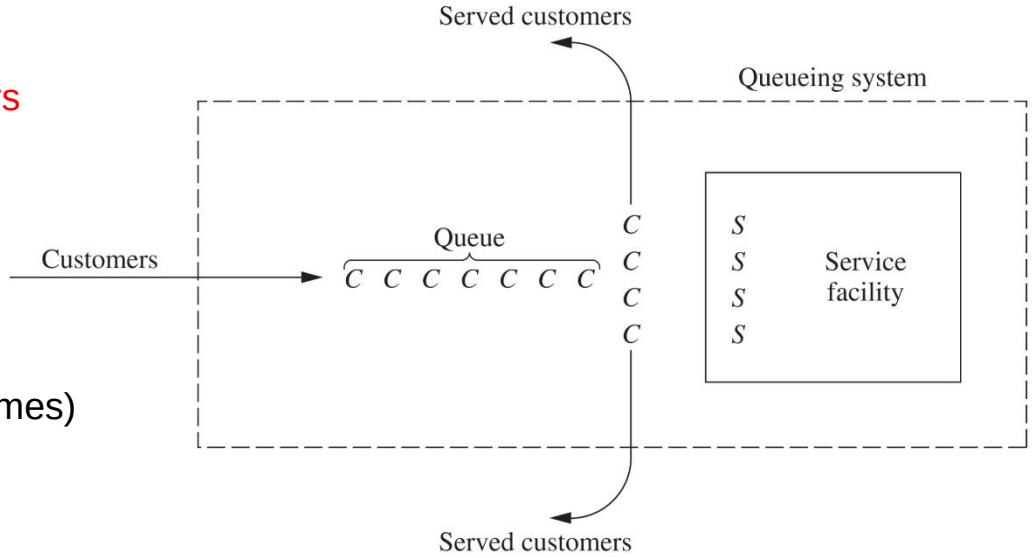
- M/M/s Queueing Model
  - First letter refers to distribution of interarrival times
  - Second letter indicates distribution of service times
  - Third letter indicates number of servers
  - Where,

    M: exponential distribution

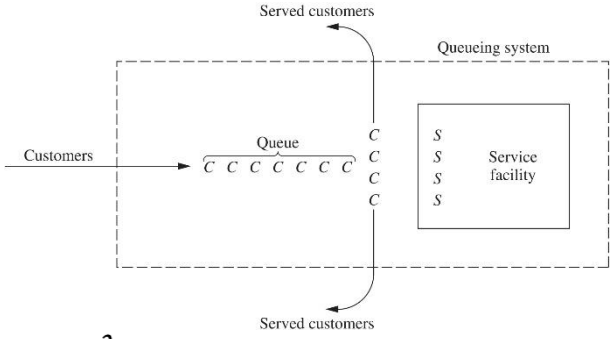
    D: degenerate distribution (constant times)

    E_k: Erlang distribution

    G: general distribution (any arbitrary distribution allowed)



Service is a stochastic system



$$\rho = \frac{\lambda}{\mu}$$

$$P_0 = 1 - \rho$$

$$P_n = (1-\rho)\rho^n$$

$$L = \frac{\rho}{1-\rho} = \frac{\lambda}{\mu - \lambda}$$

$$L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} = \lambda W_q$$

$$W_q = \frac{\lambda}{\mu(\mu-\lambda)}$$

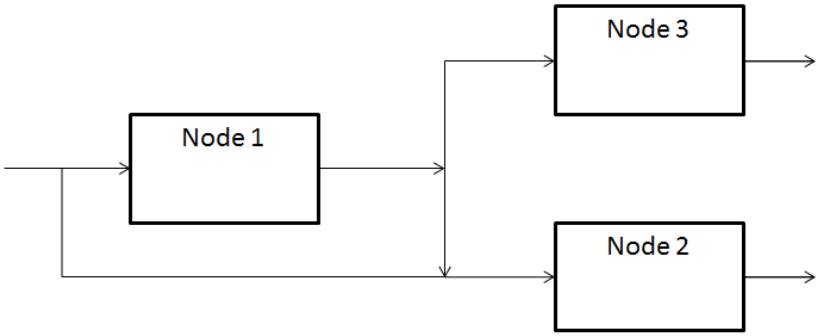
$$W = \frac{1}{\mu-\lambda} = W_q + 1/\mu$$

Service is a stochastic system

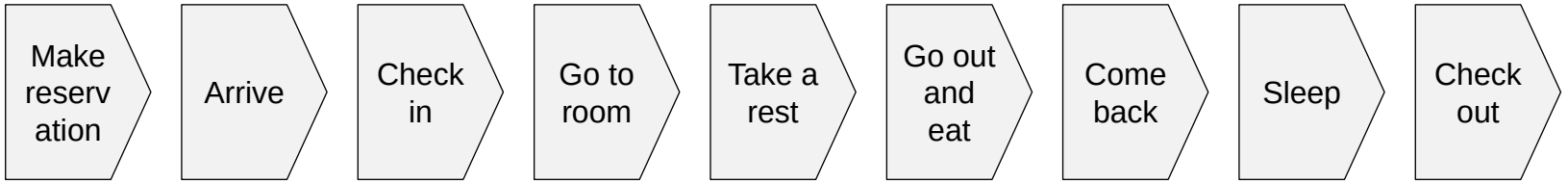
Outlet Shopping Service

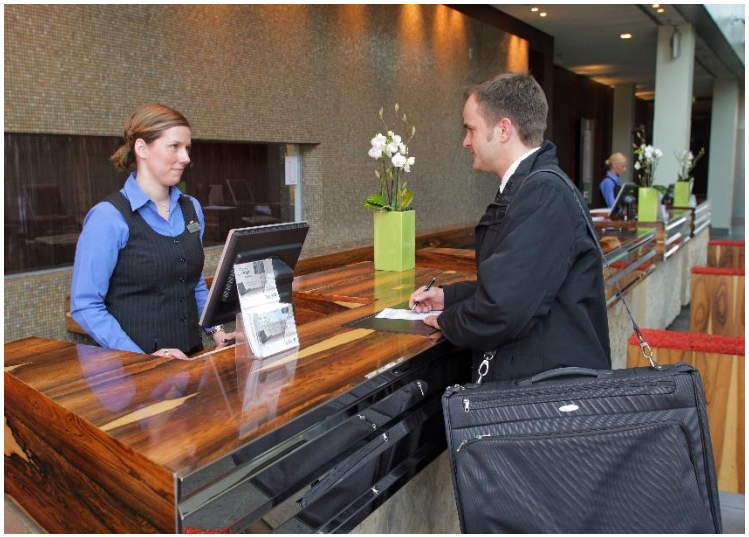
Amusement Park Service

Facility j	s_j	μ_j	a_j	p_{ij}		
				$i = 1$	$i = 2$	$i = 3$
$j = 1$	1	10	1	0	0.1	0.4
$j = 2$	2	10	4	0.6	0	0.4
$j = 3$	1	10	3	0.3	0.3	0



Service involves customer processes





Service involves interactive processes of the customer and provider

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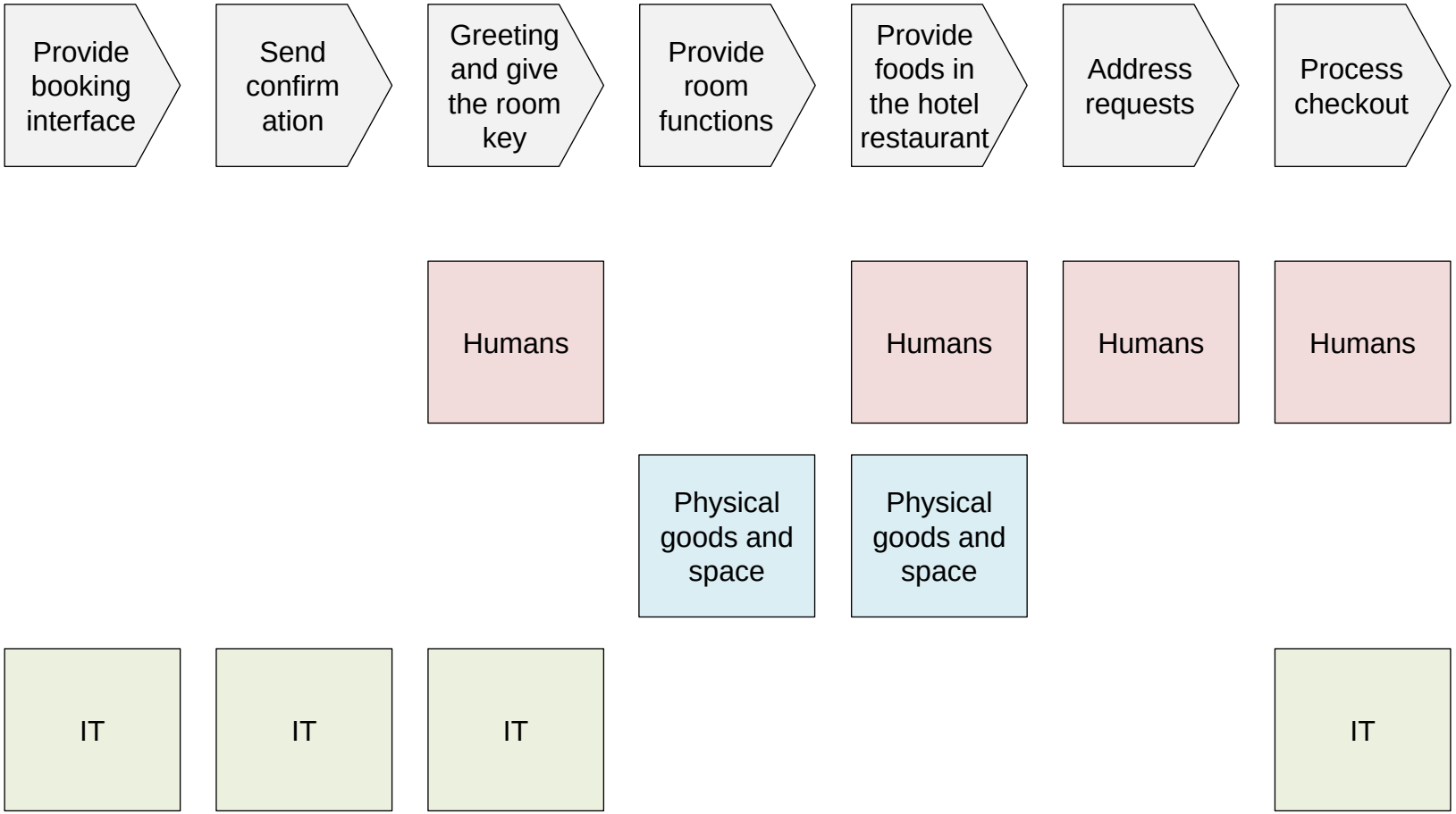
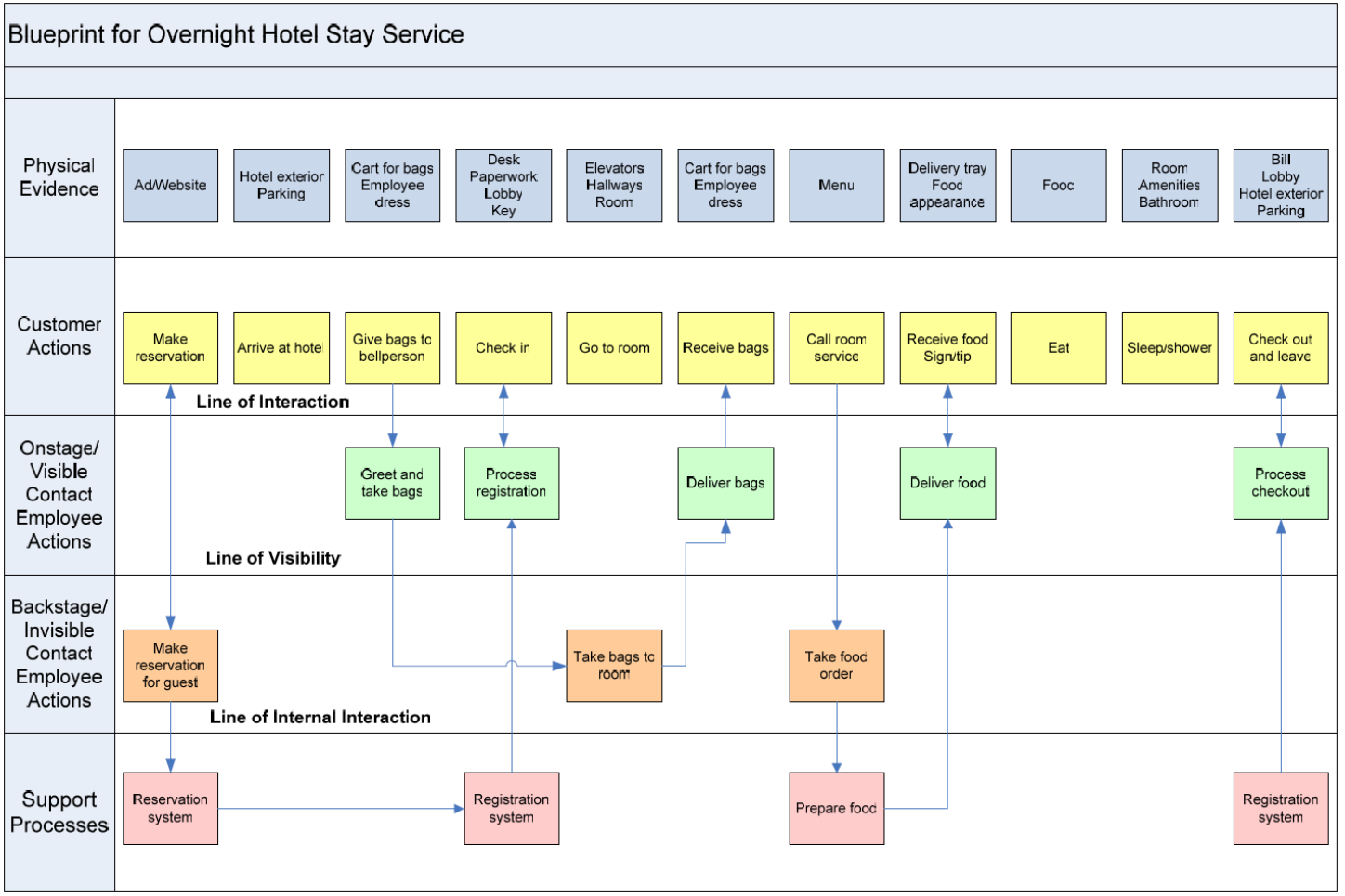


