Human Digital Twin: The developer viewpoint

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COMFORTage
Prediction, monitoring and personalized recommendations for prevention and relief of dementia and frailty

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OVERVIEW

Digital Twins technology definition

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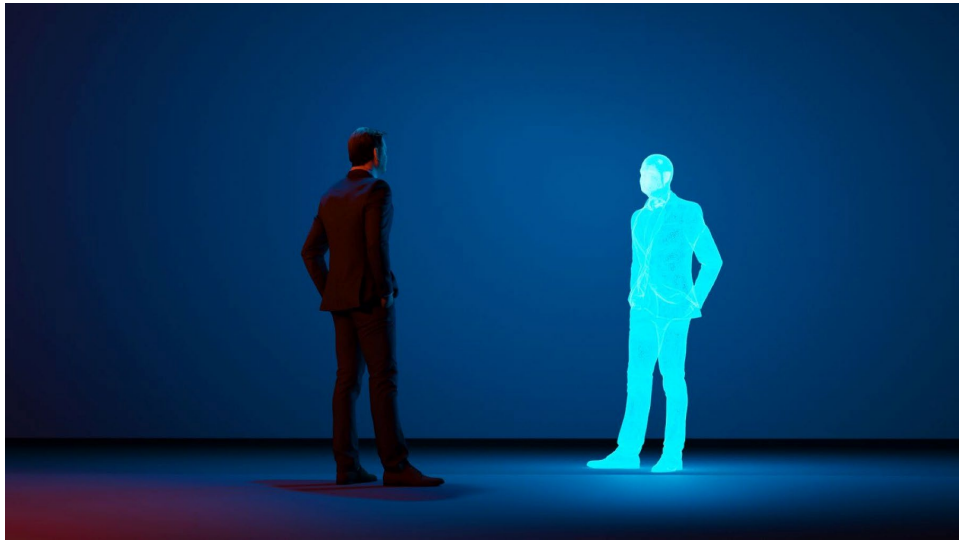
"A human digital twin is a highly detailed virtual model of an individual, designed to mirror their physical and physiological characteristics."

1. Data Aggregation and Integration
2. Advanced Modeling and Simulation
3. Artificial Intelligence and Machine Learning
4. Real-Time Data Processing
5. Visualization Tools

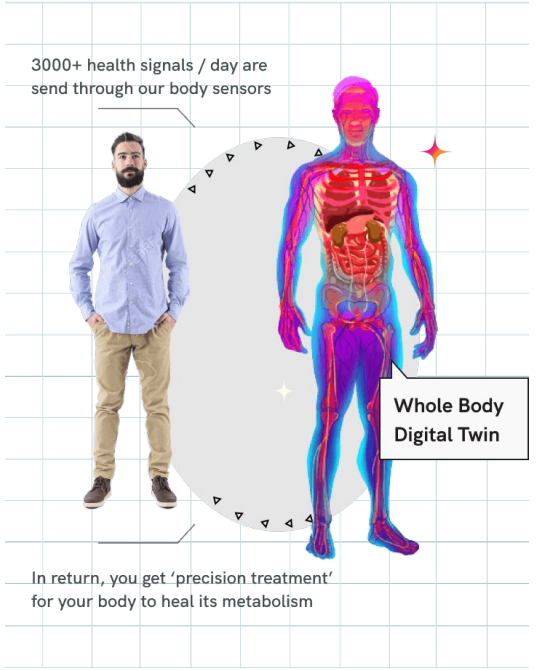


https://www.ecoticias.com/en/digital-twin-ai-intervention/5800/

Popular Digital Twins

Twin Health's whole body Digital Twin:

