VISUAL ANALYTICS FOR CULTURAL HERITAGE





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Motivation

Visual analytics is a multi-disciplinary field of data science that aims an effective understanding and an analytical reasoning of datasets facilitated by visual interfaces. We combine visual analytics with history in this project and focus on the "Fall of Constantinople / Conquest of Istanbul" event in history. We propose a framework to reflect the uncertainties of this historical event into a digital tool. Our framework contributes to the cultural heritage while creating a visual representation of a historical event by showing all the possible data that has been collected from historical records.

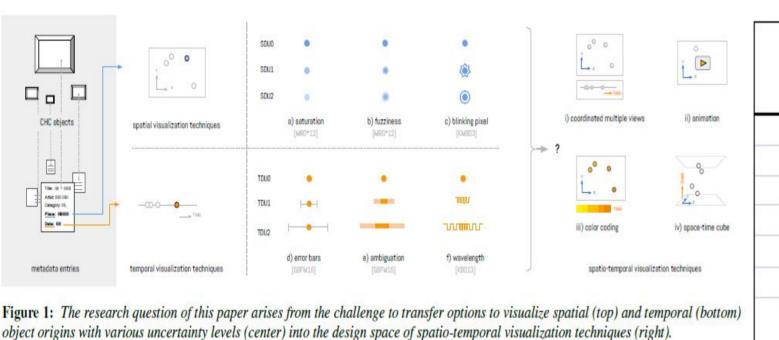
Uncertainty of Data

Possible uncertainties in spatial and temporal data, which can arise from the documentation of the approximately point-like events of object creation.

- 1. Spatial Data Uncertainty (SDU)
- 2. Temporal Data Uncertainty (TDU)
- 3. Spatio-Temporal Data Uncertainty (STDU)

Design Space of Uncertainty Data

Examples of Uncertainty in our Project



00	Starting Date	SPATIAL UNCERT		0.111 101	
		Minor Spatial Uncertainty SDU1	Major Spatial Uncertainty SDU2	Acts	References
	2-Apr	(4\7)-C\1-R	(3\7)-C\3-R	7-C	4-R
		St.Romanos	Konstantinople	A4 A	
		Golden Door to Coastal		Ottoman Army	
		Golden Door to Wooden Door		arrived to	
		Galata		Konstantinople	
		(4\5)-N\3-R		5-N	3-R
		Golden Horne		Golden Horne is chained	

	i) coordinated multiple views	ii) animation	iii) color coding	iv) space-time cube
i) spatial uncertainty, temporal certainty	···.			, , ,
ii) spatial certainty, temporal uncertainty	tool 1991		L	TIT
iii) spatial uncertainty, temporal uncertainty	SDUV: saturation, TDUV: error bars	SDUV: saturation, TOUV: fuzziness	SDUY: blinking pixel, TDUY: fuzziness	SDUV: saturation, TDUV: error bars

Figure 2: Design space for spatial, temporal and spatio-temporal uncertainty visualization for four different visualization techniques

