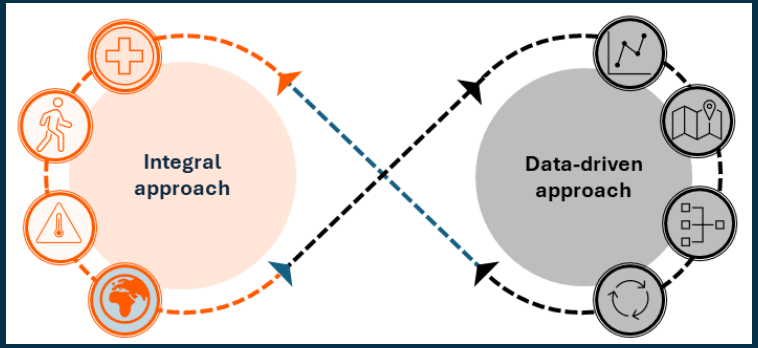
Urban Climatic Shelters to combat high temperatures

Identification and mapping of a network of shelters and comfortable routes

Nieves Peña, TECNALIA

METHODOLOGICAL APPROACH

- Identification and mapping of indoors and outdoors climate shelters, and comfortable routes,
  - **Holistic approach**: including health, mobility, accessibility, thermal comfort.
  - **Data-driven approach**: quantitative, geospatial, flexible, adaptable, transferable.



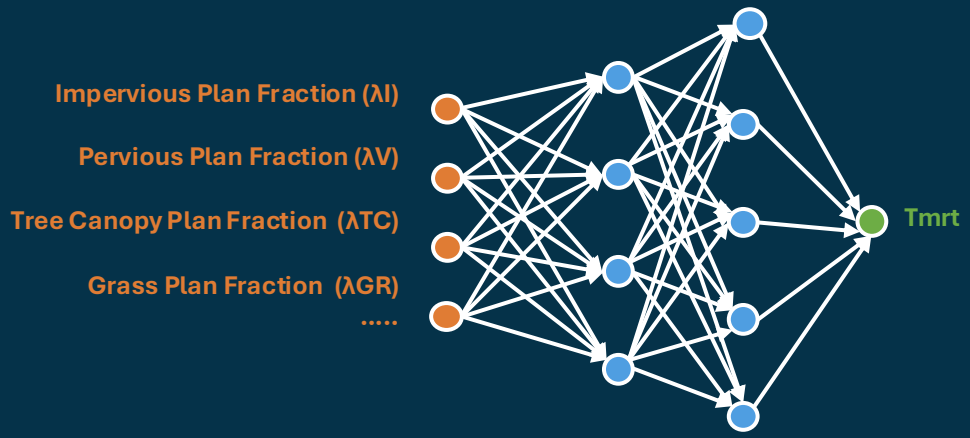
PHASE 1	PHASE 2	PHASE 3	PHASE 4	PHASE 5
Urban thermal mapping UTCI	Inventory of Existing Spaces and Facilities	Characterization and Evaluation of Climatic Shelters	Design of the Network of Shelters and routes	Identification and evaluation of new interventions
Based on a hybrid framework that integrates mesoscale modelling with	Collection of data (from local sources, EO, and open-source	Classify and characterize climatic shelters based	Identification of the criteria to ensure that citizens- especially	Determine where and how to introduce **new NbS interventions** to

ENGAGEMENT PROCESS -- INVOLVING MULTIPLE STAKEHOLDER GROUPS

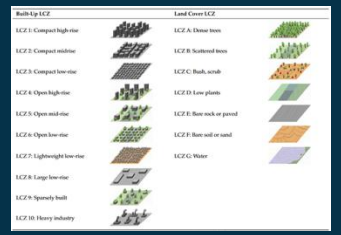
Municipal staff from different departments; **Managers of public spaces** such as school, sport centers; **Citizens** to validate their perceptions and validate needs