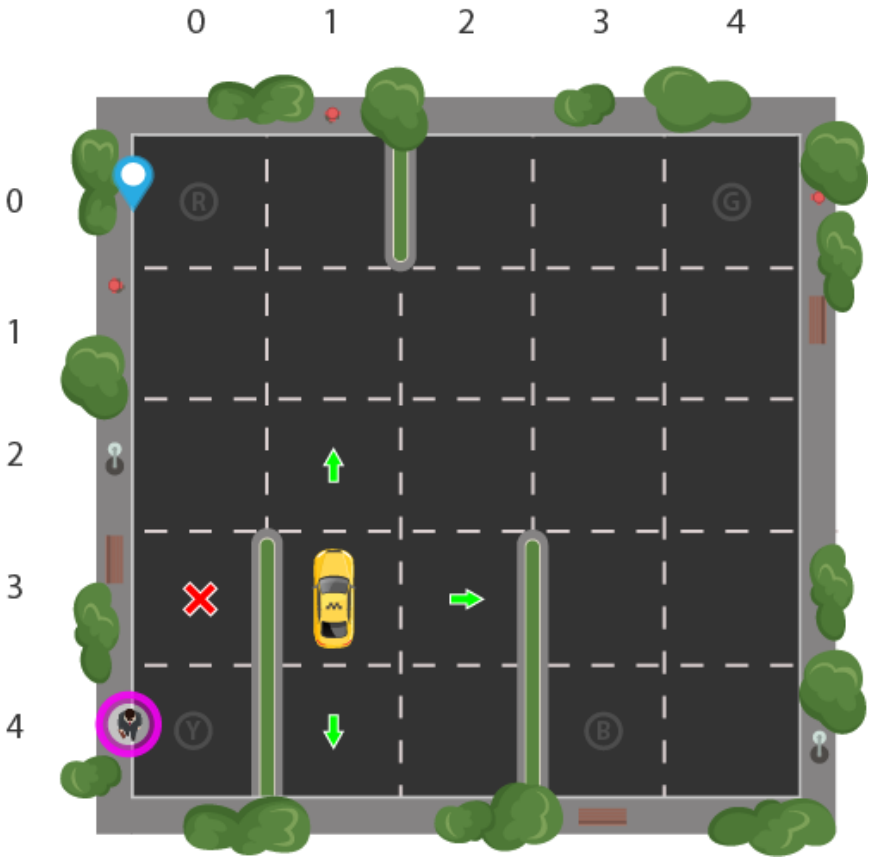
Service involves interactive processes of the customer and provider

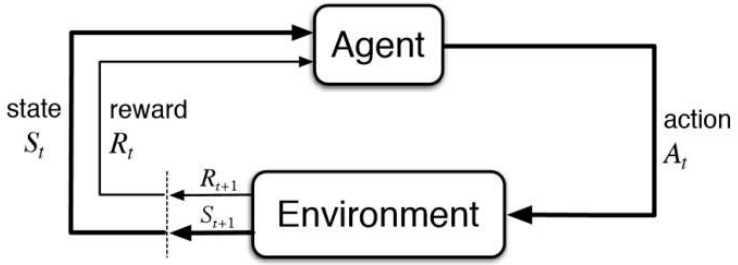
- Visualizing the customer journey and corresponding service delivery process



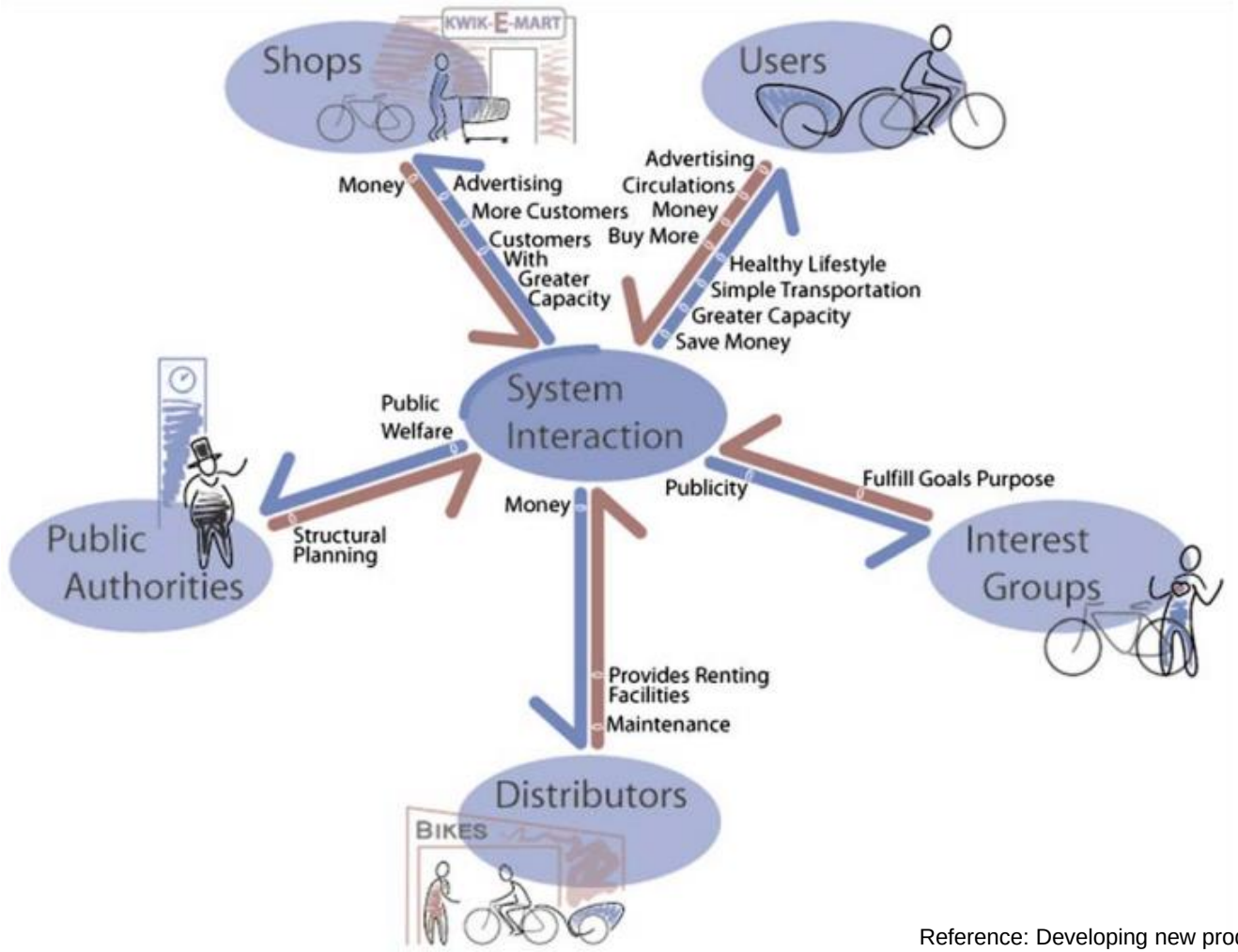
A hotel service delivery process visualized on Service Blueprint (Bitner et al., 2008)