- ❑ Nutrition
- ❑ Breathing
- ❑ Activity
- ❑ Sleep

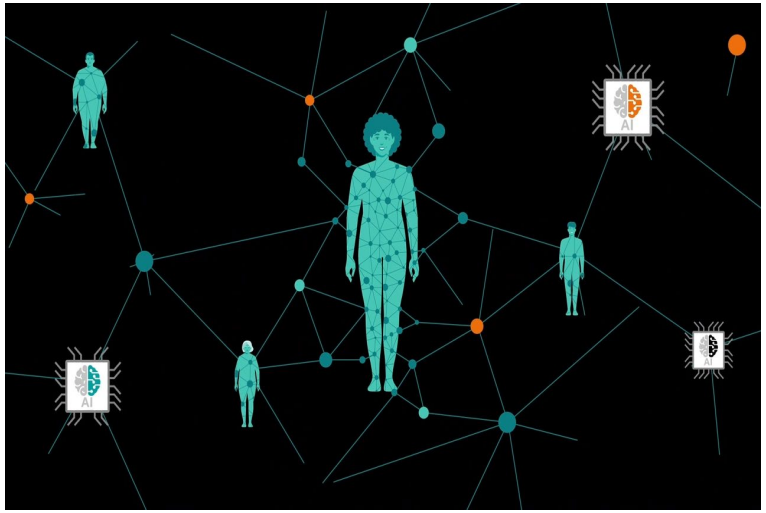


European Virtual Human Twins

- ❑ Personalized care
- ❑ Fundamental AI models
- ❑ Health Data space

Siemens Healthineers Digital Twin

- ❑ Real World
- ❑ Test most impactful changes
- ❑ Implement findings



https://ind.twinhealth.com/app/navigation/twin-works/
https://www.siemens-healthineers.com/gr/services/value-partnerships/asset-center/white-papers-articles/value-of-digital-twin-technology

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How to develop a Person Digital Twin?

Person Digital Twin WORKFLOW

1. Define Objectives and Scope

2. Data Acquisition and Integration
3. Modelling and simulation
4. AI and ML
5. Real-time Data Processing
6. Visualization and User Interface
7. Validation and Testing
8. Ethical and Legal
9. Infrastructure and Technical Requirements

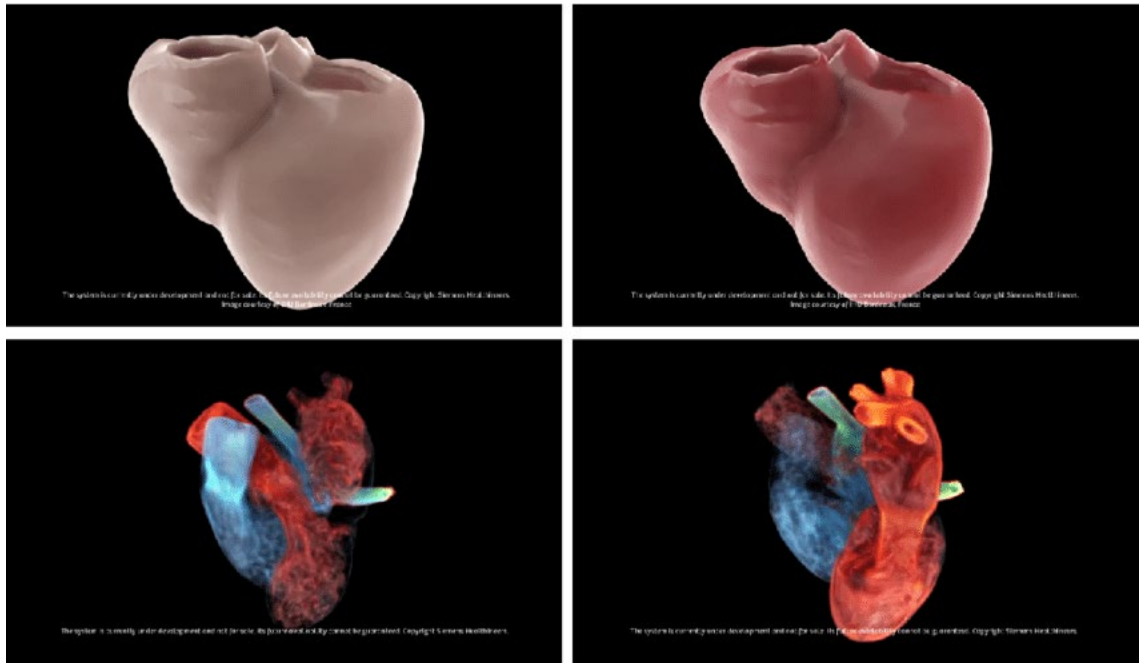
Define Objectives and Scope:

