

1 Details of Knowledge Graph

Entity type	Property	Count	Entity type	Property	Count
Painting	Name	2990	Person	Name	25
	Description			Description	
	Image			Image	
	Date			Sex	
	Height			Date_of_birth	
	Width			Date_of_death	
	Sitelink			Sitelink	
	URI			URI	
Collection	Name	334	Exhibition	Name	127
	Description			Description	
	Image			Date	
	Date			Website	
	Website			Collection_size	
	Collection_size			Visitor_per_year	
	Visitor_per_year			Sitelink	
	Sitelink			URI	
Genre	Name	29	Movement	Name	29
	Description			Description	
	Sitelink			Start_time	
	URI			End_time	
				Sitelink	
Material	Name	46	Keyword	Name	1919
	Description			Description	
	Sitelink			Sitelink	
	URI			URI	
Country	Name	39	City	Name	251
	Description			Description	
	Sitelink			Sitelink	
	URI			URI	

Table 1: A summary of entities and their properties.

Relation Type	Head Entity	Target Entity	Count
has_CREATOR	Painting	Person	6010
belongsto_GENRE	Painting	Genre	5474
belongsto_MOVEMENT	Painting	Movement	2106
in_COLLECTION	Painting	Collection	4944
in_EXHIBITION	Painting	Exhibition	632
on_MATERIAL	Painting	Material	5064
has_KEYWORD	Painting	Keyword	7742
in_CITY	Painting	City	
	Collection		
	Exhibition		
	Person		
in_COUNTRY	Painting	Country	412
	Collection		
	Exhibition		
	Person		

Table 2: A summary of relationships.

2 Intent List

Intent Name	Training Phrase
Exhibit.display	I would like to know about <i>King Caspar</i> . Tell me about <i>Two moors</i> .
Question.have	I want to ask questions. How should I ask questions?
Question.answer	Who is the creator of <i>The Night Watch</i> ? What key elements are in <i>The Night Watch</i> ?
Recommendation	Show me similar exhibits like this one. I want to know some similar exhibits.
Recommendation.attribute	Another one related to <i>oil paint</i> . Tell me another entity related to <i>Rembrandt House Museum</i> .
Recommendation.nomore	Stop the recommendation, please. That's enough, thanks.
Recommendation.new	Do you have another one? Could you show me one more suggestion?
Recommendation.connection	Why this one? What's the connection between them?
Visit.finish	Finish the visiting. I want to stop the visiting now.
Universal.yes	Yes. Why not. Sure.
Universal.no	No, thank you. I am good. It's enough.

Table 3: The intents list and samples of their training phrases. The italic name in training phrases indicates that it is an instance of an entity type, for example, *King Caspar* is an instance of **Painting** and *oil paint* is an instance of **Material**.

3 Knowledge-based Question Answering

Type	Keywords	Type	Keywords
Date	When, What time, date	Description	describe, description
Creator	Who, creator	Genre	genre, style, category
Material	material, textile	Depicts	element, object, depict, keyword
Collection	collection, museum, gallery	Exhibition	exhibition
Image	image, picture, figure	Movement	movement
Country	Which country, country, nationality	City	Which city, city

Table 4: Example for the types of keywords used to identify the question type.

Question type	Utterance	Cypher query
	Which {museum} owns <The Night Watch>?	
paintings_collection	Which {Collection} owns <Painting>?	(p:Painting)-[r:in.COLLECTION]->(?)
	Who is the {creator} of <The Night Watch>?	
paintings_creator	Who is the {Creator} of <Painting>?	(p:Painting)-[r:has_CRREATOR]->(?)
	What is the {material} of <The Night Watch>?	
paintings_material	What is the {Material} of <Painting>?	(p:Painting)-[r:on_CRREATOR]->(?)
	What is the {genre} of <The Night Watch>?	
paintings_genre	What is the {Genre} of <Painting>?	(p:Painting)-[r:belongsto_GENRE]->(?)
	What is the {key element} in <The Night Watch>?	
paintings_depicts	What is the {Depicts} in <Painting>?	(p:Painting)-[r:has_KEYWORD]->(?)
	What {movement} does <The Night Watch>belongs to?	
paintings_movement	What {Movement} does <Painting>belongs to?	(p:Painting)-[r:belongsto_MOVEMENT]->(?)
	{When} was <The Night Watch>created?	
paintings_date	{Date} was <Painting>created?	(p:Painting) return p.date
	Show me the {picture} of <The Night Watch>.	
paintings_image	Show me the {image} of <Painting>	(p:Painting) return p.image
	Which {country} is <The Night Watch>in?	
paintings_country	Which {Country} is <Painting>in?	(p:Painting)-[r:in.COUNTRY]->(?)
	Show me {paintings} in <Rijksmuseum>.	
collection_paintings	Show me {Painting} in <Collection>	(?)-[r:in.COUNTRY]->(c:Collection)

Table 5: List of the implemented question types for KBQA with examples, question type names, examples with question keywords in curly braces and entity names in angle brackets, and corresponding Cypher queries.