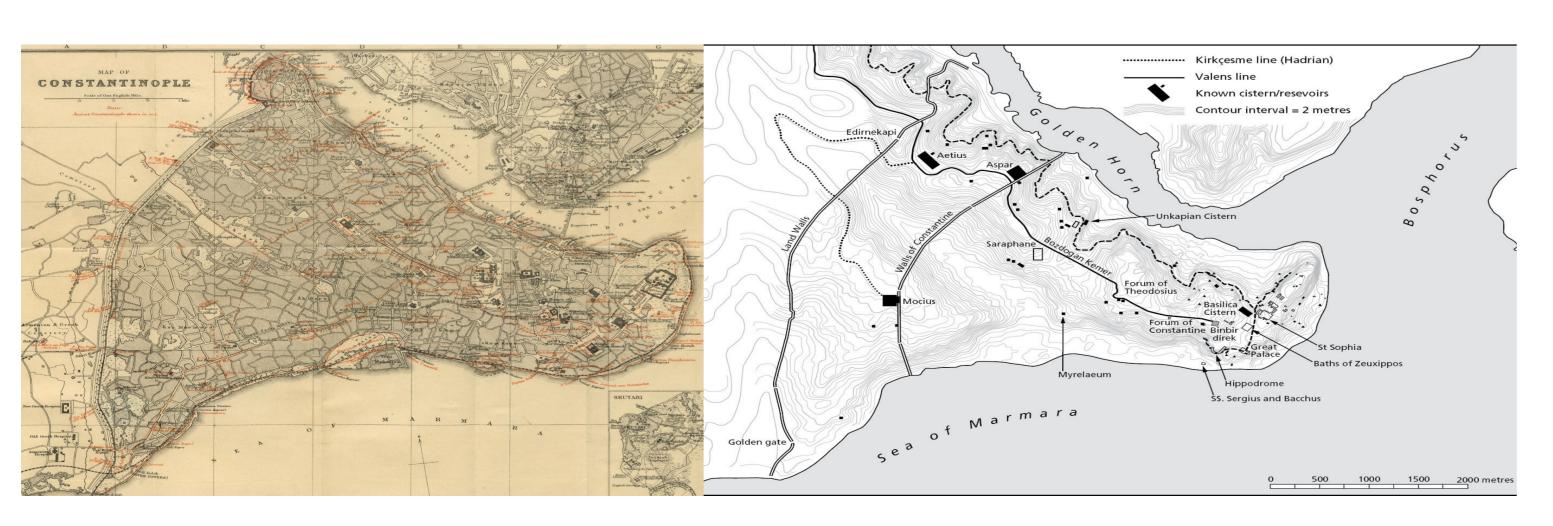
		TENT OWNE ON	TEMPONAL ONCENTAINT (100)		
	Starting Date	Point-Based Uncertainty TDU1	Interval-Based Uncertainty TDU2	Acts	References
-	2-Apr	4-R		Ottoman Army arrived	5-R
-	5-Apr	1-R		to Konstantinople	0.88
	12-Apr\18-Apr		1-R	Ottoman Army occupy	2-R
	18-Apr\19-Apr		1-R	Büyükada	Z-N

TEMPORAL UNCERTAINTY (TOU

Methodology



The map resources showing the city of Constantinople are utilized to locate the events that take place in the locations of the old city. Historical books and texts including primary and secondary sources are combined with these maps to write an event log, to project the data on the Carto map and to reflect spatio-temporal data of the conquest throughout the time.