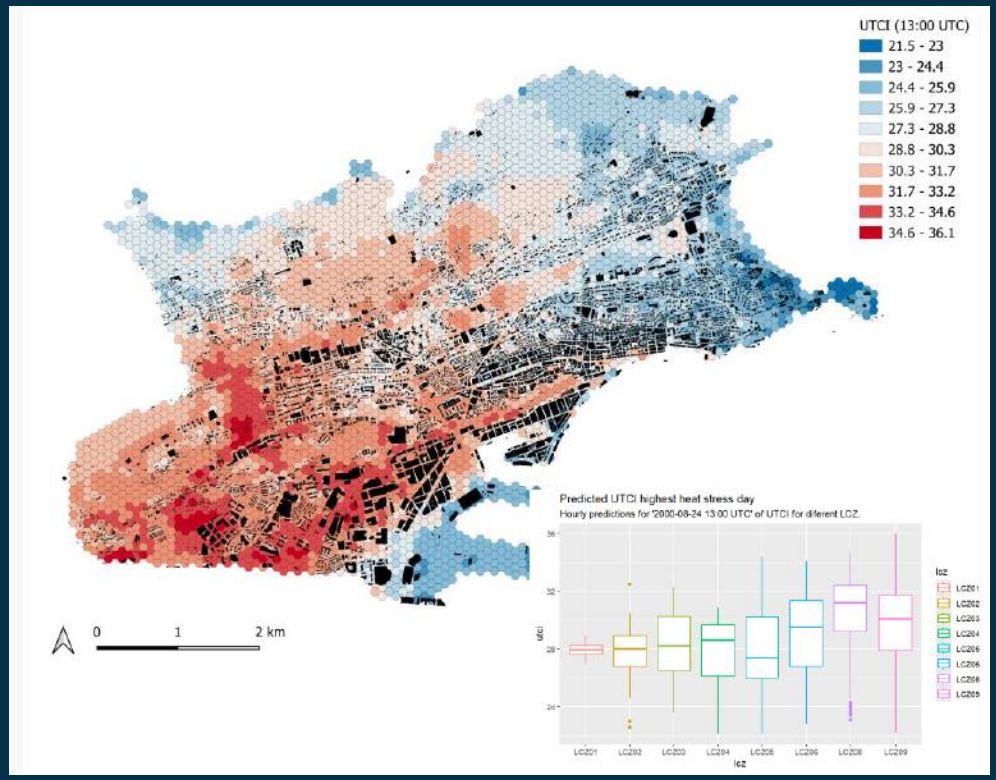
FASE I. URBAN THERMAL MAPPING

- Thermal comfort mapping based on a hybrid framework that integrates mesoscale modelling with an artificial intelligence (AI)-based emulator of Tmrt to efficiently produce high-resolution UTCI- maps.



Trained DNN MODEL





GEOSPACIAL INFORMATION
To calculate the urban parameters required by the AI model

Green infrastructure

DEM | DSM | CDSM | CORINE -landcover

URBAN MORPHOLOGY METRICS
Cell-level urban form descriptors derived from authoritative geospatial datasets

