

# Hanyang Time Machine: A New Challenge toward Convergence of Humanities and Cultural Heritage

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## 1. Introduction

The “Hanyang Time Machine” is a digital content development project carried out by the Cultural Heritage Administration as part of the “Three innovation strategies for the content industry” promoted by the South Korean government. The project, planned to be carried out for three years from 2020, aims to make Hanyang<sup>1)</sup> City's cultural heritage into 3D data and build an open platform for the private sectors so that mobile carriers, online portals, and digital game producers can use it as various virtual reality contents.

The Hanyang Time Machine project does not stop at reproducing only the city's old buildings and streets as 3D virtual reality, but goes a step further to view the lives and history of the people who lived in the city as digital data. To this end, more than 30 humanities researchers are acting as data curators and creating a “humanities knowledge semantic data archive.” What they do in this project is to collect and analyze historical records, extract meaningful knowledge elements, and create a huge knowledge network that tells the stories of the people of Hanyang. The data accumulated here will not only provide a variety of storytelling content to be seen in the virtual world but also help develop artificial intelligence that can assist the visitors of the digital world to explore the history and culture of Hanyang City.

## 2. Why do I talk about "Convergence"?

Humanities and cultural heritage are inseparable. There may be no need to mention the "convergence" of these two. However, it is undeniable that the communication between preserving and utilizing cultural heritage today and exploring and educating humanities knowledge is not satisfactory.

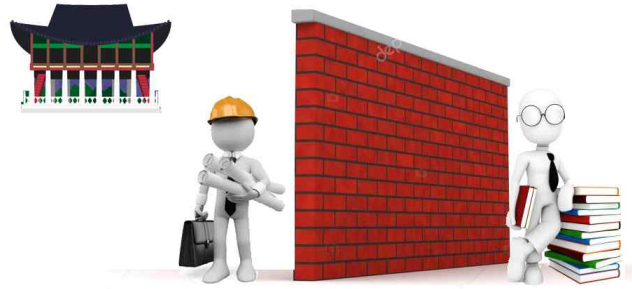
Cultural heritage is a valuable asset for modern people to know and enjoy the traditional culture created and handed down by our ancestors. In order to properly understand its historical and cultural significance, it is necessary to explore the related humanities knowledge. However, in many cases, the preservation of the physical shape of cultural heritage is recognized

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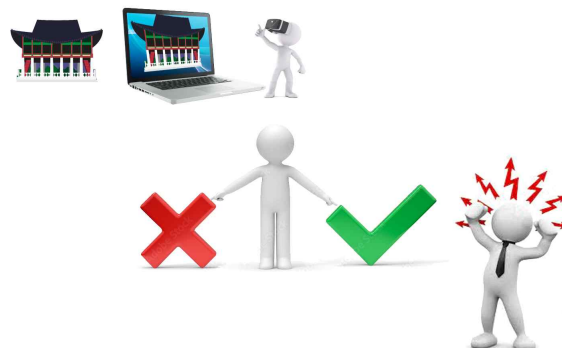
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1) Hanyang (漢陽): The old name of Seoul; the capital of Joseon (1392-1910)

as a more urgent task, so the exploration of humanities knowledge is often put on the back burner. Tasks related to cultural heritage were mainly the work of architects and civil engineers, while the scope of the humanities was limited to answering whether the results were close to the historical facts.



As digital technology was introduced into the field of cultural heritage utilization, another situation began to emerge that revealed the distance between the two areas. Reproducing cultural heritage in the digital world is mainly the work of ICT engineers, and the role of humanities is still limited to advice on the results of the work. The distance between cultural heritage and humanities knowledge is not yet close.



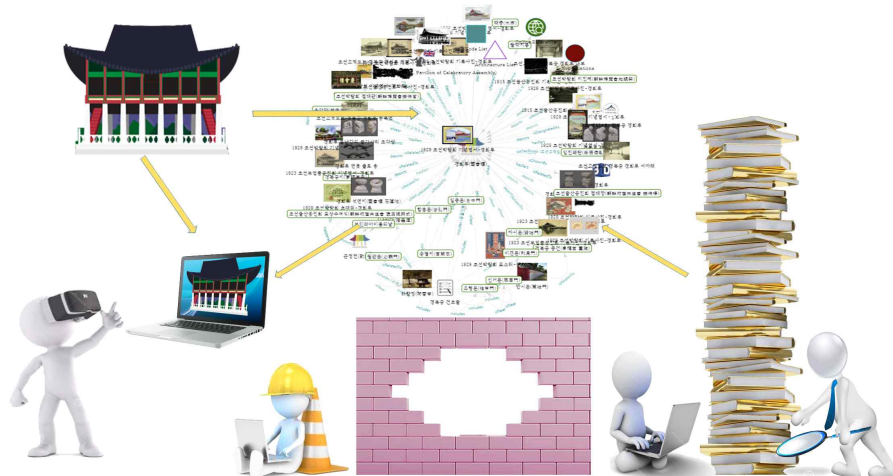
### 3. The Convergence of Humanities and Cultural Heritage

Hanyang Time Machine is a massive digital content development project that has never been attempted in Korea. Reproducing the various historical spaces of traditional Korea in the three-dimensional digital world is already challenging enough, but this project started with another more challenging task: The direct participation of humanities researchers in the production of digital data.

To date, the way humanities researchers have contributed to the development of digital content has been to provide the books and documents they have studied. However, no matter how much literary data with in-depth knowledge is provided, it will never be reflected in the content of the digital system if the digital developer is not capable of decoding it.



Thirty-two humanities researchers are participating in the Hanyang Time Machine project, with majors in history, folklore, anthropology, traditional costumes, traditional food studies, art history, classical Chinese literature, and digital humanities. Instead of providing literature materials to digital content developers, they decided to produce machine-readable data so that the knowledge information they found could be directly used on the computer systems. The goal of this plan is to enable the world of digitalized cultural heritage and the world of humanities knowledge to communicate through the establishment of a digital data archive.



## 4. Hanyang Semantic Data Archive Construction Process

Humanities researchers participating in the Hanyang Time Machine project carried out the following process to build a semantic data archive.

### 1) Selection of basic research data.

- Researchers investigated various literature materials where they can find meaningful knowledge resources related to the history and culture of Hanyang City.