Actor	Diplomatic Acts	Continental Acts		Naval Acts	Start Date Start- Day Time	End Date End- Day Tir 02 04 1453		Faction	Total Forces	Caluates	Reference	R
Byzantines				Golden Home has been chained to prevent ship passage	02.04.1453		Konstantinople					
Ottoman pioneer troops		Pioneer troops have arrived in Konstantinople			02.04.1453	02.04.1453	Konstantinople	Ottoman			Halil Inalok	
Ottomans		Sultan's marquee has setup in front of St. Romanus	Gate		06.04.1453	06.04.1453	Front of St. Romanus Gate	Ottoman			Halil Inaloik	
Ottoman cannons		Walls near Edirnekapi have partly been destructed	by bombardment		08 04 1453	07 04 1453	Edimekapi	Ottoman			Hali Inalcik	
Byzantines		Breaches in the walls have been fortified			08.04.1453 Night	07.04.1453	Edimekapi	Byzantium			Hali Inalok	
Ottomans		Underground sewers have been digged			08.04.1453 Night	07.04.1453	Konstantinople	Ottoman			Hali Inalok	
		Ditches have been filled			06.04.1453 Night	07.04.1453						
Ottomans		Ditches have been filed					Ditches of Konstantinople	Ottoman			Halil Inalok	
Baltaoğlu Süleyman Bey and his nav	al units			First attack to enter Golden Horn	09.04.1453	09.04.1453	Golden Horn (Haliç)	Ottoman			Hali Inalok	
Ottoman heavy cannons		Bombardment and destruction of Konstantinople's v	als		11.04.1453	11.04.1453	Konstantinople's walls	Ottoman			Halil Inaloik	
Byzantines		Trials to fill breaches with wooden piles and bags of	sois		11.04.1453	11.04.1453	Konstantinople's walls	Byzantium			Halil İnalçık	
Baltaoðlu Süleyman Bey and Ottoma	an maiod units			Attack on Christian naval units that have higher shipboard	12.04.1453	12.04.1453	Golden Horn (Halic)	Ottoman			Hali Inalok	
	arraya urus				12.04.1453	12.04.1453					Hali Inalok	
Christian naval units				Successful defence against Baltaoğlu Süleyman Bey			Golden Horn (Halip)	Byzantium				
Ottoman mortars				Attack on Christian naval units	12.04.1453	12.04.1453	Golden Horn (Halig)	Ottoman			Halil Inalok	
Christian naval units				One of Christian naval galleys has been destroyed	12.04.1453	12.04.1453	Golden Horn (Halip)	Byzantium		1 Galley	Halil Inaloik	
Ottomans		Attempt to burn the trenches with piles			18.04.1453	18.04.1453	Walls that are destructed by	c Ottoman			Halil Inalok	
Three Genoan Ship				Supply ships for the city sent by Pope Nicholas V has read	h 20.04.1453 Morning	20.04.1453 Morning	Konstantinople	Genoa			Hali Inalok	
One Byzantian Ship				Supply ship for the city has reached Constantinople	20.04.1453 Morning	20.04.1453 Morning	Konstantinople	Byzantium			Hali Inalok	
Baltaoğlu Süleyman Bey and Ottoma	in naval units			Unsuccessful attempt to capture three Genoan and one By		20.04.1453 Morning	Konstantinople	Ottoman		300 Ottoman sol		
Ottoman Cargo Ships				Ottoman cargo ships equipping several guns have moved to		20.04.1453 Morning	Konstantinople	Ottoman			Halil Ínalcik	
Three Genoan Ship and One Byzanti	ian Ship			They have defended against Ottoman attack successfully	20.04.1453 Morning	20.04.1453 Morning	Konstantinople	Byzantium		23 Christian sold	der	
Baltaoğlu Süleyman Bey and Ottoma	n raval units			They have returned to Dolmabahpe	20.04.1453	20.04.1453	Dolmabahoe	Ottoman			Halil Inaloik	
Byzantnes				The chain in Golden Home has been loosed	20.04.1453 Night	20.04.1453 Night	Golden Horn (Halic)	Byzantium			Hali Inalok	
											Hall Indick	
Three Genoan Ship				Three Genoan ships has entered Golden Home	20.04.1453 Night	20.04.1453 Night	Golden Horn (Haliç)	Byzantium				