earth observation based urban morphology | 100 m

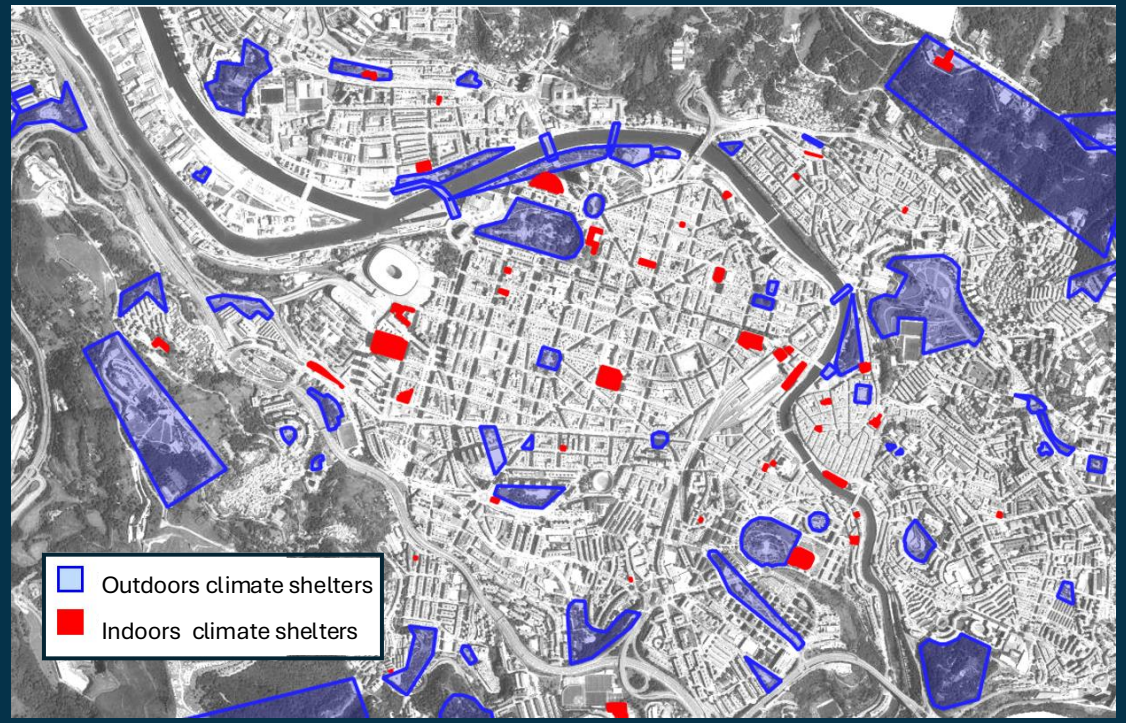
T4. CALCULATE HEAT STRESS
The Tmrt values are calculated for each cell for the 24 hours based on the **trained AI model** and the **UTCI distribution** based on of air temperature, relative humidity, wind speed, and Tmrt as inputs

Stewart, I. D., & Oke, T. R. (2012). Local Climate Zones for Urban Temperature Studies. Bulletin of the American Meteorological Society, 93(12), 1879–1900. https://doi.org/10.1175/BAMS-D-11-00019.1

FASE II. INVENTORY OF EXISTING SPACES AND FACILITIES

- Collection of data (local sources, Earth Observation, open-source datasets) to identify **potential spaces (indoor and outdoor)** that could be used or adapted to function as climatic shelters.

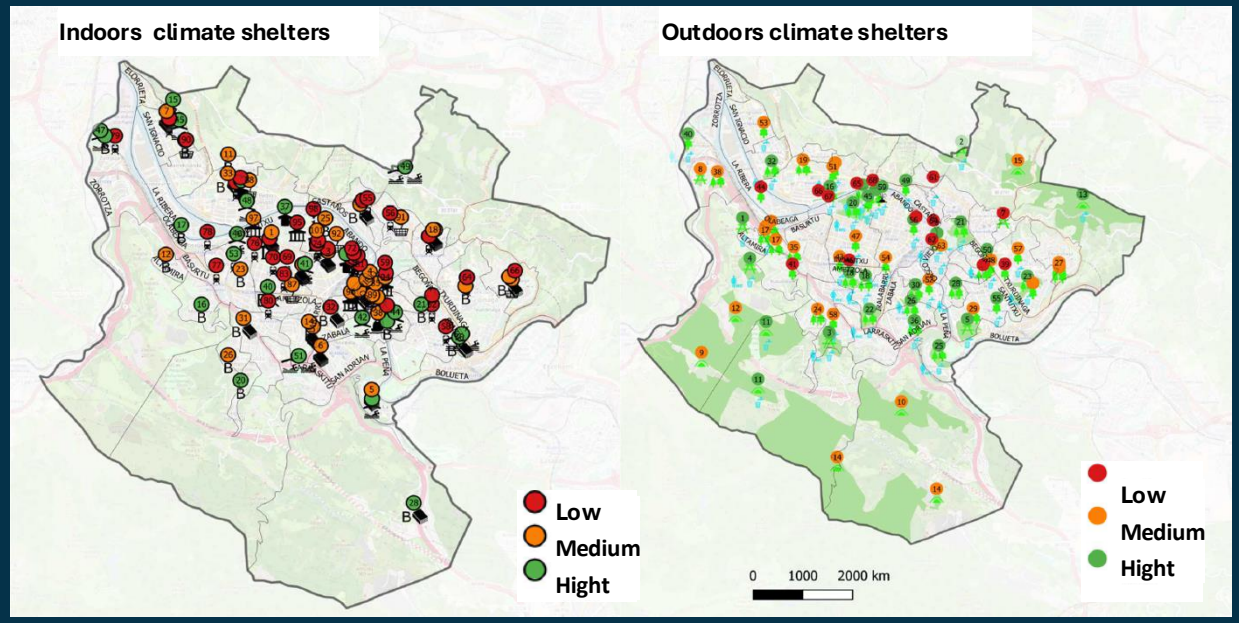
Type of Shelter	Data types	Possibles data sources
Indoors climate shelters	○ Map of Facilities ○ Map of Commercial Areas ○ Map of Municipal and Public Buildings ○ Essential Services	○ Catastral data ○ General Urban Development Plan ○ OpenStreet Map
Outdoors climate shelters	○ Map of public spaces ○ Map of natural areas ○ Maps of green spaces: NDVI, EVI ○ Environmental and spatial factors ○ Collaborative maps of perceived heat by citizens	○ Copernicus Land Monitoring Service ○ Sentinel2- Landsat 8 ○ OpenStreet Map