※ Types of literature to be investigated:

- † historical records
- † dissertations, journal papers, monographs
- † exhibition catalogues, photo albums
- † newspaper articles
- † databases of museums, archive collections
- † web resources

- Research seminars to read and analyze these literature materials were operated as a regular class at the Graduate School of the Academy of Korean Studies. The class, which began in the fall semester of 2020, has been in effect for its third semester.

### 2) Selection of digital storytelling topics

- The research team investigated various storytelling topics, focusing on historical events in Hanyang and historical figures who played an important role.
- Based on these topics, textual reading and analysis was conducted to discover various contextual elements of Hanyang City's historical story.

### 3) Data curation

- The research team developed semantic network data by finding contextual elements that make up the story, defining elements as nodes in the network, and determining their relationships.
- The modeling of old buildings or artifacts into 3D data requires very specific historical evidence: text, illustrations, drawings, photos, etc. This kind of historical records or objects discovered by the research team were also curated as semantic network nodes.
- Data curation was performed in an online collaboration environment based on wiki software and a network database management system. This allows for individual researchers' curations to be linked to those of other researchers and to allow the database to always be checked for errors and redundancy.

## 5. Development and Expansion of the Ontology: EKC Data Model v. 2021

The ontology schema for Hanyang data curation is based on the EKC (Encyclopedic Archives of Korean Culture) data model. The EKC Data Model was first established in 2016 by the Center for Digital Humanities at AKS and has been expanding every year.

The research team enacts a draft ontology to be applied to the data curation of a new project at the time when the basic research materials and story topics are selected, and monitors the use of ontology vocabulary while performing data curation work based on the draft ontology. A task force is in charge of managing the ontology vocabulary—determining, enacting, and disclosing new vocabulary when requested.

※ The domain of EKC ontology: historical facts and contexts of traditional Korean culture

### 1) Class Definition in the EKC Data Model v. 2021

Class	Description
Architecture	한양도성 건조물 및 주변의 유관한 건축/조형물 Buildings in Hanyang and historically related buildings/structures
Actor	역사적인 인물. 집단적 행위 주체로서의 단체, 운영주체로서의 기관 Historical figures; Organizations as collective actors and institutions as operating entities
Event	한양도성에서 일어난 사건, 궁중 의례 및 이를 재현하는 행사, 기념제 Events held in Hanyang City, court ceremonies, and events that reproduce them today
Place	역사적 배경(사건, 인물)과 관련이 있는 장소. 유물의 소장처 Places related to historical events or characters; Places where historical relics or artifacts are located
Object	각종 의례/행사의 도구, 그 시대의 문화를 보이는 물품들 Items used in various ceremonies or events; Items or tools that show the culture of the time.
Clothing	역사적 인물들이 착용했던 다양한 성격의 복장과 복식 요소들 Costumes, components of costumes, or traditional ornaments
Food	궁중 의례·행사에서 차려졌던 궁중음식과 상차림 Foods, ingredients, or table settings that were prepared at court ceremonies and events
Concept	제도, 의례, 풍속 등을 설명하는 데 필요한 용어와 개념 Terms and concepts necessary to explain institutions, rituals, customs, etc.
Record	문헌, 사진, 도면, 금석문 등 지식 데이터의 원천 자료가 되는 기록물 Records that serve as the source of knowledge such as literature, photographs, drawings, and inscriptions
Multimedia	건축물의 3D 모델, 특정 공간의 위치를 알리는 3차원 지도 3D model of a building; 3D map indicating the location of a specific place
WebResource	월드 와이드 웹 상에서 접근할 수 있는 참고 자료 Reference materials that can be accessed on the World Wide Web
Bibliography	학술적 연구 자료의 목록 List of academic research materials
Text	설명적 증거 기능을 하는 문헌상의 텍스트 Text in the literature that functions as evidence of explanation

## 2) Examples of Object Property Design

### A. Object properties designed for curating the "Ceremonies and Rites" recorded in the *Royal Protocols of the Joseon Dynasty* (朝鮮王室儀軌)

**Uigwe (儀軌): The Royal Protocols of the Joseon Dynasty**  
 A unique form of documentary heritage, the *Uigwe* is a collection of royal protocols of the over 500 year-long Joseon Dynasty (1392-1910) that both records and prescribes through prose and illustration the major ceremonies and rites of the royal family<sup>2)</sup>

#### A-1. Information about the record

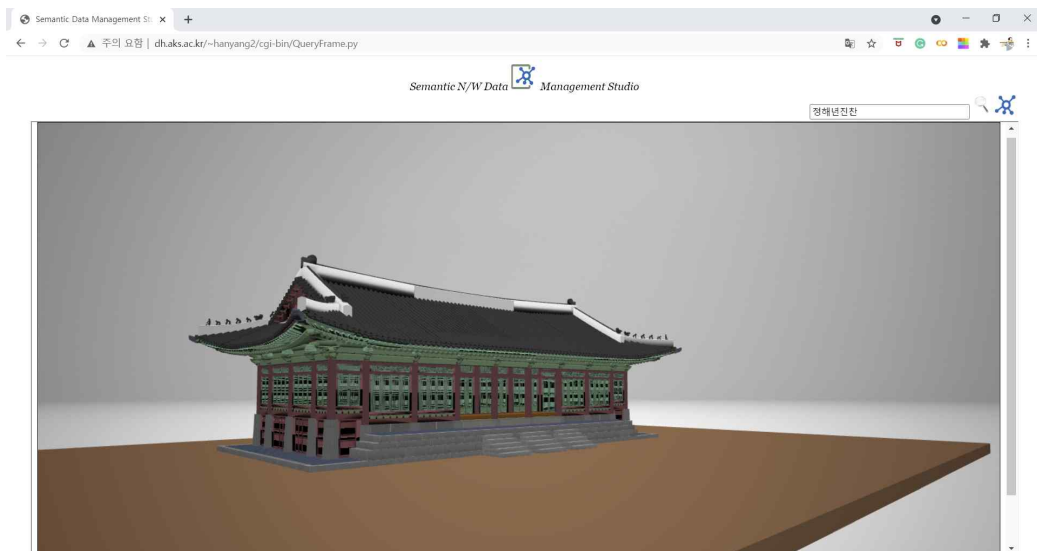
Namespace	Object Property	Domain	Range	Context
dcterms:	hasPart	Document	Text	Text A (is a part of) Document A
dcterms:	publisher	Record/Object	Actor	Record/Object B (was published by) Actor A
edm:	currentLocation	Record/Object	Place/Actor	Record/Object A (is currently located in) Place[Archive/Museum] B
edm:	formerLocation	Record/Object	Place/Actor	Record/Object A (was formerly located in) Place[Archive/Museum] B
ekc:	depicts	Record/Object	Event/Place/Actor	Record/Object A (depicts) Event/Place/Actor
ekc:	documents	Record/Object	Event	Record/Object A (is a documentary record of) Event B