One Byzantian Ship				One Byzantine cargo ship has entered Golden Home	20.04.1453 Night	20.04.1453 Night	Golden Horn (Halig)	Byzantium			Halil Inalok	
Baltaoğlu Süleyman Bey	He has been dismissed. He would have been	executed.			20.04.1453	20.04.1453		Ottoman			Halil İnalok	
Hamza Bev	He has taken over the place of Baltaodiu Sille				20.04.1453	20.04.1453		Ottoman			Hali Inalok	
Ottomans	There have been some desertions in the Otto				20.04.1453	20.04.1453		Ottoman			Half Inalok	
	many make used surice desertions in the Otto		Database Tonas		20.04.1453	20.04.1453	Laborathology				Hali Inalok	
Ottomans		Ottomans have intensified their bombardment and o					Lykos Valley	Ottoman				
Seventy Ottoman ships slipping on or	radies and carried by oxes	Seventy Ottoman ships carried by oxes have move	from Dolmabahge to Golden Horn over the roads an		22.04.1453 Morning	22.04.1453 Noon	Dolmabahge to Golden Horn				Halil İnalok	
Byzantines				Unsuccessfull attempt to burn Ottoman ships that are trans	28.04.1453	28.04.1453	Golden Home (Halig)	Byzantium			Halil İnalok	
Ottomans		Severe bombardment over the coasts of Golden Ho	me		28.04.1453	28.04.1453	Golden Home (Halic)	Ottoman			Hall Inalok	
Byzantines			e bombardment of Ottomans over the coasts of Golde	an Morea	28.04.1453	28.04.1453	Golden Home (Halic)	Byzantium			Hali Inalok	
		A bridge connecting Awarsaray and Süttüge has b		and the same	28.04.1453	28.04.1453	Between Awarsaray and Si				Hali Inalok	
Ottomans												
Ottoman heavy cannons		Heavy cannons on the bridge bombarded Blakhem			28.04.1453	28.04.1453	Blakhemai	Ottoman			Halil Inalok	
Ottomans				Trials to seize whole Golden Home haven't been succesful		28.04.1453	Golden Home (Halig)	Ottoman			Halil Inalcik	
Admiral Alviso Longo and his navy				has moved to Tenedos for gathering forces and supply	28.04.1453	28.04.1453	Konstantinople to Tenedos	Byzantium			Hali Inalok	
Loredans and their naval fleet	have joined to Admiral Alviso Longo and his n	Part I			28.04.1453	28.04.1453	Tenedos	Venine			Halil İnalok	
		lawy			28.04.1453	29.05.1453	Tenedos to Constantinople				Pari Indicik	
Admiral Alviso Longo, his navy with L	Loredans			returned to Constantinople				Venice				
Ottoman Forces		After three hours of heavy bombardment, the trend	in the breach could not be vaccinated.		07.05.1453 Night	07.05.1453	Topkapı Kesimindeki Doldur	Ottoman			Hali Inalok	
Ottoman Forces		The attack did not yield any results.			12.05.1453 Night		Blakhemai Surlan	Ottoman			Halil Ínaloik	
Ottoman Forces		The attack did not yield any results.			12.05.1453 Night		Theodosius Surfani	Ottoman			Halil İnalnık	
Christian Ships		The acade on the year any results.		The ships took refuge in the harbor.	13.05.1453		Halige'teki Neorion Limanı (3				Halil Ínalok	
				The snips took reruge in the narbor.							Hall Inaicik	
Christian Ships		The castle walls were repaired.			13.05.1453		Blakhemai Surlan	Byzantium			Hali Inalok	
Ottoman Forces		Cannons moved.			16.05.1453		Lykos Vadisi	Ottoman			Halil Inaloik	
Ottoman Navy				The Ottoman navy moved from Dolmabahoe to the Golden	18.05.1453	17.05.1453	Halio	Ottoman			Halil Inaloik	
Ottoman Navy					16.05.1453	17.05.1453	Dolmabahoe	Ottoman			Hali İnalok	
		Consideration of		The Ottoman navy retreated against the Byzantine navy.	16.05.1453 16.05.1453	17.05.1453 23.05.1453	Joinsburge				Hali Inalok Hali Inalok	
Ottoman Forces		Cannonball continued.						Ottoman				
Ottoman Forces		Sewers continued to be excavated.			16.05.1453	23.05.1453		Ottoman			Halil İnaloik	