Mapping of shelters in Bilbao city

FASE III. CHARACTERIZATION AND EVALUATION OF CLIMATIC SHELTERS

- Classify and assess potential climatic shelters by applying a comprehensive set of criteria — such as ***location, accesability, green coverage, physical conditions, availability of essential services*** — to determine their suitability as climatic shelters.



Characterization of shelters Vitoria city

Criteria	Description	Score
Location	Address, proximity to population	
Timetable	Opening hours, seasonal schedules	
Accessibility	Transport, inclusive access	
Green Coverage	Tree cover, green cover (NDVI)	
Essential services	Drinking water, restrooms, etc	

FASE IV. DESIGN OF THE NETWORK OF SHELTERS AND COMFORTABLE ROUTES

tecnal:a
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

- This phase focuses on integrating the identified climatic shelters into a **coherent, functional urban network** and creating comfortable, thermally safer routes that connect them. The goal is to ensure that citizens—**especially vulnerable groups**—can move through the city and reach shelters safely during periods of extreme heat.

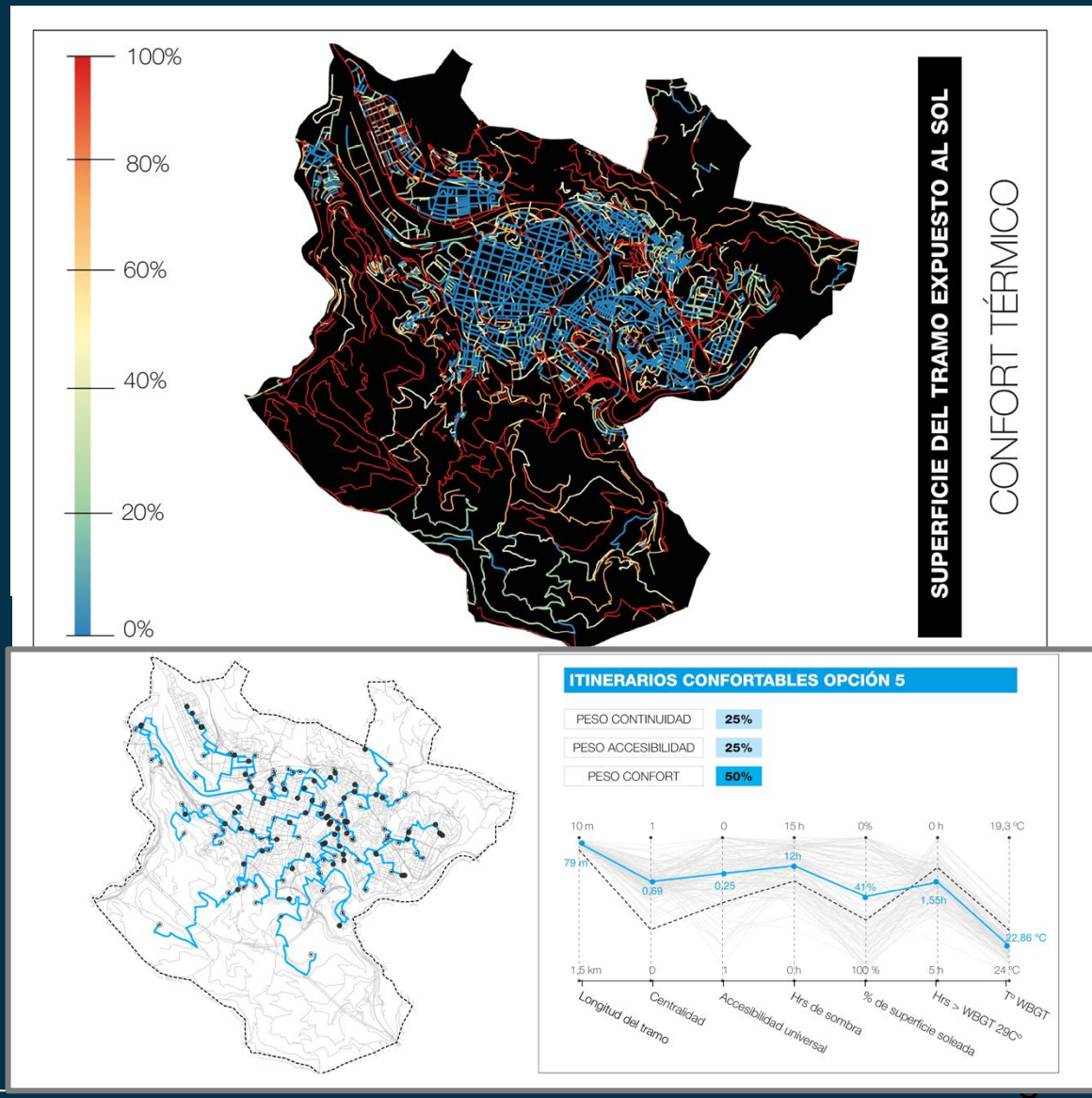
GEOSPACIAL INFORMATION
Needed to calculate the **thermal conditions**: SHADOW, UTCI index