Service involves a stochastic decision making process



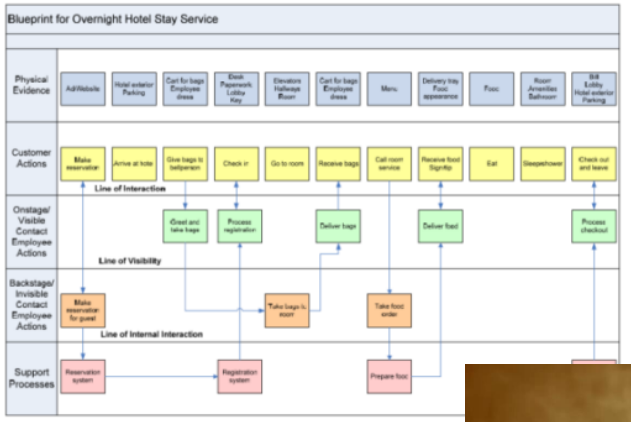


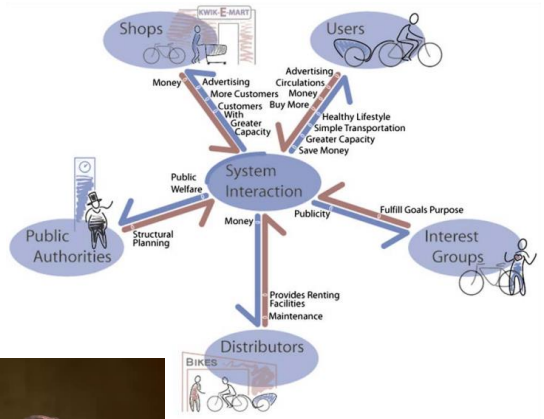
Service is a network of actors

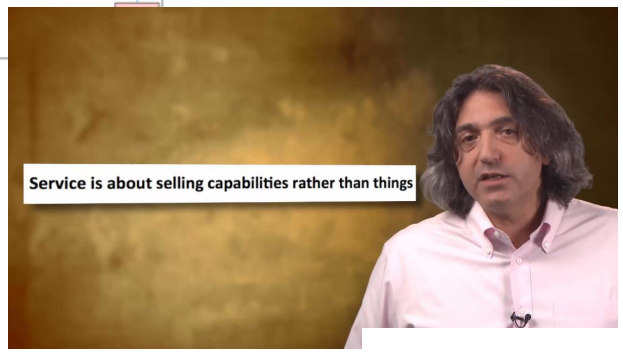


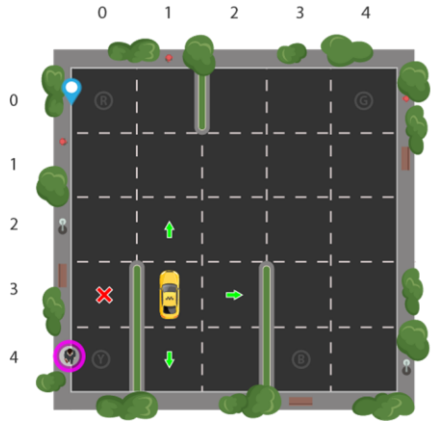
Reference: Developing new product service systems (PSS): methodologies and operational tools (Morelli, 2006)

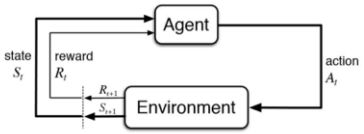
Integrating Existing Perspectives into a Service Concept

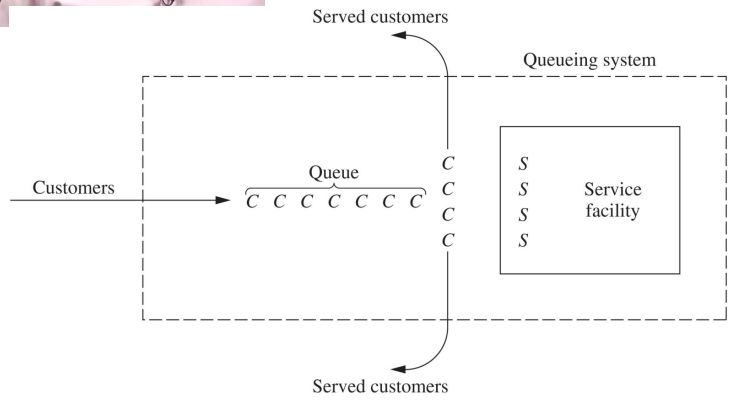








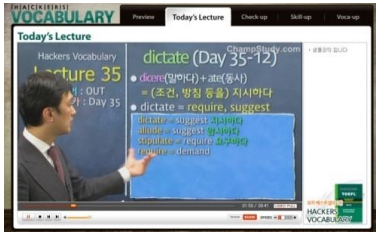




Service Concept in the Context of this Course

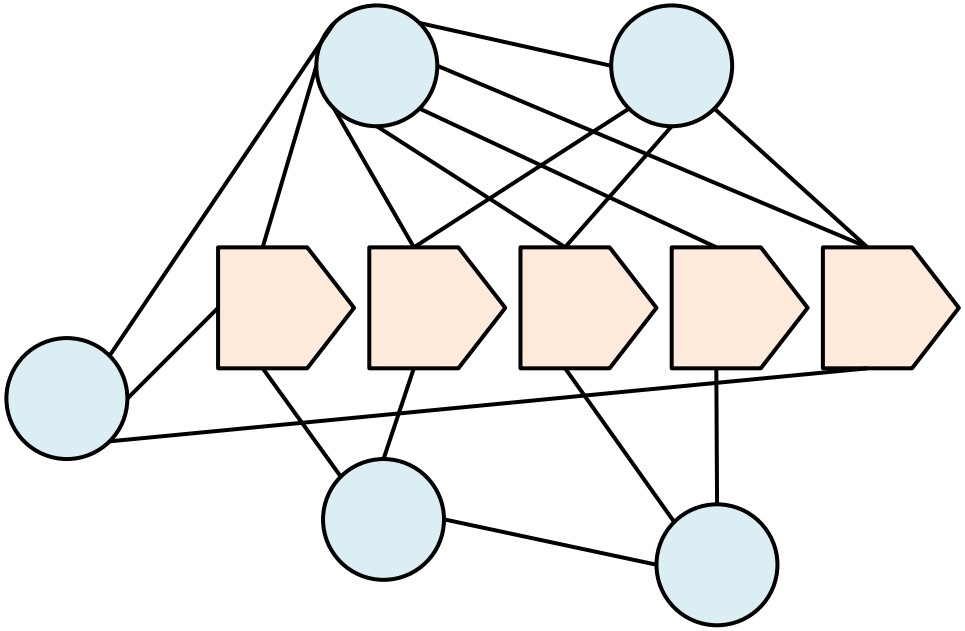
Health Care Service

Coffee Shop Service



E-learning Service

Car Sharing Service

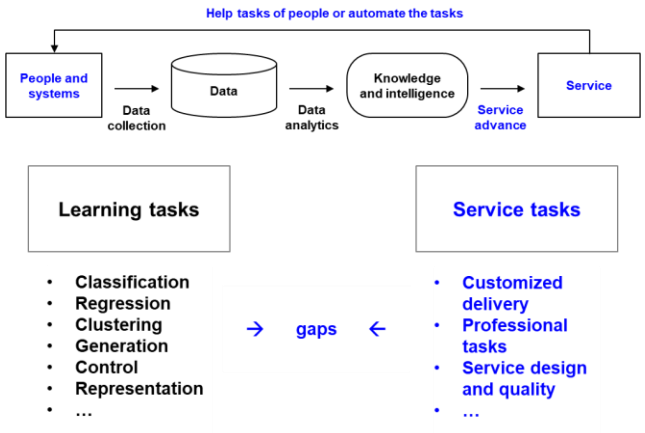


- Service systems are networks of actors and resources that operate together to get accomplish tasks and co-create value through multi-step processes
- The tasks performance mechanism of a service system can be described as a stochastic process with multiple variables

Service Concept in the Context of this Course

Then what are the service tasks and domains related to the service concept?

We should first need understand service tasks and domains, the problem area



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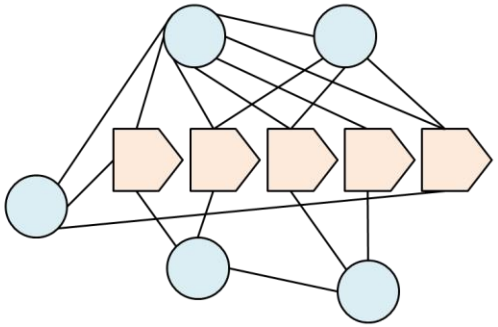

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Note: Industry 4.0 and Service

- Why should we understand “Service Tasks” in Industry 4.0?

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Artificial Intelligence does not perform entirely new processes.

What an AI does is the automation or assist of traditional processes/systems previously done/managed by humans (e.g., prediction, control of environment, and design).

Thus, fundamental understanding of services will help you better utilize and develop intelligence for real-world services in the future.

Car Sharing Service

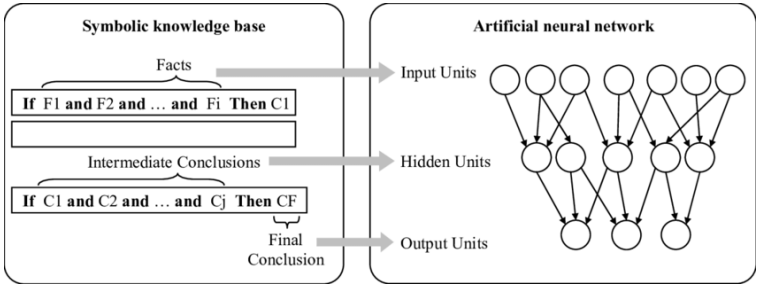
Leisure Service

Mobile Game Service

A Bottom-Up Approach to Understand Service Tasks and Domains

Service Tasks and Domains: Shall We Ask to Service Research Leaders?

Service Tasks and Domains: Shall We Develop an Intelligence on Service?



Restaurant Service

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Data Sources: Representative Journals of Service Research

Journal of Service Research

Journal of Service Management

Manufacturing & Service Operations Management

Service Science

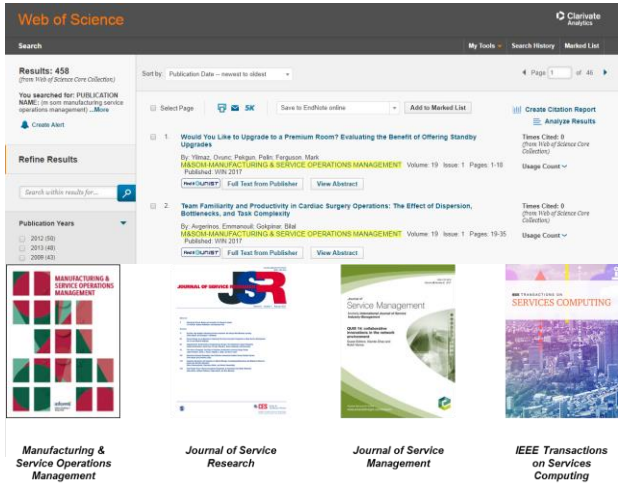
IEEE Transactions on Services Computing

Data Sources: Representative Journals of Service Research

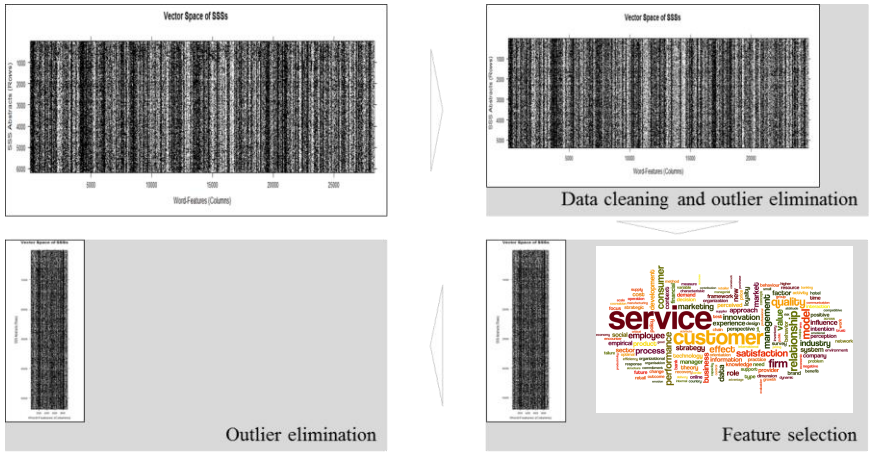
- Data source
  - Eight selected service-related journals: *Journal of Service Management*, *Journal of Service Research*, *Service Science*, *Manufacturing & Service Operations Management*, *Journal of Service Theory and Practice* (formerly *Managing Service Quality*), *Service Business*, *The Service Industries Journal*, and *Journal of Services Marketing*