Ottoman Forces		A tower made of wood was advanced towards the o	aste walls.		18.05.1453	23.05.1453	Mesetenion (Topkapı)	Ottoman			Halil Inaloik	
Ottoman Forces		The filling of the trench continued under the protect	on of the lower		18.05.1453	23.05.1453	Mesetenion (Topkapi)	Ottoman			Hali Inalok	
Ottoman Forces		The tower was burned by the Byzantines.	or or one words.		18.05.1453	23.05.1453	Mesetenion (Topkapi)				Hali Inalok	
								Ottoman				
Ottoman Forces		The sewers were neutralized by the Byzantines.			18.05.1453	23.05.1453	Mesetenion (Topkapi)	Ottoman			Halil Inaloik	
Brigantini of Venice				Venice Brigantini escaped from the pursuit of Ottoman ship	23.05.1453		Haliç'e doğru denizden ilerle	r Bizans			Halil Inaloik	
Hungarian Ambassadors	The truce meeting with the Sultan was not ac-	nested by the Burantine Emperor			23.05.1453		1	Bizans			Hali Inalok	
Venice Naw	The same meeting with the Junior Hall flot ac-	organic of an observe orders.		The Venice Navy arrived in the Aegean.	25.05.1453		Aegean Sea				Hali Inalok	
				The vertice many arrived in the Aegean.			wedeau sea	Bizans				
Isfendiyar Beyoğlu İsmail Bey	The Sultan requested them to pay 100 000 go	old coins and surrender the city.			25.05.1453			Ottoman			Halil İnalok	
The Emperor's Ambassador	The Italians did not accept to give up.				25.05.1453			Byzantium			Halil Inaloik	
		Venetians and Hungarians come to help.			26.05.1453			Byzantium			Halil Ínalok	
Candadi Halil Pasa	He wants to finish the siege and decide to with				26.05.1453			Ottoman			Half Inalok	
					20.00.1403			Ottoman			Hali Inalok	
Zaĝanos Paşa	He wanted the siege to continue.											
Koca Turahan Bey	He wanted the siege to continue.				26.05.1453			Ottoman			Halil İnalok	
Sahabettin Pasa	He wanted the siege to continue.				26.05.1453 27.05.1453			Ottoman			Halil Inalcik	
Ottoman Forces		Cannonball continued.					Top Yıkığı Kesimi	Ottoman			Halil Inaloik	
Sultan 2. Mehmet		He commands the commanders to attack.			27.05.1453 Night		Top Yıkığı Kesimi	Ottoman			Halil Ínalcik	
Sultan 2. Mehmet				Orders the sea walls to attack.	28.05.1453 Morning		Dolmabahge	Ottoman			Halil İnalçık	
Sultan 2. Mehmet					28.05.1453 Afternoon		marquee	Ottoman			Halil İnalçık	
Zaĝanos Pasa		He directs the forces in the Golden Horn to Blakher	nai.		28.05.1453		Blakhemai	Ottoman			Hali Iralok	
Zaganos Paşa The Emperor		Calls on everyone at the last Assembly meeting to a			28.05.1453 Evening		The Emperor palace	Byzantium			Hall Indok	
The Emperor Sultan 2 Mehmet		Calls on everyone at the last Assembly meeting to only the portions to attack from the land					rive Emperor parace	Ottoman			Hali Iraiok	
		me orders to attack from the land.			29.05.1453 Night							
Sultan 2. Mehmet				He orders an attack from the sea.	29.05.1453 Night			Ottoman			Halil Inaloik	
Ottoman Forces		Light infantry forces make the first attack.			29.05.1453			Ottoman			Halil İnalcık	
Ishak Paşa		Anatolian military attacks.			29.05.1453 Night			Ottoman			Halil Ínalcik	
Hungarian Urban		the cannons of Urban opened a breach in the wood	en shields.		29.05.1453 Morning		tree trench	Ottoman			Halil İnalçık	
Ottoman Forces		soldiers entered through the breach.			29.05.1453 Morning		tree trench	Ottoman	300 Anatolian S		Hall Indek	
Ottoman Forces		they were annihilated by the defense forces.			29.05.1453 Morning		tree trench	Ottoman	COUNTY OF THE PARTY OF		Hali Inalok	
Ottoman Forces		The Janmiseries, unshaken by the heavy fire of arro	and become associated to the boards		29.05.1453 Morning 29.05.1453		week treatment	Ottoman			Hali Inalok	