2) Uigwe: The Royal Protocols of the Joseon Dynasty, Memory of the World, <http://www.unesco.org/>

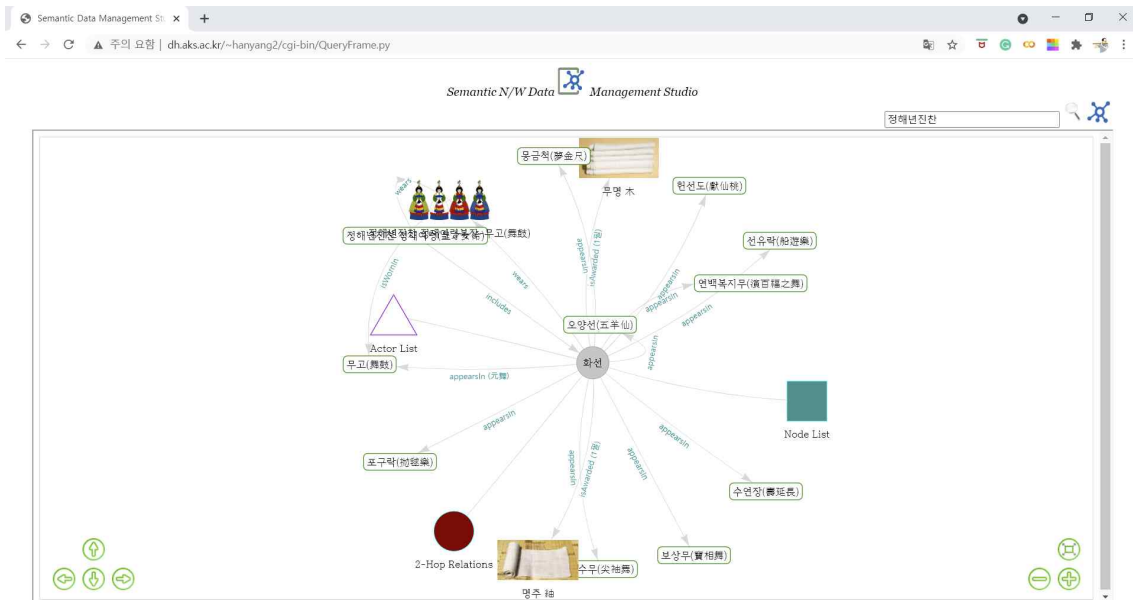
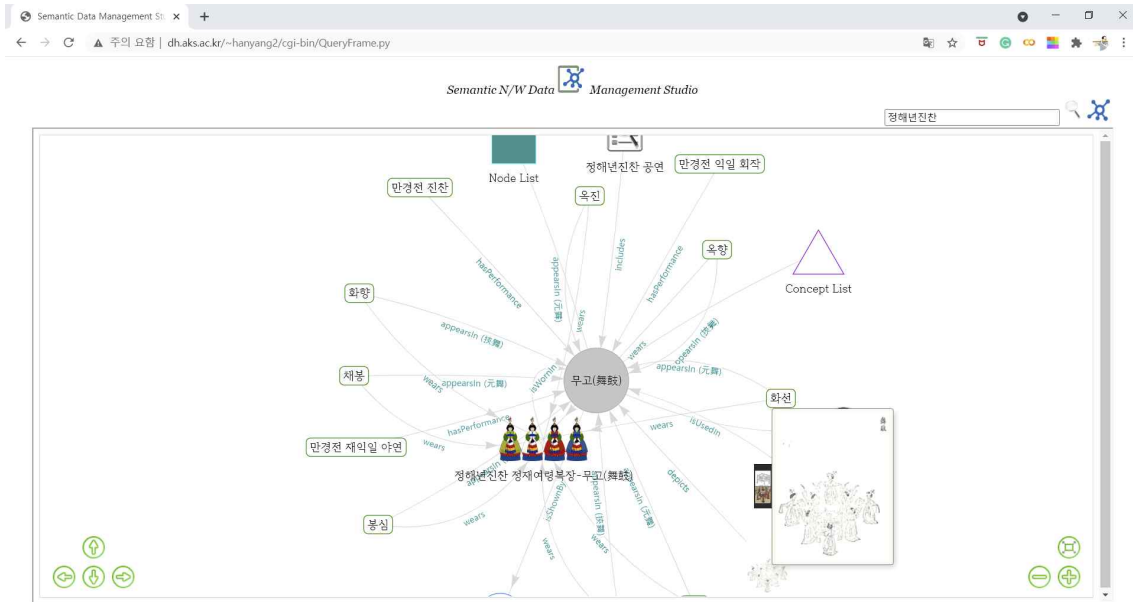
A-2. Information about the event documented in the record

Namespace	Object Property	Domain	Range	Context
dcterms:	hasPart	Event	Event	Event B (is a part of) Event A
ekc:	isHeldAt	Event	Place/Architecture	Event A (was held at) Place/Architecture
ekc:	participatesIn	participatesIn	Actor	Actor A (participated in) Event B