- Data
  - Text data of titles, abstracts, and keywords of 3,547 original research articles
  - Review or editorial articles were all excluded
  - As of April 27, 2017, the set of 3,547 articles is the “full” population (i.e., not a sample) of the eight journals archived in the Web of Science Core Collection databases of “Science Citation Index Expanded (1945–)” and “Social Sciences Citation Index (1987–)”

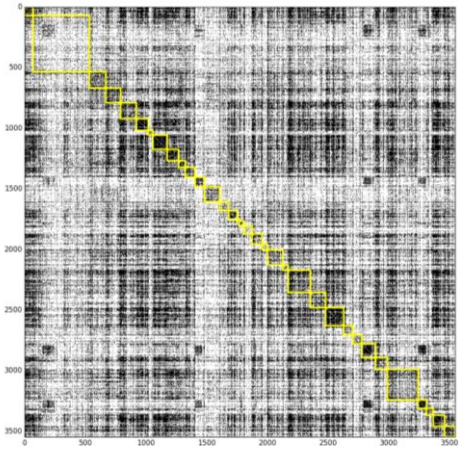
Data-driven Understanding of the Service Tasks and Domains



Manufacturing & Service Operations Management | *Journal of Service Research* | *Journal of Service Management* | *IEEE Transactions on Services Computing*



Research topic	Some of the keywords identified from topic modeling and the five metrics
1. service experience	experience, service, customer, interaction, dimension, process, emotion, satisfaction, etc.
2. service management model	service, model, customer, management, industry, cost, system, factor, performance, business, etc.
3. professional service	firm, service, professional, industry, client, performance, relationship, business, manufacturing, etc.
4. service innovation	innovation, service, firm, performance, business, customer, strategy, empirical, company, etc.
5. service quality measurement	quality, service, customer, scale, satisfaction, dimension, perception, measurement, etc.
6. service failure and recovery	service, recovery, failure, customer, satisfaction, negative, influence, compensation, etc.
...	...



Reference: Toward a unified model of service systems (Lim and Maglio, 2017)

Vector Representation of a Text Dataset

- Represent the dataset as a vector space (a "document-term matrix")

	service	customer	relationship	firm	quality	...	word n
Document 1	3	3	2	0	1	...	0
Document 2	5	0	0	3	3	...	0
...	...	...	...	...	...	...	...
Document m	1	0	5	0	0	...	2

To find the significance of a term in a document

- Calculate a "TF-IDF" value and transform the vector space

$tf-idf\ value\ after\ normalization, when$

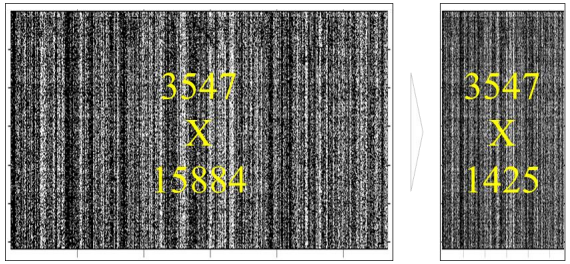
$$tf-idf(t,d) = tf(t,d) \times (log\frac{1+n_d}{1+df(d,f)} + 1)$$

	service	customer	relationship	firm	quality	...	word n
Document 1	0.291	0.120	0.071	0	0.142	...	0
Document 2	0.231	0	0	0.146	0.228	...	0
...	...	...	...	...	...	...	...
Document m	0.038	0	0.115	0	0	...	0.243

Identification of Significant Word-Features: Algorithm Idea

- Three types of words in a corpus
  - (1) Case-sensitive words such as authors' acronym or specific product name: "CASS" "IMSS" …
  - (2) Representative words of the overall topic: "customer" "value" "health" "delivery" …
  - (3) General words of technical documents and English words: "study" "within" …

- Requirements of the selection of significant word-features
  - Include the type (2) words as much as possible
  - Exclude the types (1) and (3) words as much as possible



- In general, Types (1) and (2) words have high TF-IDF values, while Type (3) words have low values

Reference: Lim, C. and Maglio, P., "Data-driven Understanding of Smart Service Systems through Text Mining," *Service Science*, Vol. 10, No. 2, 154-180, 2018.

Five Metrics for Word-Feature Evaluation

- Top words of the service literature selected based on the five metrics

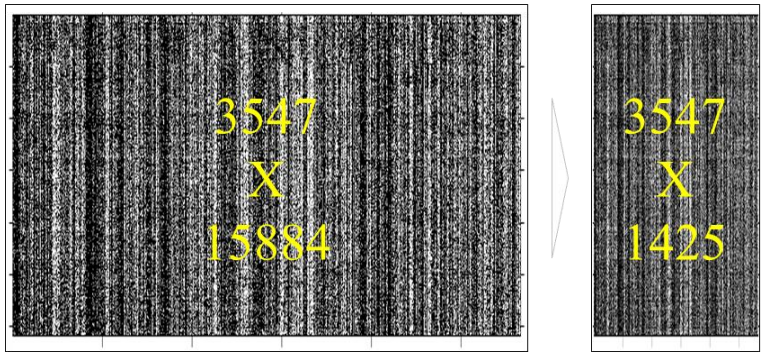
Term's ranking		Mean of TF-IDF Score	Mean of Cosine Similarity from Other Data	Cosine Similarity from the Mean Data	Dot Product Score	NMF Score	**Overall score* (SORT)**
1	service	0.09346	0.059219	0.696189	0.9263	14402.74	**1**
2	customer	0.059748	0.043398	0.523338	0.597716	6734.931	**0.63867**
3	relationship	0.028917	0.032379	0.392984	0.283789	2800.619	**0.355637**
4	firm	0.02865	0.034218	0.403671	0.281558	2463.7	**0.351163**
5	quality	0.032326	0.028001	0.342811	0.318617	2518.539	**0.344379**
6	consumer	0.024713	0.030438	0.348303	0.249313	2077.726	**0.305016**
7	satisfaction	0.025703	0.026834	0.331524	0.254842	1963.552	**0.294781**
8	performance	0.024042	0.02917	0.346249	0.233613	1926.887	**0.292097**
9	value	0.024163	0.0259	0.314032	0.243088	1996.373	**0.28424**
…	…	…	…	…	…	…	**…**

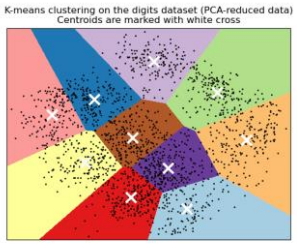
*Overall score: geometric mean of the 0-1 scaled (standardized) values of the five metrics

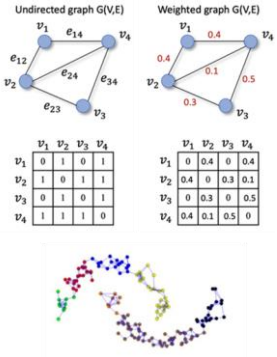
Attributes of the Service Research Corpus: Word Cloud by the Five Metrics

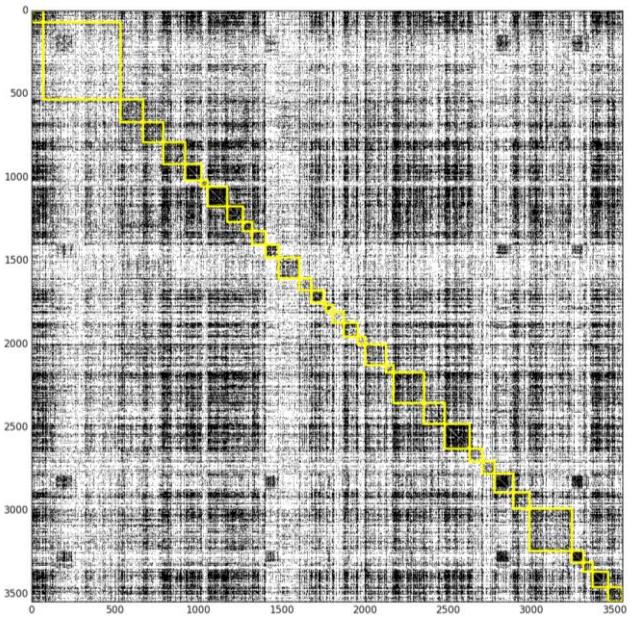
Clustering of Key Research Topics Related to Services

- Spectral clustering to the core vector space with 3,547 data and 1425 word-features



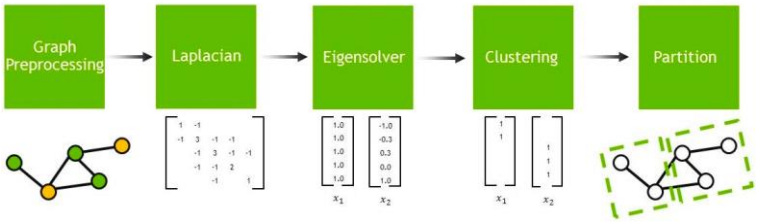






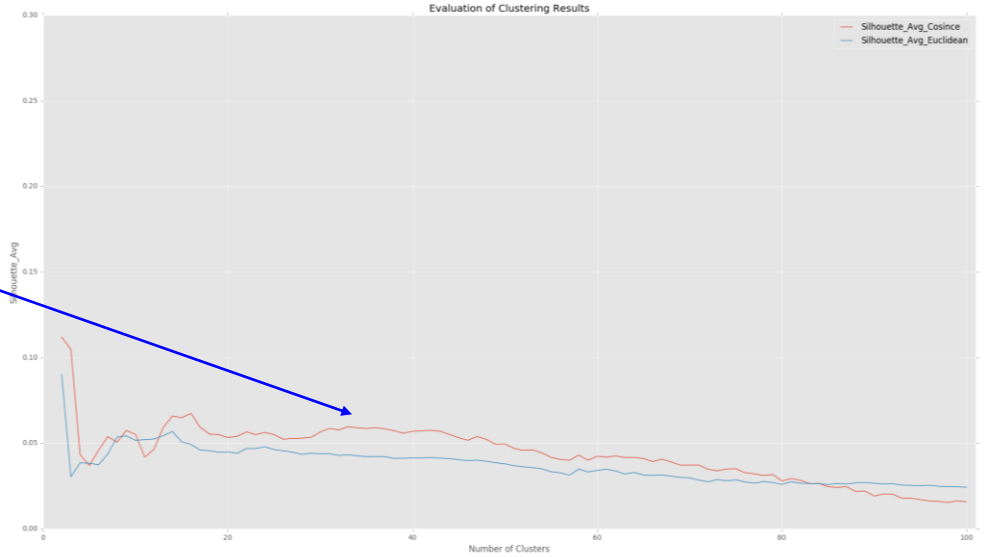
Clustering of Key Research Topics Related to Services