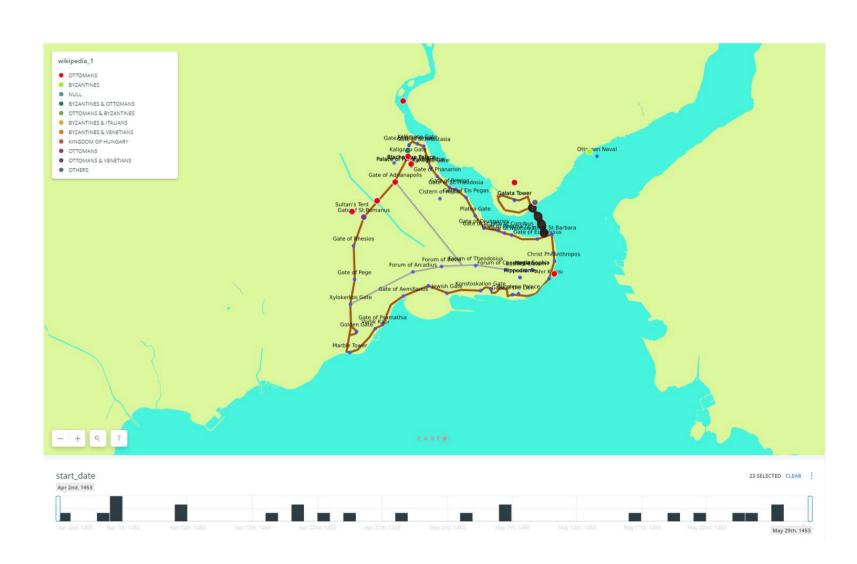
Ottoman Forces			Kerkoporta (the Belgrad Gate) at Blachemae which	was unintentionally left open by the Byzantines.	29.05.1453		Belgrad Gate	Ottoman	50 Soldier		Halil Ínalcik	
Supreme Commander Guistiniani		The Supreme Commander was seriously injured.			29.05.1453		Top Yıkığı Kesimi	Byzantium			Halil Ínalcik	
				The Commander in Chief Gustiniani was orawely inkned at The Commander in Chief soldiers followed him.	29.05.1453 29.05.1453		Halin Halip	Avrantium Byzantium			Hali İnalnık Hali İnalnık	
Sunreme Commander Guistiniani	Gustnan			The Commander-in-Chief soldiers followed him.								
		the Sultan sent the Janissaries behind the Commar			29.05.1453		Haliç	Ottoman			Halil Ínalcik	
Sultan 2. Mehmet		Ulubatir Hasan, with a battle axe in his hand, cleare	d the way over the palisades,		29.05.1453		At the breach	Ottoman			Halil Ínalcík	
Sultan 2. Mehmet		The Janissaries behind him, however, managed to			29.05.1453		At the breach	Ottoman			Halil İnalçık	
Sultan 2. Mehmet Ulubati Hasan		they proceeded to the inner walls			29.05.1453		Inside walls	Ottoman			Hali Inalok	
Sultan 2. Mehmet Ulubatlı Hasan Janissaries					29.05.1453		trench	Ottoman			Halil Ínaloik	
Sultan 2. Mehmet Ulubath Hasan Janissaries Janissaries					29.05.1453		Upside of walls	Ottoman			Hall Inaloik	
Sultan 2. Mehmet Ulubati Hasan Janissaries Janissaries Janissaries		They destroyed the enemy entering the trench.										
Sultan 2. Mehmet Ulubati Hasan Janissaries Janissaries Janissaries		They climbed on the castle walls.										
Ulubati Hasan Janissaries Janissaries Janissaries		They climbed on the castle walls. Ottoman flags fluctuated on the walls.			29.05.1453		Kerkoporta	Ottoman			Halil Ínalcík	
Sultan 2 Mehmet Ulubati Hasan Janissanies Janissanies Janissanies Janissanies Janissanies		They climbed on the castle walls. Ottoman flags fluctuated on the walls. The defense at Blakhemai had collapsed			29.05.1453 29.05.1453		Kerkoporta Blakhemai	Ottoman Ottoman			Halil İnaloik Halil İnaloik	
Sultan 2 Mehmet Ulubati Hasan Janissanies Janissanies Janissanies Janissanies Janissanies		They climbed on the castle walls. Ottoman flags fluctuated on the walls.			29.05.1453 29.05.1453 29.05.1453		Kerkoporta	Ottoman			Halil Ínalcík	
Sultan 2. Mehmet Ulubah Hasan Janissaries Janissaries Janissaries Janissaries Venedik Balyosu		They climbed on the castle walls. Ottoman flags fluctuated on the walls. The defense at Blakhemai had collapsed		the naval azeb forces entered the city through the sea walk	29.05.1453 29.05.1453 29.05.1453		Kerkoporta Blakhemai	Ottoman Ottoman			Halil İnaloik Halil İnaloik	
Sultan 2. Mehmet Ulubati Hasan Janissaries Janissaries Janissaries		They climbed on the castle walls. Ottoman flags fluctuated on the walls. The defense at Blakhemai had collapsed		the naval aseb forces entered the city through the sea walk	29.05.1453 29.05.1453 29.05.1453		Kerkoporta Blakhemai Blakhemai	Ottoman Ottoman Byzantium Byzantium			Halil İnaloik Halil İnaloik Halil İnaloik	