### A-3. Information about the performance performed in the event

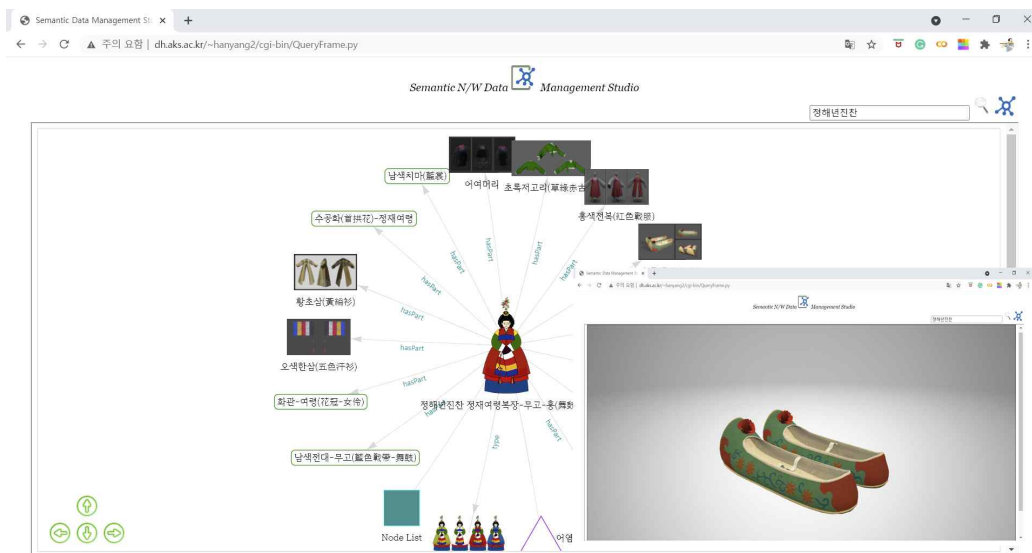
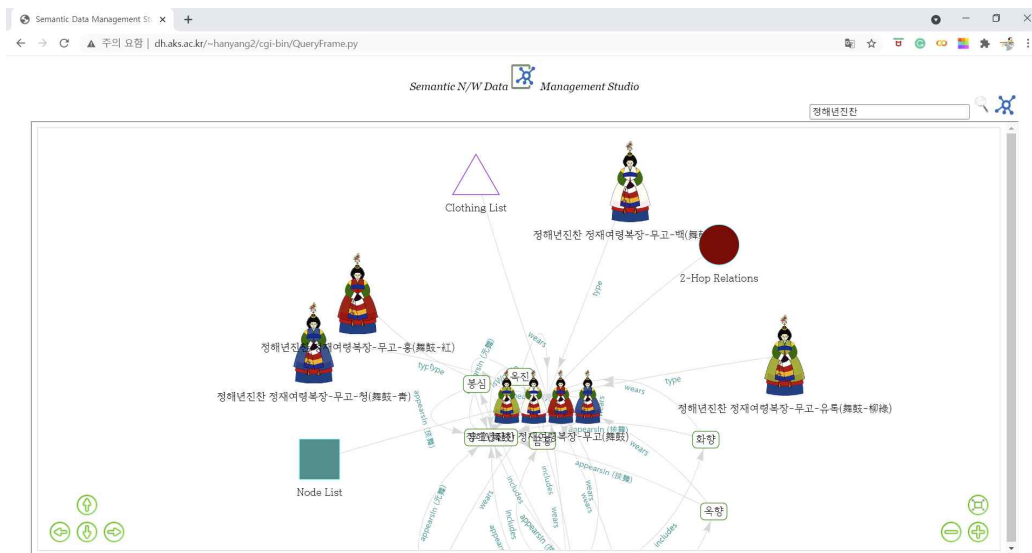
Namespace	Object Property	Domain	Range	Context
ekc:	appearsIn	Actor	Concept	Actor A (appeared in) Concept[Performance] B
ekc:	hasPerformance	Event	Concept	Event A (has a performance) B
ekc:	isAwarded	Actor	Object	Actor A (was awarded) Object B





A-4. Information about the costume worn by the people during the event

Namespace	Object Property	Domain	Range	Context
dcterms:	hasPart	Clothing	Clothing	Clothing[Element] B (is a component of) Clothing A
dcterms:	type	Clothing	Clothing	Clothing A (belongs to) Clothing B
ekc:	isWornIn	Clothing	Concept	Clothing A (is worn in) Concept[Performance] B
ekc:	wears	Actor	Clothing	Actor A (wore) Clothing B
dcterms:	hasPart	Food[Dish]	Food[Ingredient]	Food[Ingredient] B (is an ingredient of) Food[Dish] A
dcterms:	hasPart	Food[Table]	Food[Dish]	Food[Table] A (includes) Food[Dish] B



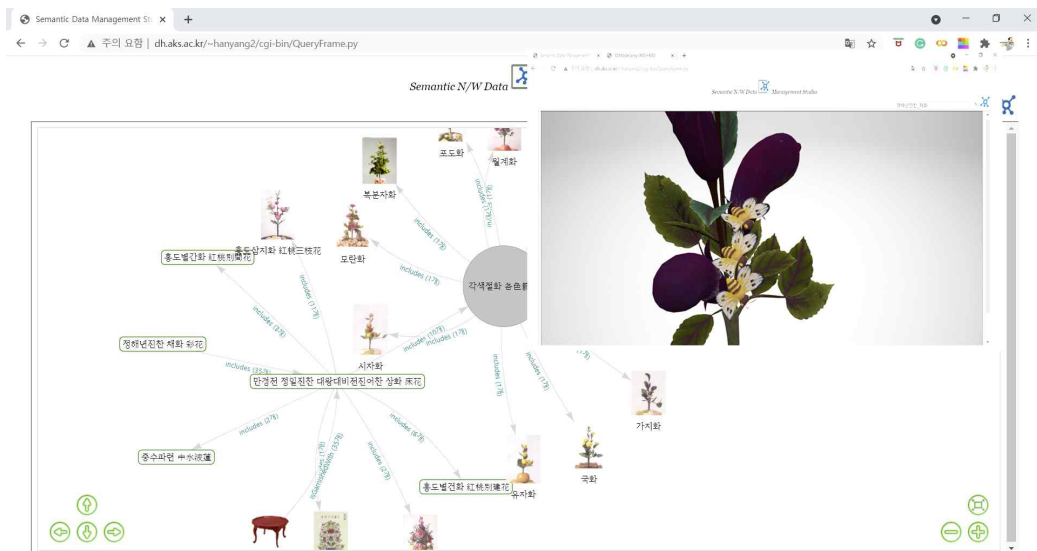
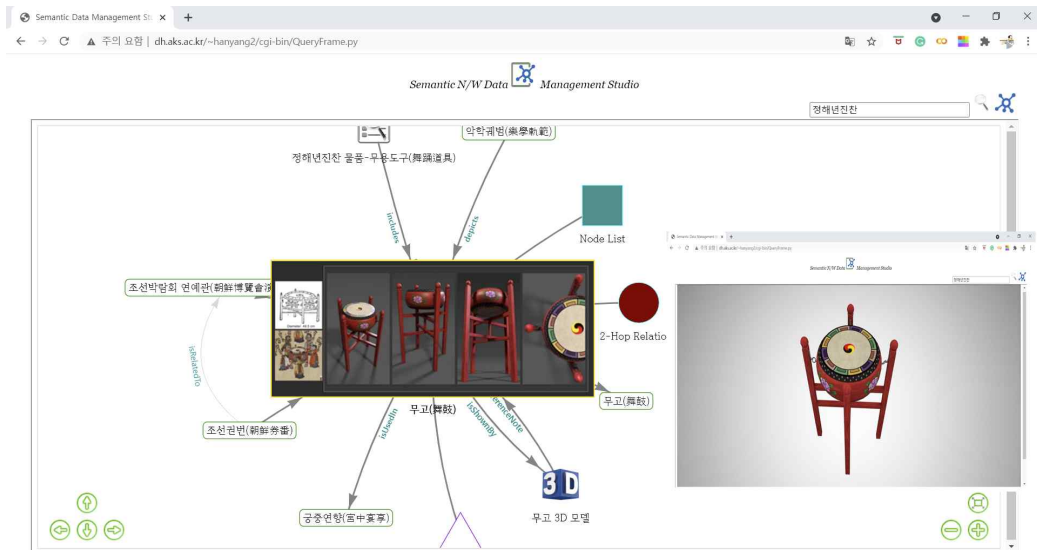
A-5. Information about the royal cuisine served to the participants of the event