- Silhouette Coefficient score graph (n_clusters = 2 to 20; 100 iterations for each)
  - The graph partitioning problem in a spectral clustering is an NP-hard problem
  - The clustering result and the corresponding Silhouette Coefficient score change every time



The mean Silhouette Coefficient scores based on the cosine and Euclidean distance are high at ‘n_clusters = 34’

After a manual interpretation, 34 was considered an optimal number of clusters



$$s(i) = \frac{(b(i) - a(i))}{(\max(a(i), b(i))}$$

Data-driven Understanding of the Service Tasks and Domains

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33. technology and self-service
34. service design and development

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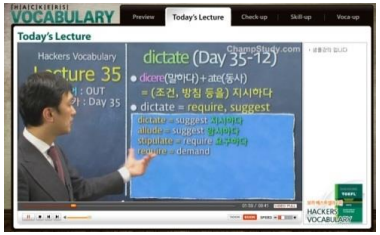
Revisiting the Service Concept in the Course

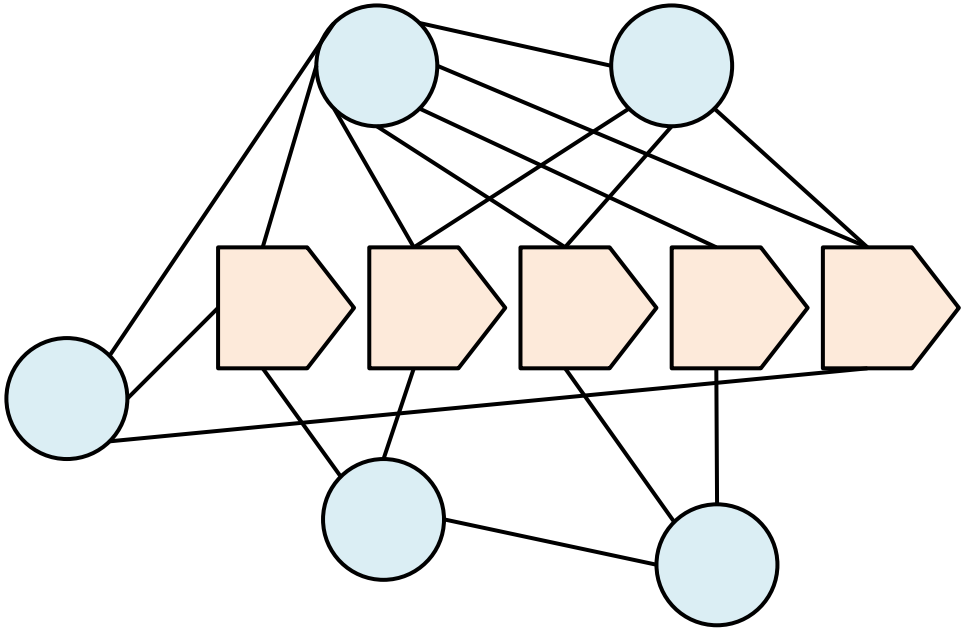
Health Care Service

Coffee Shop Service



E-learning Service

Car Sharing Service



- Service systems are networks of actors and resources that operate together to get accomplish tasks and co-create value through multi-step processes
- The tasks performance mechanism of a service system can be described as a stochastic process with multiple variables

Matching the Service Tasks to the Service Concept

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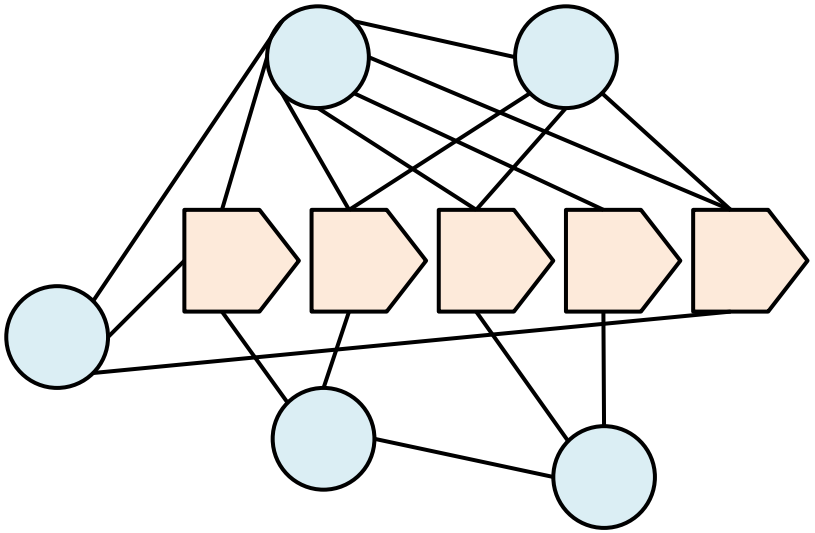
Matching the Service Tasks to the Service Concept

consumer behaviors
(user behaviors)

service delivery
and experience

technology and
self-service



quality

value cocreation

relationship

innovation

design and
development

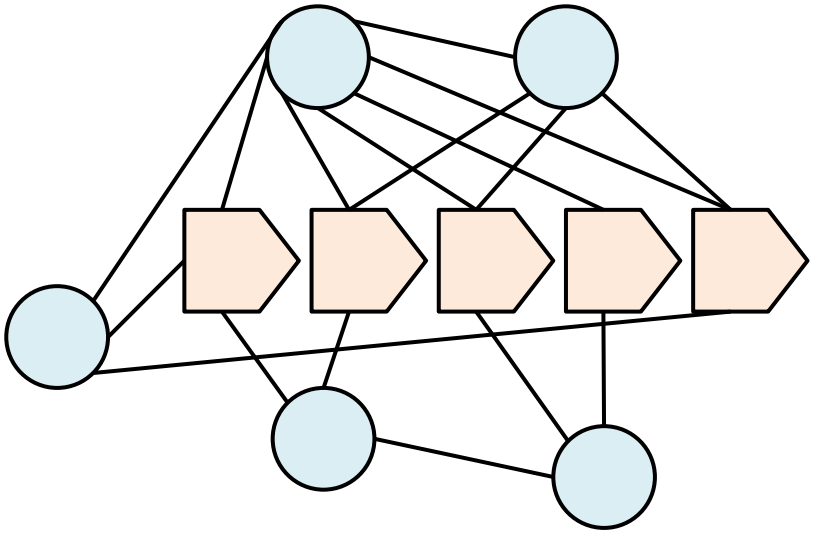
productivity

knowledge and
employee
management

cost and pricing

service operations
and supply chain
management

Matching the Service Tasks to the Service Concept

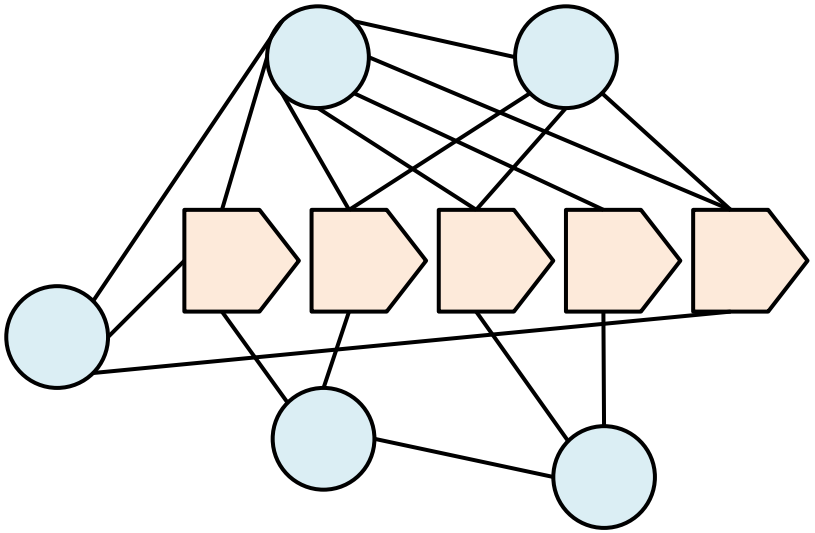


quality

relationship

productivity

Matching the Service Tasks to the Service Concept



knowledge and employee management

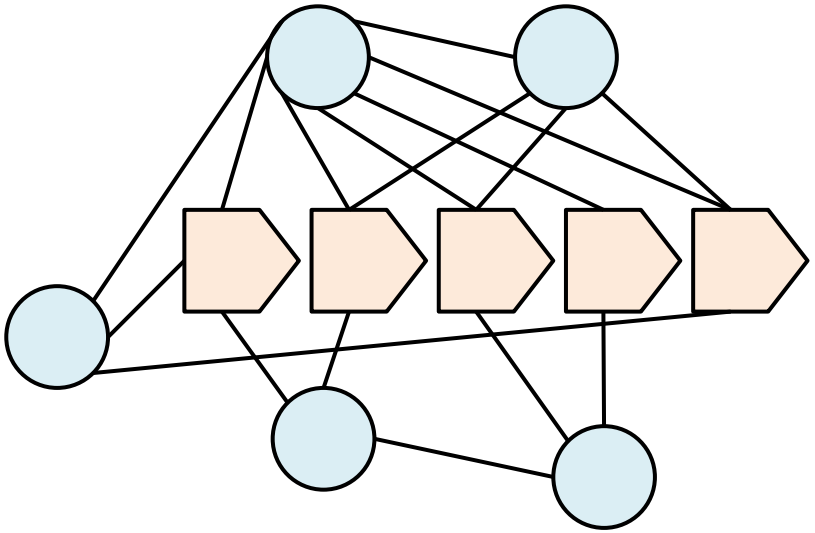
cost and pricing

service operations and supply chain management

Matching the Service Tasks to the Service Concept

consumer behaviors (user behaviors)

service delivery and experience



quality

value cocreation

technology and self-service

relationship

innovation

design and development

productivity

knowledge and employee management

cost and pricing

service operations and supply chain management

Matching the Service Tasks to the Service Concept

consumer behaviors (user behaviors)