4 User Study

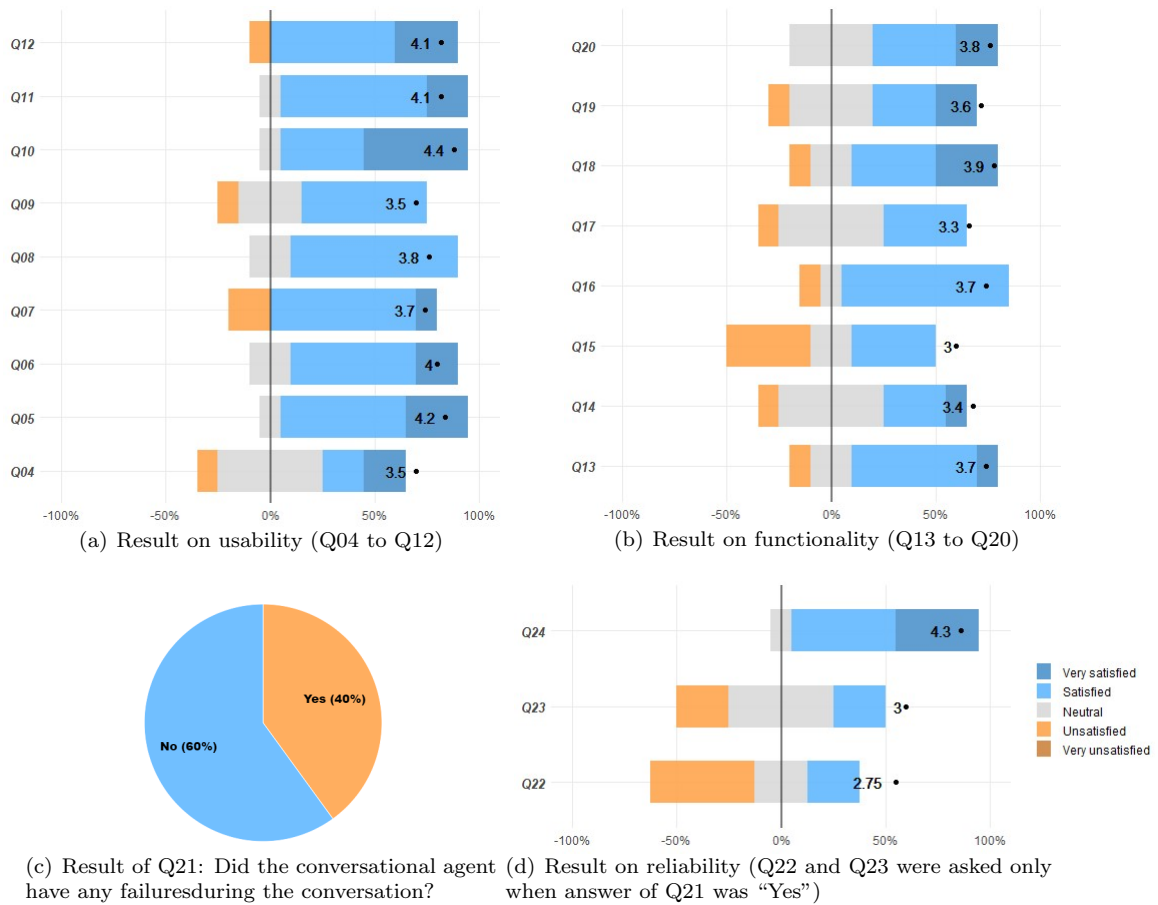


Figure 1: Results of user evaluation on usability, functionality and reliability

Category	Sub-category	Number	Questionnaire Item
Overall Evaluation		Q1	Have you used a chatbot or a conversational agent as a museum guide before?
		Q2	Do you think your visit experience was improved by having the conversation with the virtual guide?
		Q3	Do you think the guide was annoying and spoiled your visit experience?
Usability	Ease to start conversation	Q4	I think it was easy and clear to start a conversation with the agent.
		Q5	I would imagine that most people would learn to start the conversation quickly.
		Q6	I quickly realized what information the chatbot could give me.
	Maxim of quantity	Q7	The amount of received information was neither too much nor too less.
		Q8	The amount of recommendation from agent is appropriate.
		Q9	The agent gives me only the information I need.
	Understandability	Q10	The agent's responses were easy to understand.
		Q11	I felt comfortable with the conversational interface, i.e. the chat box.
	Speed of answer	Q12	My wait time is short for the response from the agent.
Functionality	Ability to maintain a conversation	Q13	I felt that the conversation is coherent and ongoing.
	Recognition of the user's intent	Q14	I felt my intentions were understood by the agent.
		Q15	I had to rephrase my input multiple times for the agent to be able to understand me.
	Relevance of information	Q16	During the whole conversation, the agent offers relevant information about what I asked.
		Q17	The agent's recommendations are always interesting to me.
	Satisfaction to functions	Q18	I liked to see the connections between exhibits through the knowledge graph.
		Q19	I felt asking questions to the agent was not troublesome or unnecessary to me.
		Q20	My experience of visiting improved due to the recommendation from the agent.
Reliability	Resilience to failure	Q21	Did the conversational agent have any failures during the conversation?
		Q22	The agent response appropriately when it encountered a problem.
		Q23	The agent helped me back to the normal conversation when a failure happened.
	Security	Q24	I felt my personal information is secured during the whole conversation.

Table 6: Question types and examples in questionnaire.