Namespace	Object Property	Domain	Range	Context
ekc:	cooks	Actor[Office]	Food[Dish]	Actor[Office] (cooks) Food[Dish]
ekc:	isGarnishedWith	Food[Table/Dish]	Object	Food[Table/Dish] (is garnished with) Object B
ekc:	isOperatedIn	Actor[Office]	Event	Actor[Office] (temporarily operated during) Event B
ekc:	isProvidedIn	Food	Event	Food[Table] A (was provided in) Event B
ekc:	isServedTo	Food	Actor	Food[Table] A (was served to) Actor A
ekc:	prepares	Actor[Office]	Food[Ingredient]	Actor[Office] (cooks) Food[Ingredient]
ekc:	serves	Actor[Office]	Food[Dish]	Actor[Office] (serves) Food[Dish]



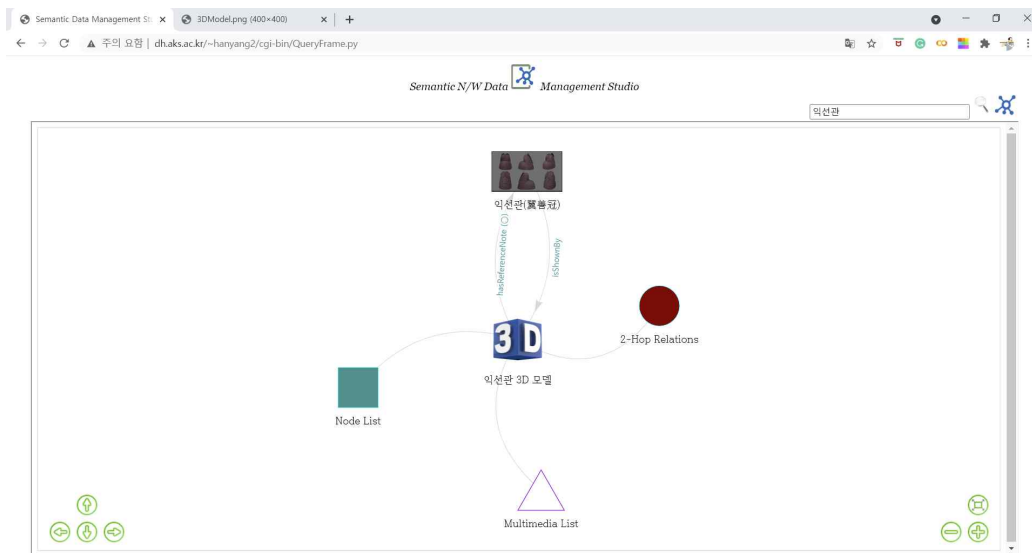
A-6. Information about the objects used in the event

Namespace	Object Property	Domain	Range	Context
ekc:	includes	Object	Object	Object A (includes) Object B
ekc:	isUsedIn	Object	Concept	Object A (was used in) Concept[Performance] B
ekc:	isUsedIn	Object	Event	Object A (was used in) Event B





A-7. Reference data / multimedia data / related storytelling

Namespace	Object Property	Domain	Range	Context
ekc:	bibliography	Any	Bibliography	B (is a list of studies on) A.
ekc:	onlineReference	Any	WebResource	B (is a list of online resources on) A.
ekc:	hasReferenceNote	Multimedia	Text	Multimedia Asset A (has historical evidence listed in ) Text B
ekc:	isShownBy	Architecture	Multimedia	Architecture A (is shown by) Multimedia Asset B
edm:	isRelatedTo	Storry	Any	Storytelling A (is related to) B



The screenshot shows the detailed information page for '익선관' (Ikseongwan) in the Semantic N/W Data Management Studio. It includes a table of references and an online reference section.

source	target	relation	attribute	image
정해년진찬	조선_고종	isUsedIn		
정해년진찬	조선_순종	isUsedIn		
국립고궁박물관	익선관	references	<ul style="list-style-type: none"> <li>• <b>사이즈 정보:</b> 전체높이 22cm, 앞 높이 9.8cm, 배덕 세로 17.5cm, 배덕 가로 20.5cm</li> <li>• 가죽과 말총에 옷질을 하여 모체를 만든다.</li> <li>• 모체 위에 진한 갈색 사(紗)를 배접하여 제작한다.</li> <li>• 모체 뒤쪽에 달려있는 예미날개 모양의 작은 장식이 붙어 있다.</li> <li>• 예미날개 모양 장식은             <ol style="list-style-type: none"> <li>1) 안쪽에 10cm 길이의 날개를 붙이고</li> <li>2) 그 위에 높이 15cm의 날개를 이중으로 덧붙여 제작한다.</li> </ol> </li> <li>• 모체의 중앙부에는 진한 갈색 비단실을 굵게 고이 두 줄로 장식한다.</li> </ul>	 

type	resource	title	description/caption	URL
웹서	AKC Encyclo...	익선관		https://akc.ac.kr/Encyclopedia/Encyclopedia/익선관/46

B. Object properties designed for curating the “Gathering of Officials” portrayed in the documentary paintings

**Gyehoedo (契會圖): Painting of Gathering of Officials**

Social gatherings of senior citizens aged 70 or older or colleagues working in the same government office were very popular during the Joseon Dynasty. At such meetings, painters were often asked to paint the scene of the gathering, and participants in the meeting shared copies of the painting. These paintings give a glimpse into the social network of literati-officials during the Joseon Dynasty.