DEM | DSM | CDSM

SOCIAL VULNERABILITY INFORMATION
To calculate the social, economic, demographic, or conditions affecting vulnerability index

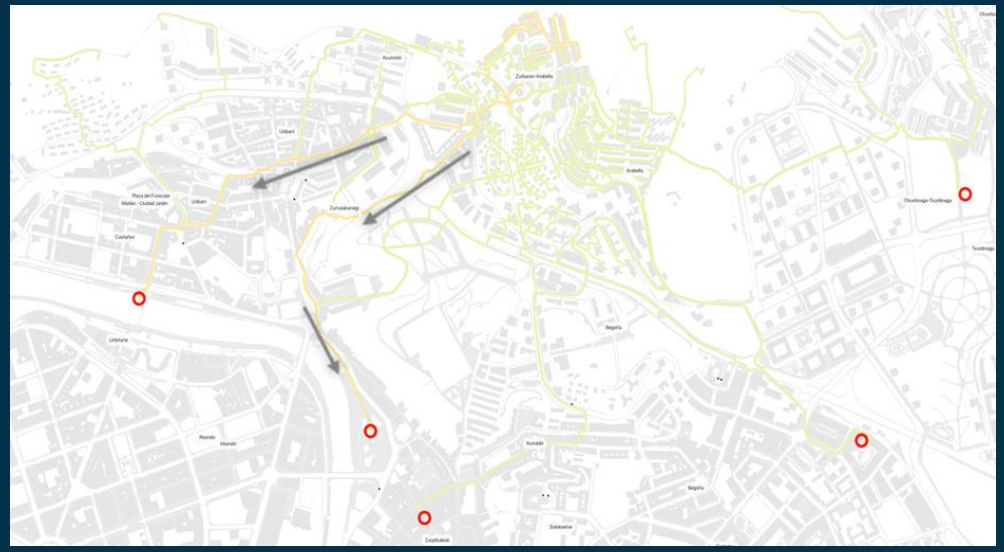
Socio-demographic | Accessibility and Mobility | Soci-economic | Environmental and spatial factors