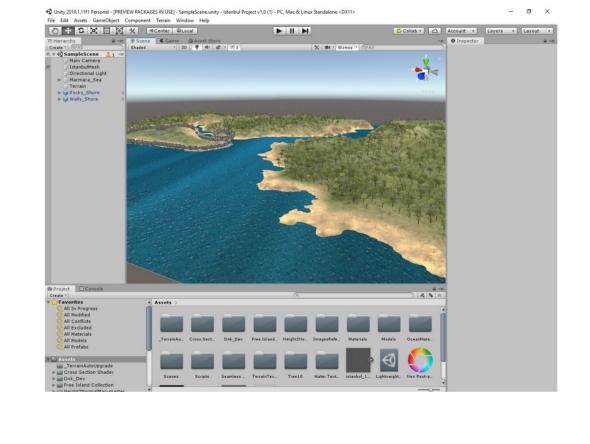
PostgreSQL



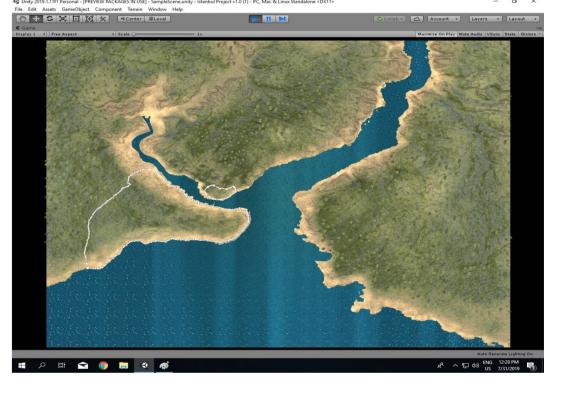
PostgreSQL is used as the SQL database for the project. The data gathered from the maps and texts are stored on Google Sheets as tables. The data written on the rows are sorted with respect to their original source. The columns comprising of the parameters such as actor, act, time and place determine the specific variants for each event that happened during the conquest.

The 2D projection of the data has been created on Carto map tool. Unique symbols mark the location names, landmarks and the actors that the event log refers to. The uncertainty in the event data is expressed by distinguished colouring and shaping methods so that the project visualizes the events by applying an objective perspective. Selections attached next to the map provide settings for specific timeline and source options. Selecting the sources and adjusting the time interval as desired enable comparisons between the events recorded on the sources and gives an insight about how "the Conquest" happened. In the creation of this map, the data recorded as the tables is combined with the historically approximate coordinates of the locations.

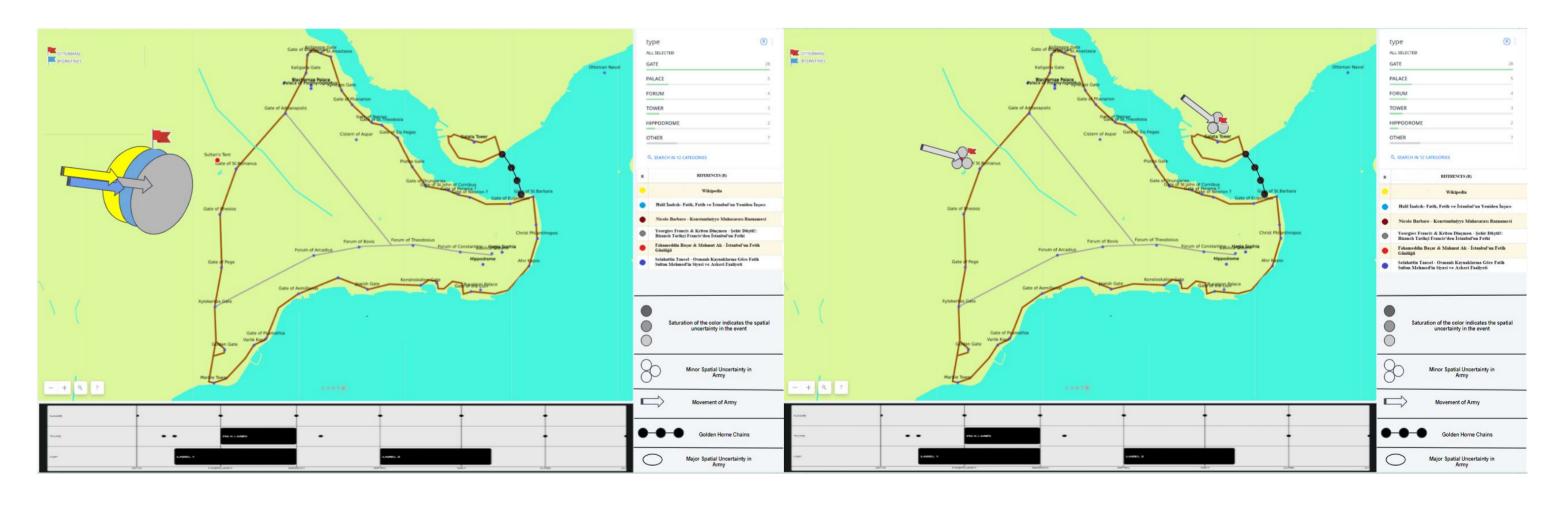




As a future plan, Unity is the modelling tool that will generate the 3D projection of the Fall of Constantinople.



Mock Up Screen



Two frames of the project, representing the events that is captured on the date of April 2 and demonstrating the spatial uncertainty utilizing distinguished shapes and colors with respect to the references.

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