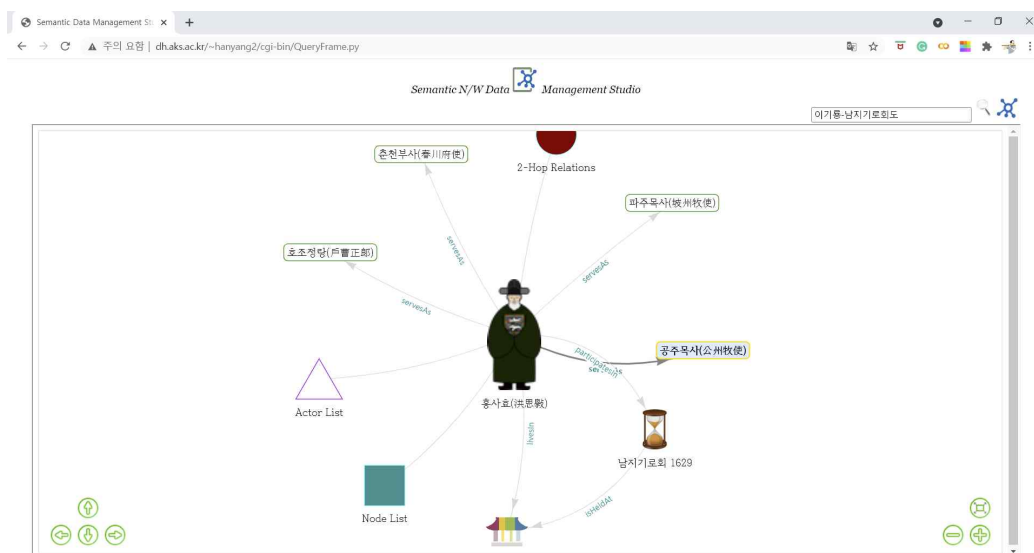
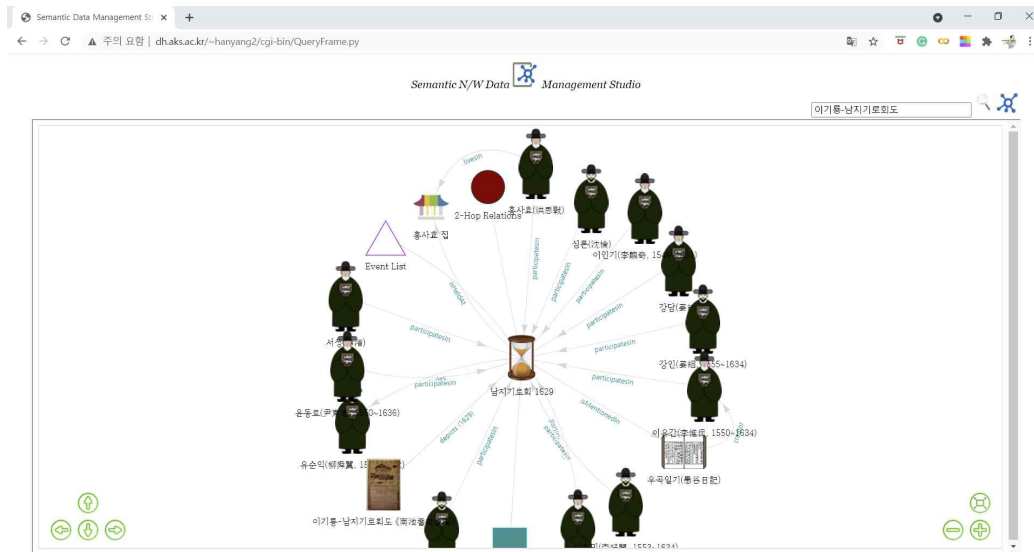
B-1. Information about the painting

Namespace	Object Property	Domain	Range	Context
dcterms:	contributor	Record/Object	Actor	Actor B (is a contributor of) Record/Object A
dcterms:	creator	Record/Object	Actor	Actor B (is the creator of) Record/Object A
edm:	currentLocation	Record/Object	Place/Actor	Record/Object A (is currently located in) Place[Archive or Museum] B
edm:	formerLocation	Record/Object	Place/Actor	Record/Object A (was formerly located in) Place[Archive or Museum] B
edm:	isDerivativeOf	Record/Object	Record/Object	Record/Object A (is a derivative of) Record/Object B
ekc:	depicts	Record/Object	Place/Architecture/Event/Actor	Record/Object A (depicts) Place/Architecture/Event/Actor
ekc:	isDesignatedAs	Record/Object	Heritage	Record/Object A (is designated as) National Cultural Heritage No. xxxxxxx



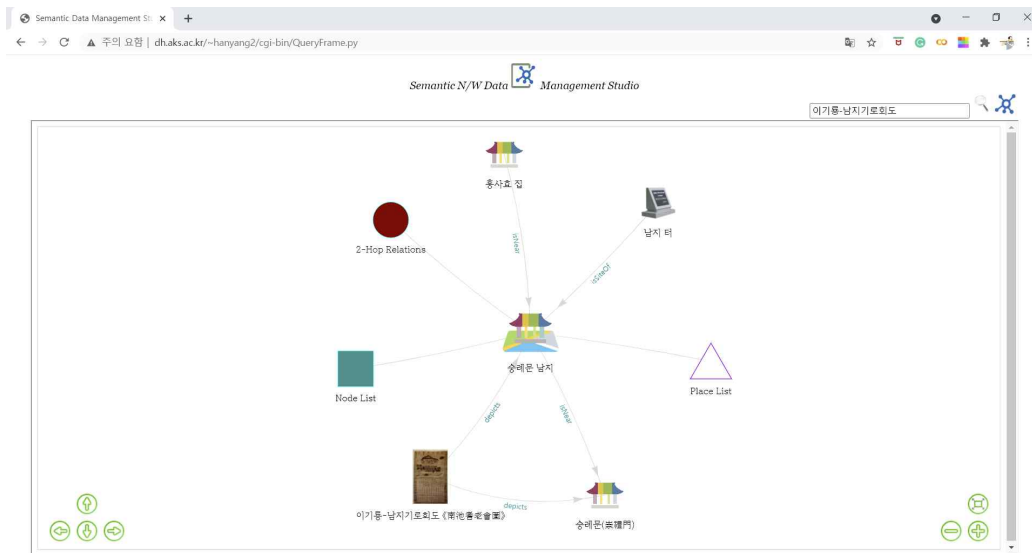
B-2. Information about the event and participants portrayed in the painting