service delivery and experience

quality

technology and self-service

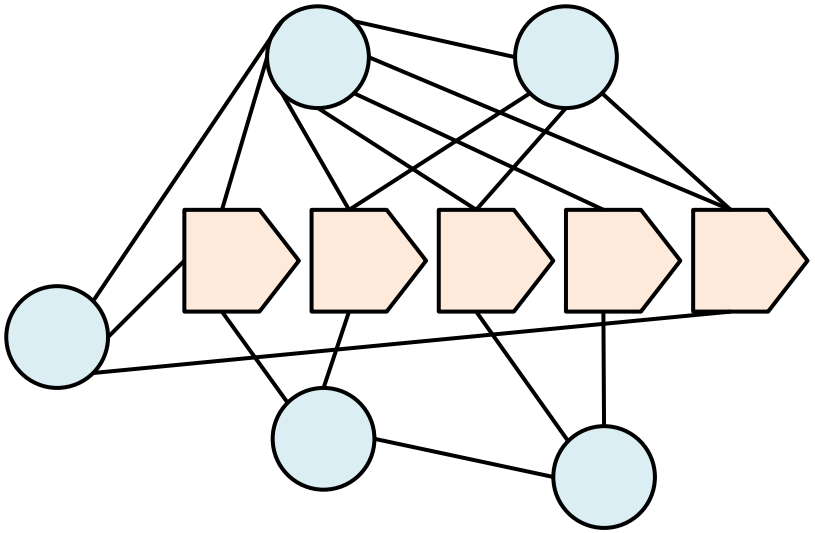
relationship

productivity

knowledge and employee management

cost and pricing

service operations and supply chain management



value cocreation

innovation

design and development

Matching the Service Tasks to the Service Concept

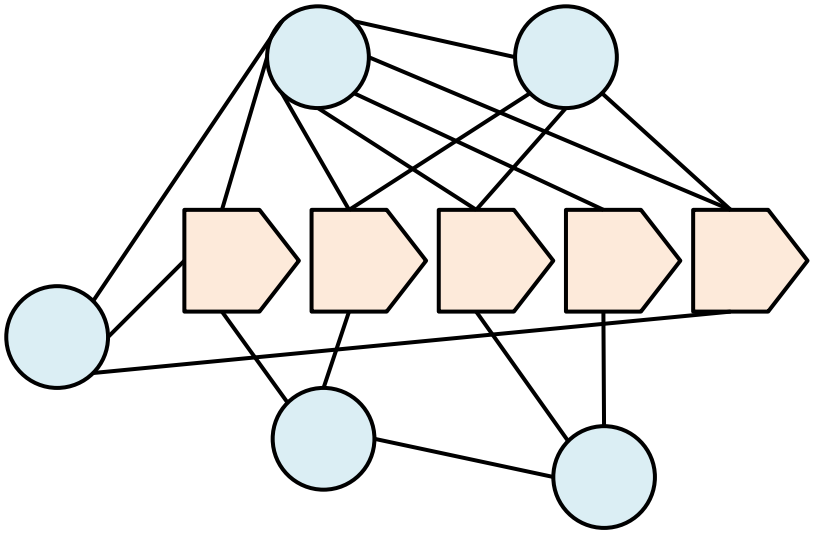
consumer behaviors (user behaviors)

service delivery and experience

quality

value cocreation

technology and self-service



relationship

innovation

design and development

productivity

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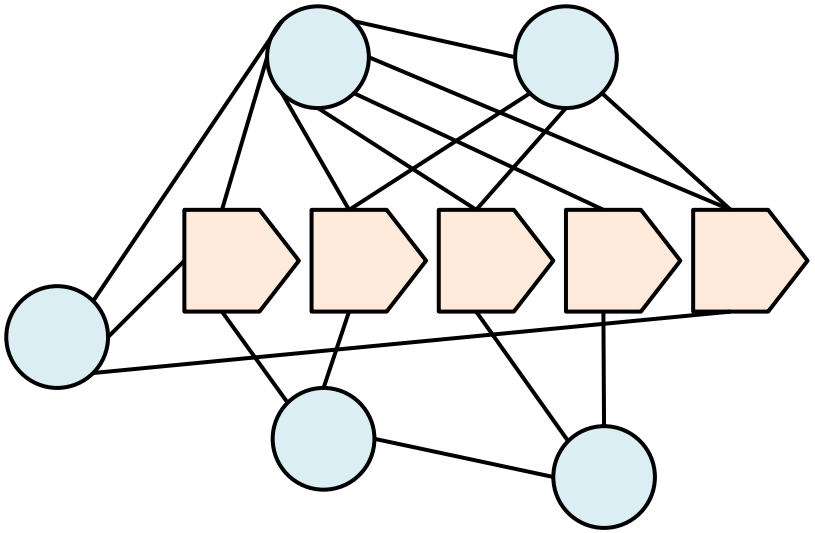
service operations and supply chain management

Matching the Service Tasks to the Service Concept

consumer behaviors
(user behaviors)

service delivery
and experience

technology and
self-service



quality

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relationship

innovation

design and
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productivity

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employee
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cost and pricing

service operations
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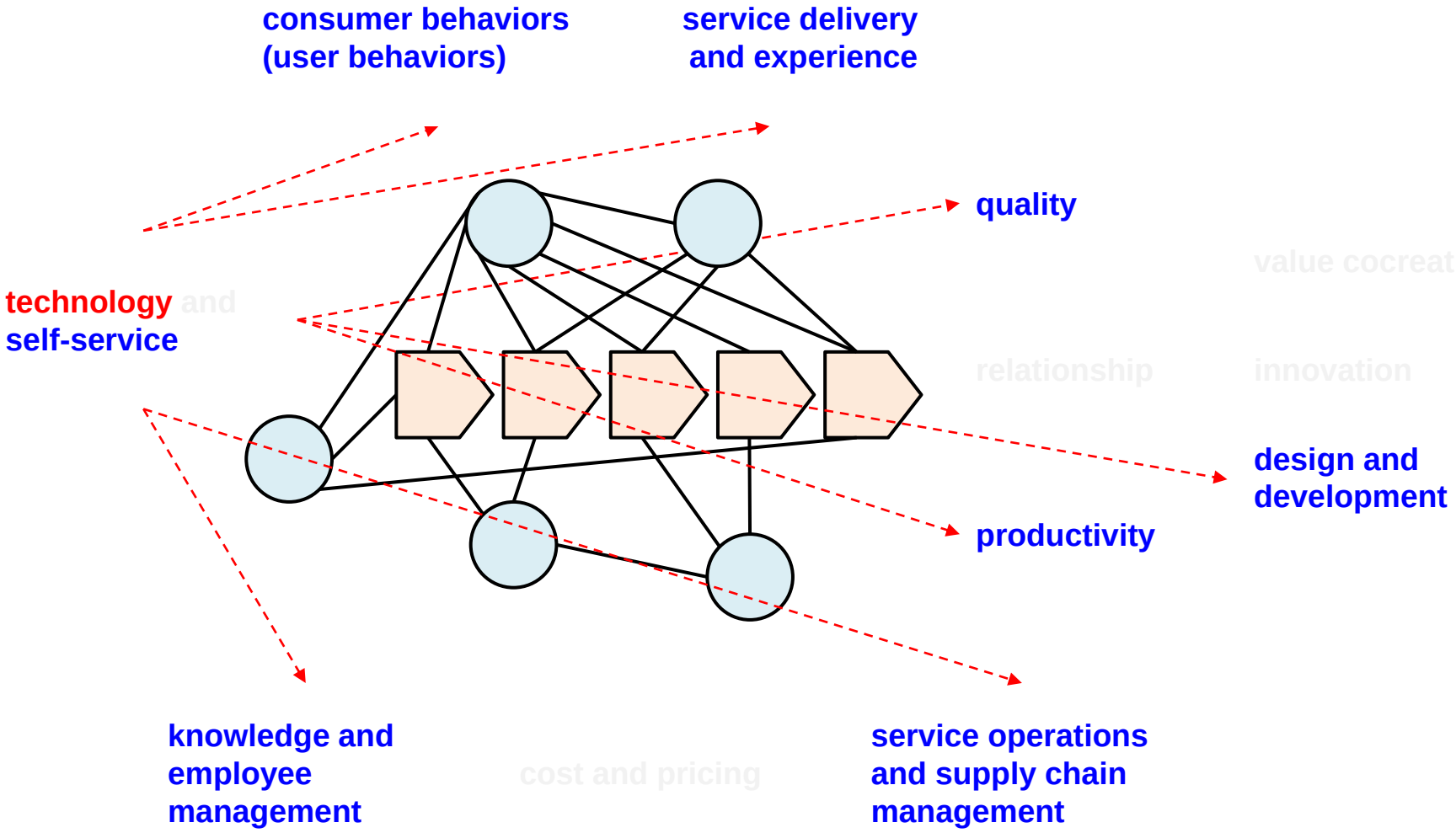
management