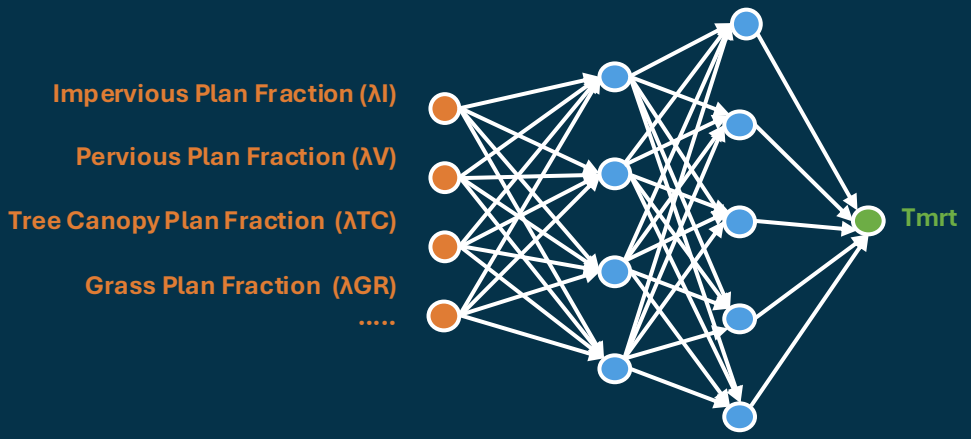
Different **layers** and **weights** are considered to prioritize the different routes



FASE V. DESING OF NEW INTERVENTIONS TO STRENGTHEN SHELTER CONNECTIVITY (OPTIONAL)

- The goal is to determine **where and how** to introduce **new NbS interventions** to fill gaps in the network, to **enhance pedestrian comfort** between shelters during extreme heat events.
    - Identification of priority areas (hotspots)
    - Identification of Appropriate Nature-Based Solutions (Urban trees, green infrastructure, etc.)
    - Evaluation of its Impact





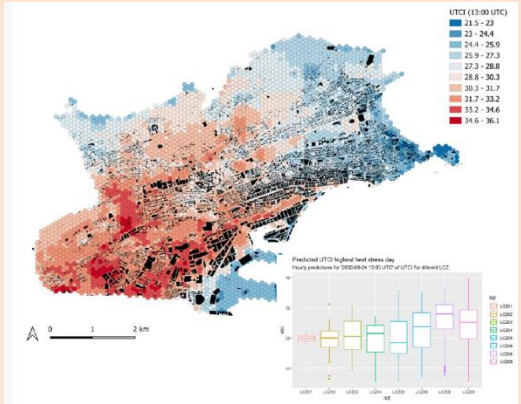
Trained DNN MODEL

Practical cases

- Tecnalia has developed this methodological approach based on the exercises done in several cities

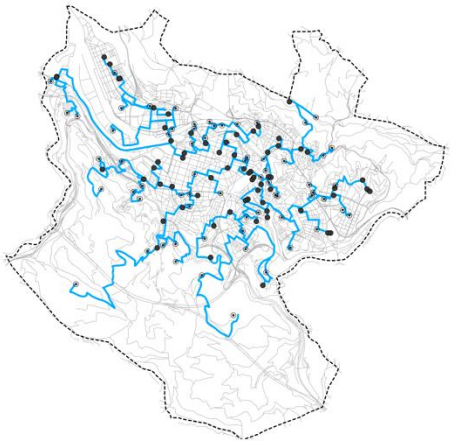
SANTANDER

- Data used
- Activities carried out
- Results of the process



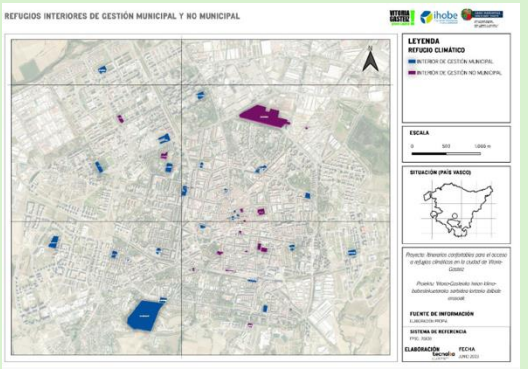
BILBAO

- Data used
- Activities carried out
- Results of the process



VITORIA-GASTEIZ

- Data used
- Activities carried out
- Results of the process



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