Name space	Object Property	Domain	Range	Context
ekc:	isHeldAt	Event	Place	Event A (was held at) Place B
ekc:	isMentionedIn	Any	Record	A (is mentioned in) Record B
ekc:	isOfficialPostOf	Concept	Actor	A (is an official post of) Actor[Agent] B
ekc:	livesIn	Actor	livesIn	Actor A (lived in) Place B
ekc:	participatesIn	Actor	Event	Actor A (participated in) Event B
ekc:	servesAs	Actor	Concept	Actor A (served as an official) B



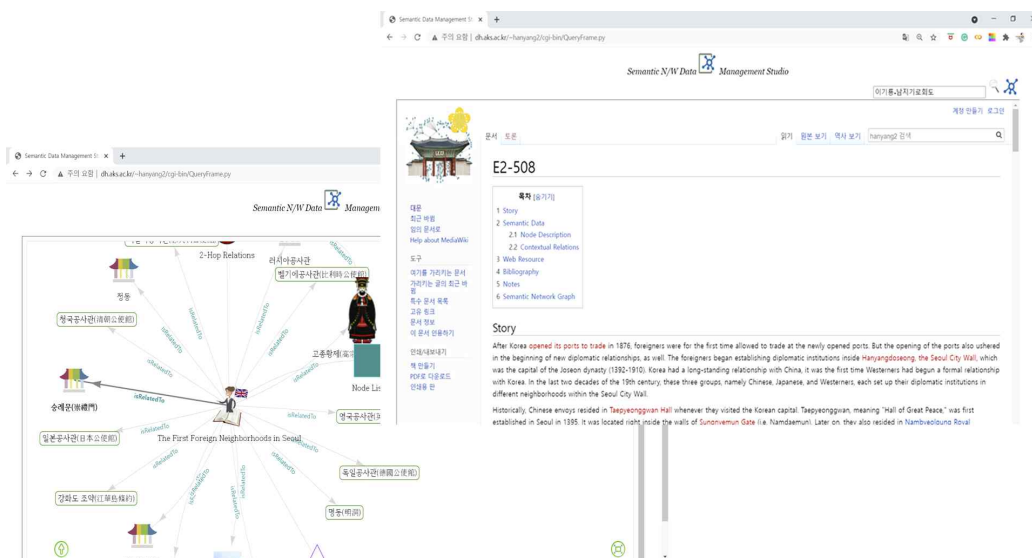
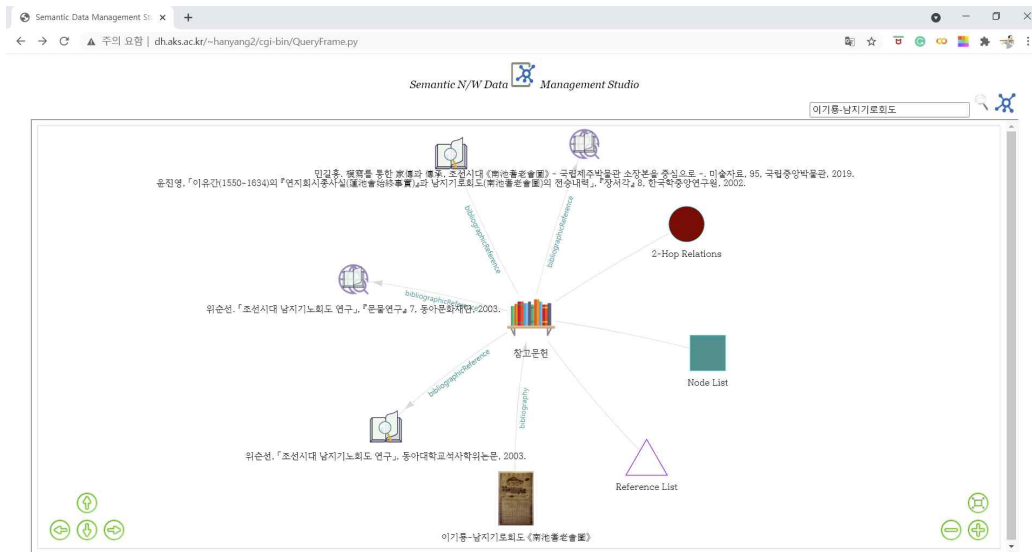
B-3. Information about the space portrayed in the painting

Namespace	Object Property	Domain	Range	Context
dcterms:	hasPart	Place	Architecture	Architecture B (is part of) Place A
edm:	isRelatedTo	Architecture	Event	Architecture A (is related to) historical Event B
ekc:	isNear	Place/Architecture	Place/Architecture	Place A (is near) Place B
ekc:	isSiteOf	Place	Place/Architecture	Place A (is the historical site of) Place/Architecture B



B-4. Reference Data / Multimedia Data / Related Storytelling

Namespace	Object Property	Domain	Range	Context
ekc:	bibliographicReference	Any	Text	A (is verified by) Text B
ekc:	bibliography	Any	Bibliography	B (is a list of studies on) A
ekc:	onlineReference	Any	WebResource	B (is a list of online resources on) A
ekc:	hasReferenceNote	Multimedia	Text	Multimedia Asset A (has historical evidences listed in) Text B
ekc:	isShownBy	Architecture/Object/Clothing/Food	Multimedia	Architecture/Object/Clothing/Food A (is shown by) Multimedia Asset B
edm:	isRelatedTo	Story	Any	Storytelling A (is Related to) B