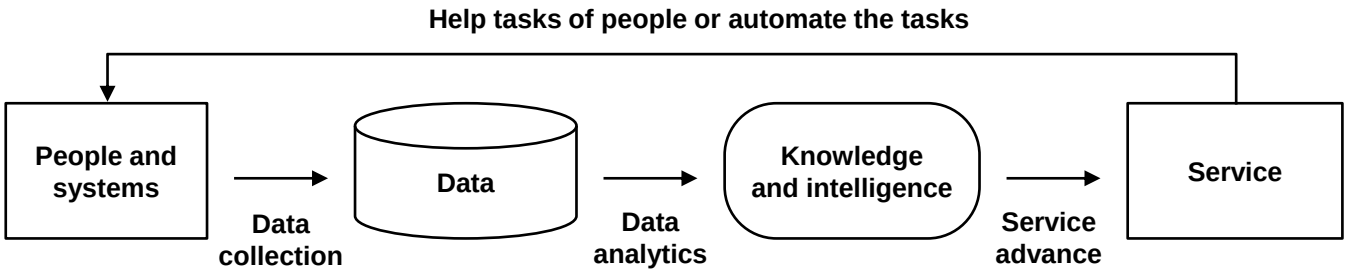
Focused Tasks of this Course



Some Cases of Developing

Service Intelligence in Industry and Society

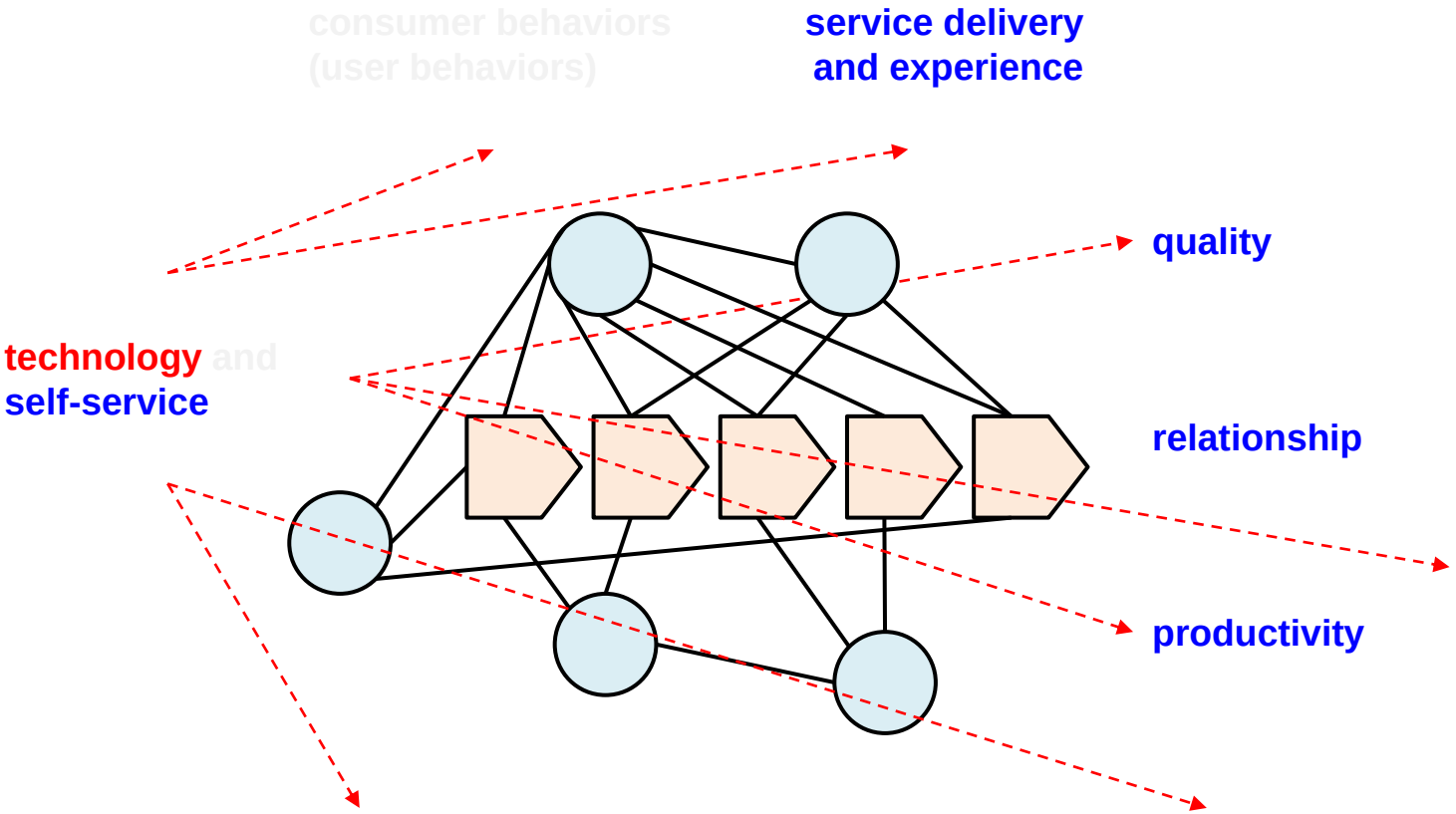
Example Cases



Learning tasks	Service tasks
• Classification • Regression • Clustering • Generation • Control • Representation • …	• Customized delivery • Professional tasks • Service design and quality • …

Reference: Lim, C. and Lyons, K., "Toward service intelligence: On the gaps between artificial intelligence and service research," *Journal of Service Management*, Invited, 2022.

Supporting the Sales and Delivery Task



Recommender Systems for Sales and Delivery Automation

- Contribution and impact of recommender systems to the click through rate and actual purchase

35%

Proportion of the purchase based on recommendation

70%

Proportion of the watch based on recommendation

75%

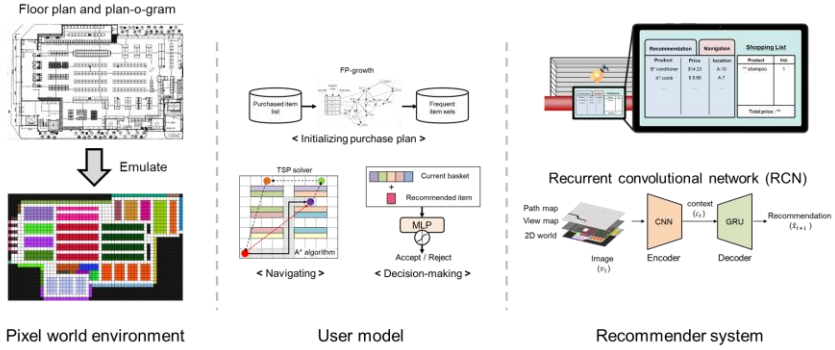
Proportion of the watch based on recommendation

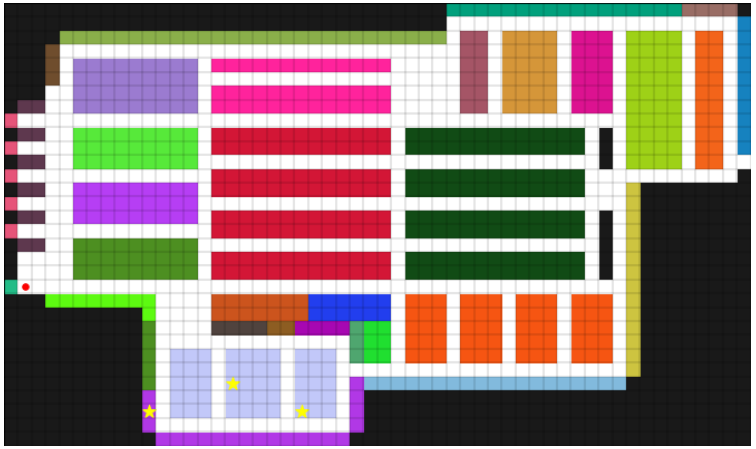
50%

Proportion of the users who want recommendation

- Recys contribute to the positive service experience, sales, and customer loyalty (Gomez-Uribe et al., 2015)
- Recys effectively reflect the value from items that users look for (Schafer et al., 1999)
- Recys help users make a better decision that fits to their contexts and needs (Vig et al., 2009)

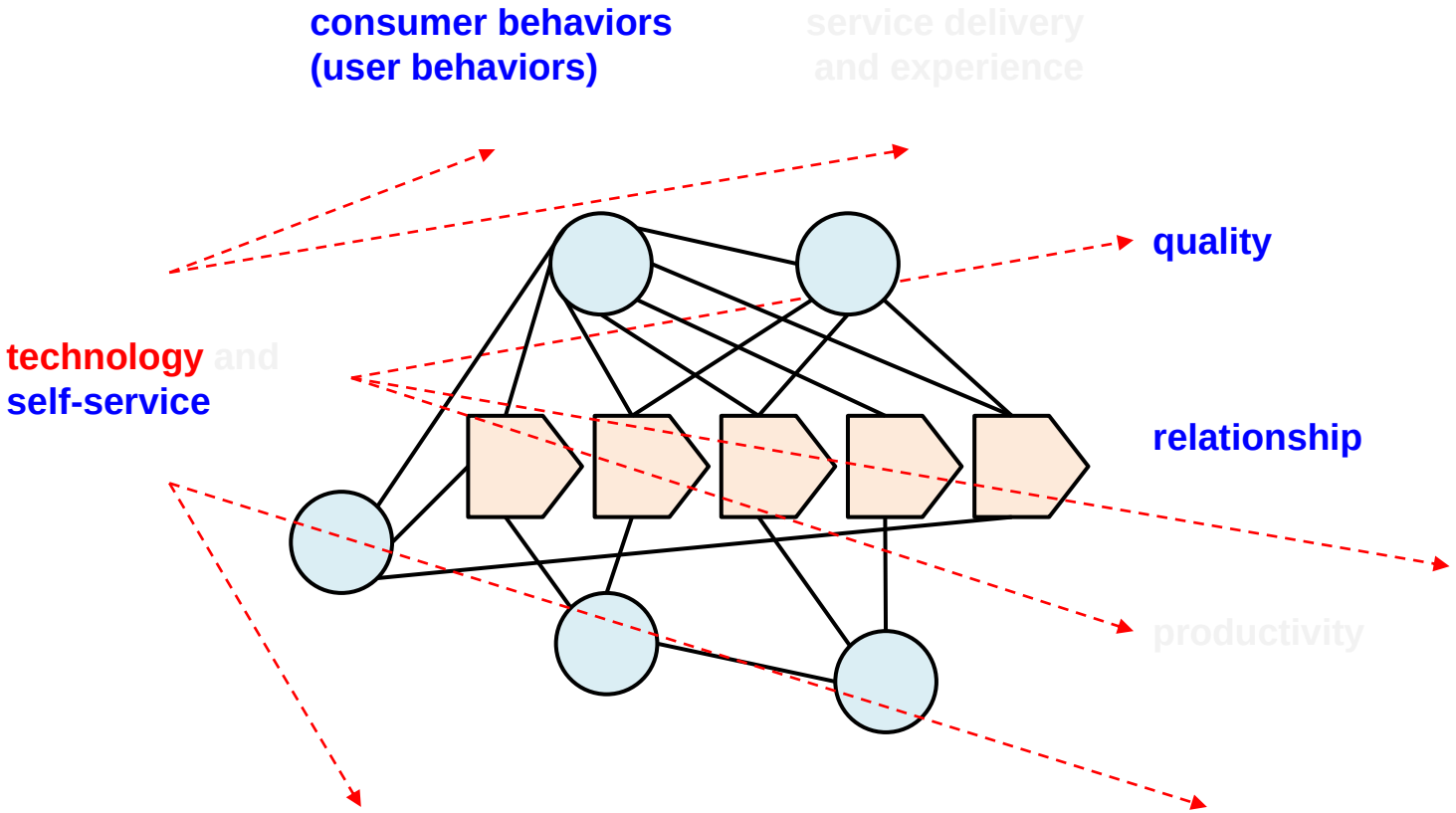
Recommender Systems for Sales and Delivery Automation



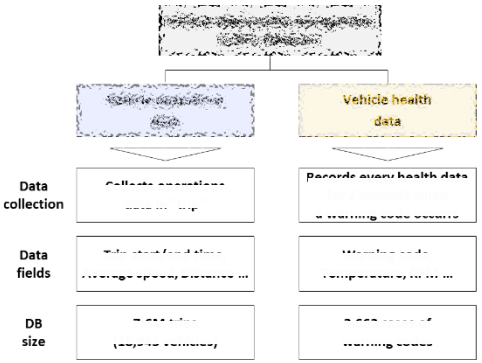


Reference: Shin, J., Lee, C., Lim, C., Shin, Y. and Lim, J., "Recommendation in Offline Stores: A Gamification Approach for Learning the Spatiotemporal Representation of Indoor Shopping," 28th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining (KDD), August 14 - 18, 2022.