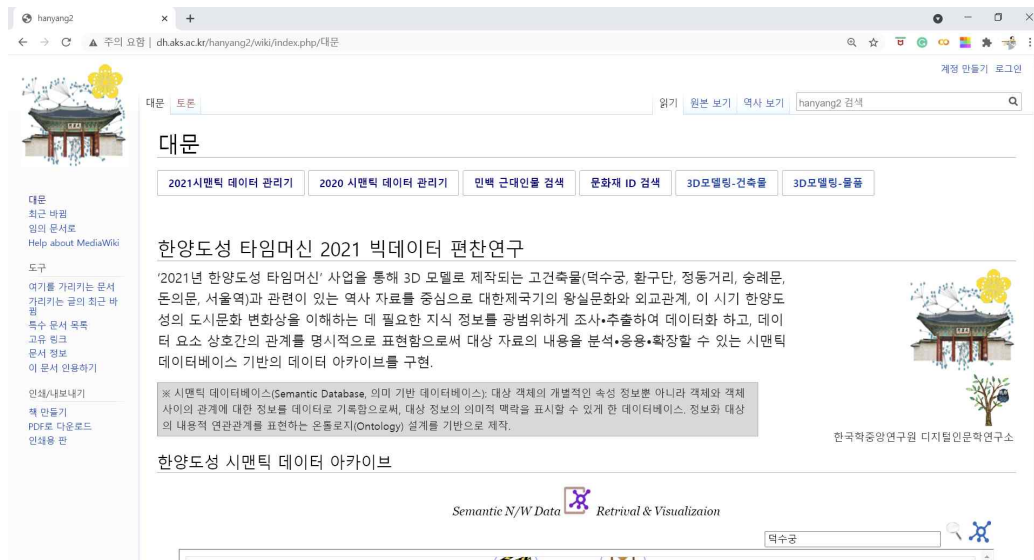
## 6. Operation of Online Collaboration Platforms

The semantic data shown in the previous section of this presentation are all compilations of data extracted and curated by professional researchers who study royal rituals, traditional clothing, food, and art history. The researchers supplemented the existing ontology in the process of synthesizing and organizing data extracted from each specialized field, and, again, created new data using the updated ontology.

Since such collaborative research cannot be conducted with a conventional humanities research method, our research team at the Center for Digital Humanities at the Academy of Korean Studies (hereafter DH Center) built digital-based research support systems and conducted data compilation work in that environment. There are two support systems that we used for collaborative data curation research.

### 1) Hanyang Wiki

The DH Center operated a wiki-based online collaboration system for researchers' data curation. Research references such as the list of basic literature, story topics, and ontology supplementations are released through this wiki system, and all data generated during the data curation process is recorded on the wiki page of this system so that other researchers can share it.



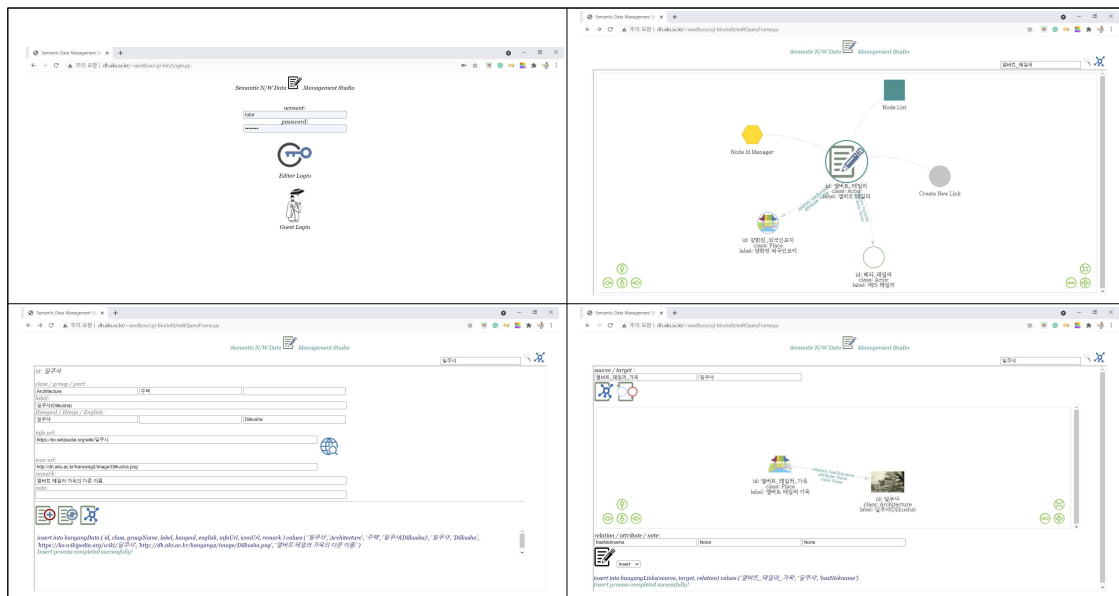
## 2) Development and operation of semantic data management software

The DH Center developed data management software that can manage semantic data consisting of nodes and links in real time, and trained individual researchers who perform data curation to directly use the system.

### ※ Semantic Network Data Management Studio (SN-DMS):

- This network database management tool enables the creation, modification, and deletion of nodes and links in the semantic database, and real-time monitoring of changed semantic networks.
- This program provides the following functions:
  - (1) Visualizes semantic data that follows the Resource Description Framework (RDF) format in the form of a network graph
  - (2) Provides a semantic navigation function that searches for data and expands the connections to related data on the network graph
  - (3) Performs data management tasks such as adding, updating, and deleting nodes or links of the semantic network

† Distribution and support: Center for Digital Humanities at the Academy of Korean Studies



## 7. Conclusion

The Hanyang Time Machine Project, which reconstructs Hanyang, the capital of Joseon (1392-1910), in the digital virtual world aims not only to show the appearance of the buildings, but also to know who lived in the city, what relationships they maintained, and what culture they enjoyed.

To achieve this goal, we have created a collaborative organization between digital engineers and humanities researchers, and are making efforts to convert humanities knowledge related to cultural heritage into digital data.

The way we chose to convert humanities knowledge into digital data is to create Resource Description Framework (RDF) triples by extracting the contextual elements and relationships from the text recorded in the old literature. Over the past two years, we have created about 50,000 nodes and 105,000 links of data. Users visiting the Hanyang Time Machine will be able to find numerous stories about the Hanyang people's culture in the semantic network that these data make up. Our plan is to expand this semantic network data to a scale that includes about 65,000 nodes and 130,000 links by the end of 2022.

Semantic data compiled by the Hanyang Time Machine research team can be used by anyone for research, education, or commercial digital product development. The RDF data we are creating is a conversion of humanities knowledge from a form that was ambiguously contained in written human language into explicit data that computers can recognize. This can be used as primary learning data for the deep-learning process of AI. I also expect that this data will greatly contribute to the development of artificial intelligence that can help people study traditional Korean culture.