Supporting the User Behaviors (Processes)



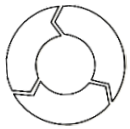
Supporting the Driving Behaviors (Processes)



Data related to driving processes

Driving process

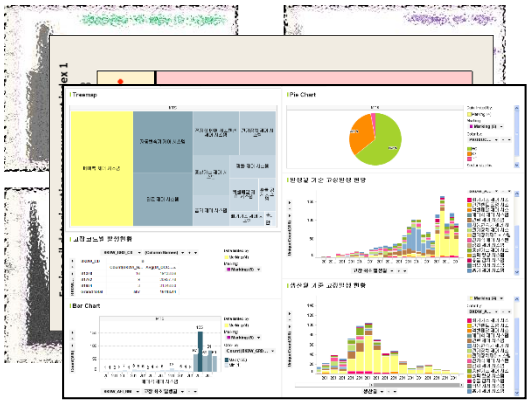
Service for driving process management



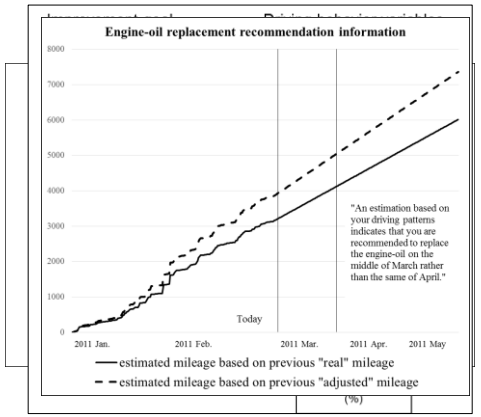
Continuous process improvement

Driving characteristics (annual)	Driver 1	Driver 2	...	Driver 1688
Number of trip	874	382	...	87
Mileage (km)	6656	2276	...	872
Average mileage per trip (km)	7.62	5.96	...	10.02
Ratio of short trip (< 18km)	91.08	97.64	...	87.36
Average of low speed (< 29 km/h) ratio per trip	73.18	72.87	...	68.15
Engine oil deterioration indicator 1	284	159	...	34
Engine oil deterioration indicator 2	32.49	41.62	...	39.08
Tire wear indicator 1	0.018	0.018	...	0.019
...	...	...	...	...

Driving process characteristics



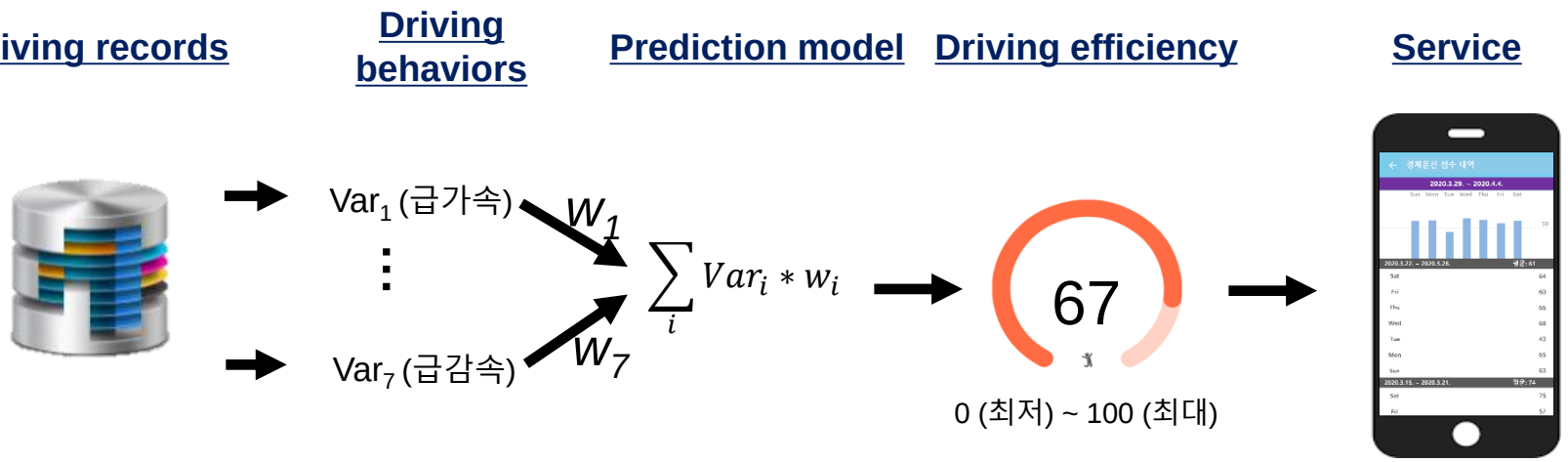
Driving process analysis



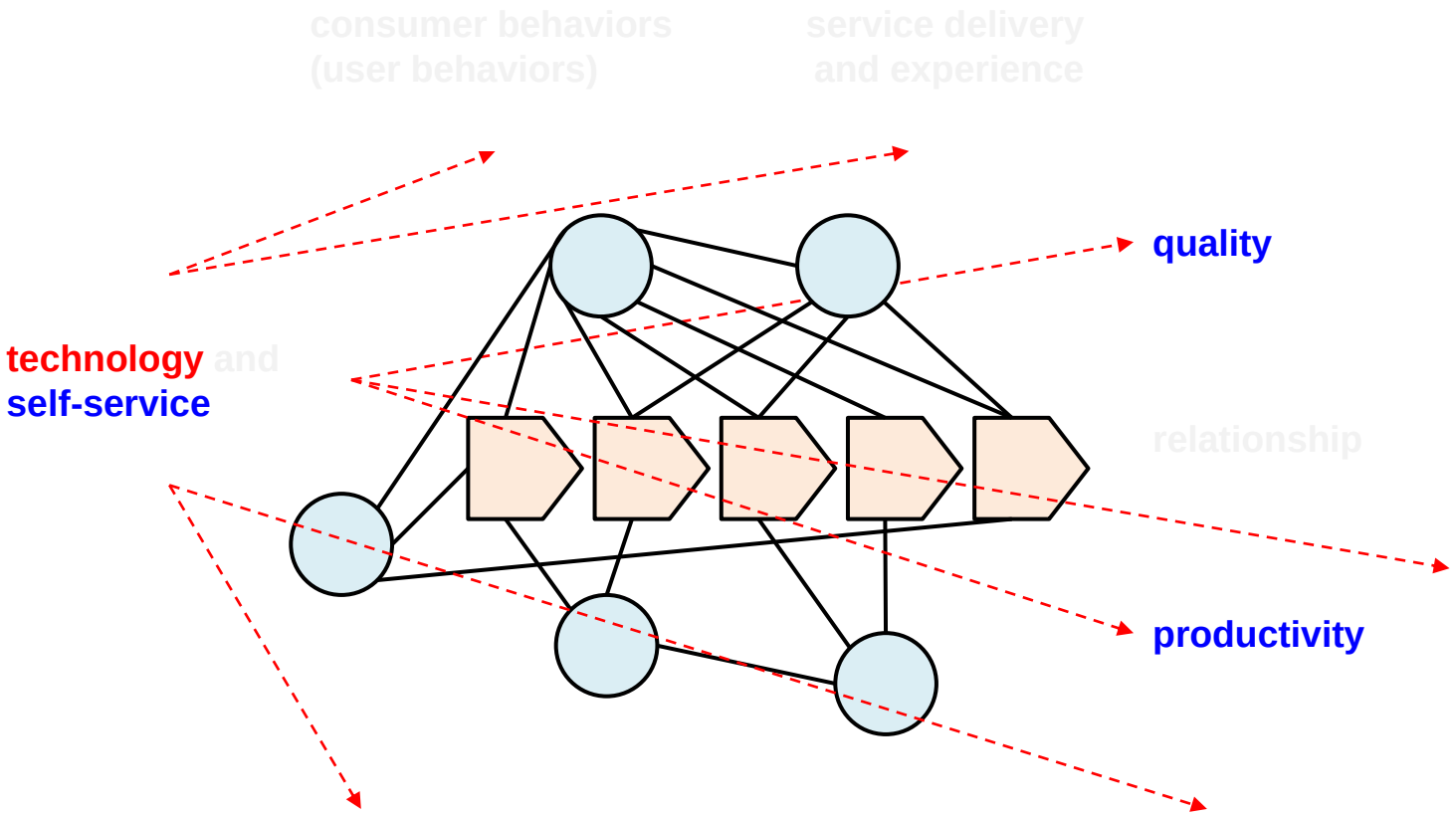
Information for process improvement

Reference: “Customer Process Management” (Lim et al., 2019; *JoSM*)

Supporting the Driving Behaviors (Processes)



Supporting the Professional's (Employee's) Work Processes



Diet Planning Service by Dietitians






$$\max \sum_{x \in \mathcal{M}} x$$

where x is a random menu variable that is of value one if the menu is selected. This model aims to maximize the total number of menus selected under constraints such as

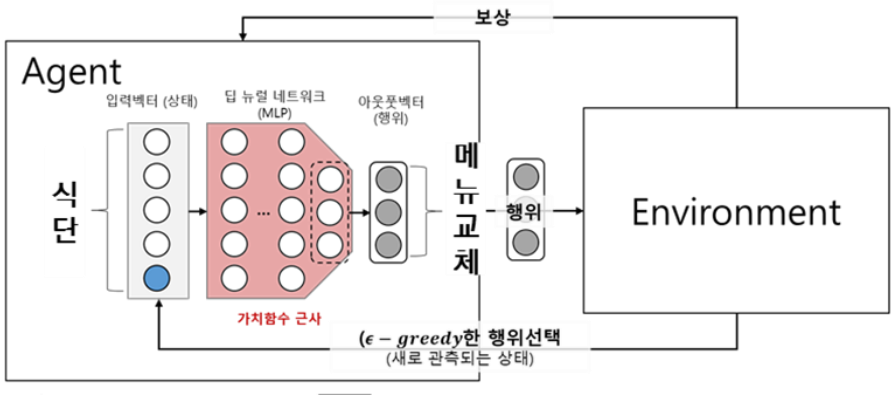
$$\sum_{i=1}^{N} x_i = 14 \quad (11)$$

$$945 \leq \sum_{i=1}^{N} calorie(x_i) \leq 1155 \quad (12)$$

$$15 \leq \sum_{i=1}^{N} protein(x_i) \leq Inf \quad (13)$$

$$\vdots$$

$$2 \leq \sum_{i=1}^{N} is\_snack(x_i) \leq 4 \quad (14)$$



Think About Learnable Tasks and Data in the Services You Care

Restaurant Service


Health Care Service

Location-based Mediation Service


E-learning Service

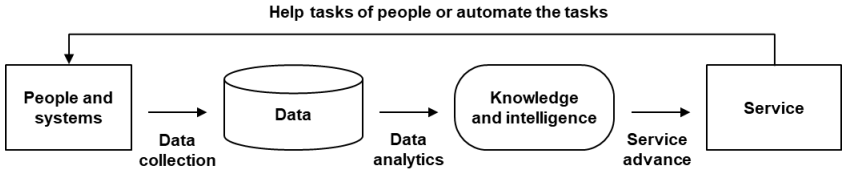

Amusement Park Service


Ingredients Delivery Service

Car Sharing Service


Leisure Service


Mobile Game Service



Learning tasks

- Classification
- Regression
- Clustering
- Generation
- Control
- Representation
- …

Service tasks

- Customized delivery
- Professional tasks
- Service design and quality
- …

Service Review Mining

Behavioral Data Mining

Recommender Systems Development

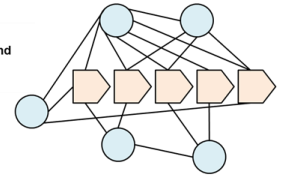
consumer behaviors (user behaviors)

service delivery and experience

Service Quality Evaluation and Improvement

All Weeks

technology and self-service



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

Notice for the Next Classes

Classes Next Week

- Recommender systems
  - On Monday (9/5), we will discuss recommender systems for service delivery
  - On Wednesday (9/7), we will conduct practice on recommender system development
  - Read [The Netflix Recommender System - Algorithms, Business Value, and Innovation] in advance