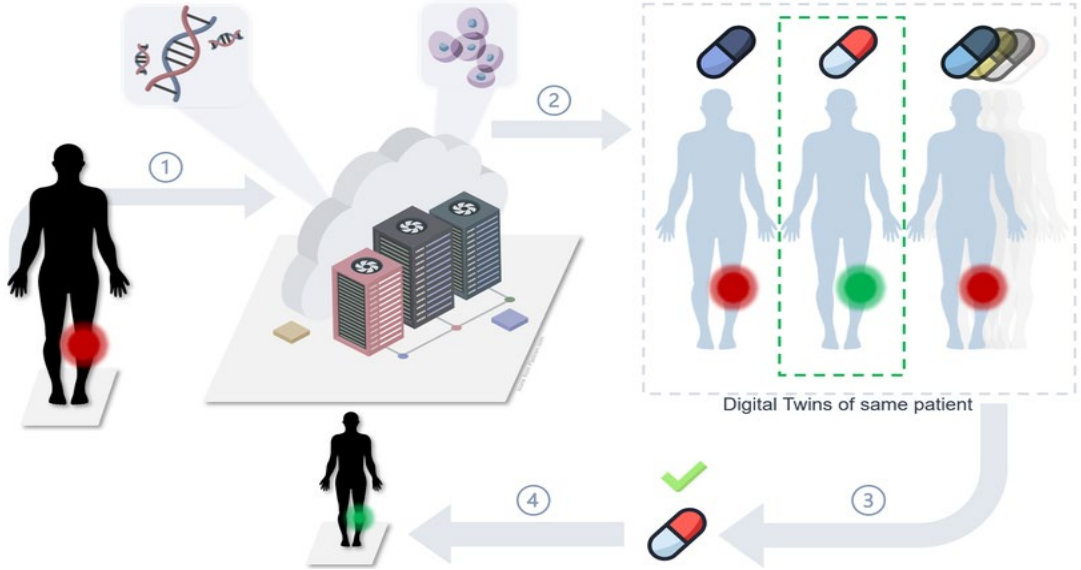
Purpose identification:

- ❑ Personalized medicine
- ❑ Predictive diagnostics
- ❑ Treatment planning
- ❑ Medical device testing

Scope limitation:

- ❑ Whole body
- ❑ Specific organ
- ❑ Specific system





Knebel, Francisco. (2020). An open Digital Twin framework based on microservices in the cloud.
De Benedictis, Alessandra & Mazzocca, Nicola & Somma, Alessandra & Strigaro, Carmine. (2022). Digital Twins in Healthcare: An Architectural Proposal and Its Application in a Social Distancing Case Study. IEEE Journal of Biomedical and Health Informatics. PP. 1-12. 10.1109/JBHI.2022.3205506.

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Data Acquisition and Integration

Data sources:

- Medical imaging: MRI, CT scans etc.
- Electronic Health Records (EHRs): Patient history, lab results, clinical notes.
- Wearable devices and IoT sensors: Real-time physiological data like heart rate, blood pressure, and activity levels.
- Genomic and proteomic data: Genetic makeup and protein expressions.

Data Integration:

- Interoperability standards: Use HL7 FHIR or DICOM standards for seamless data exchange.
- Data fusion techniques: Combine heterogeneous data sources into a cohesive dataset.

Data Privacy and Security:

- Regulatory compliance: Adhere to EU DATA, GDPR, and other relevant regulations.
- Encryption and anonymization: Protect sensitive information through advanced security measures.

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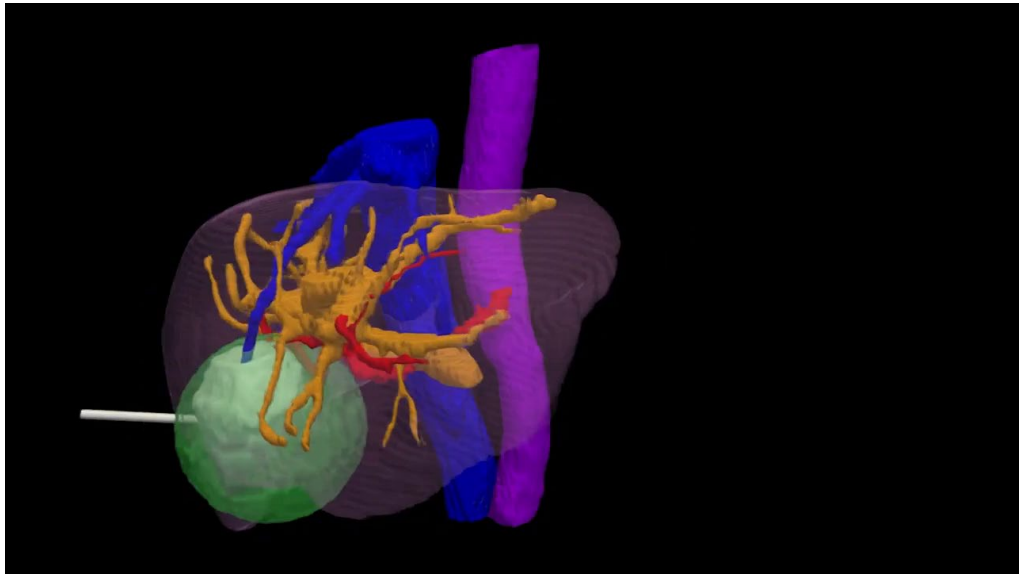
Modelling and simulation



Anatomical modelling:

- 3D Reconstruction
- Mesh generation

Physiological modelling:

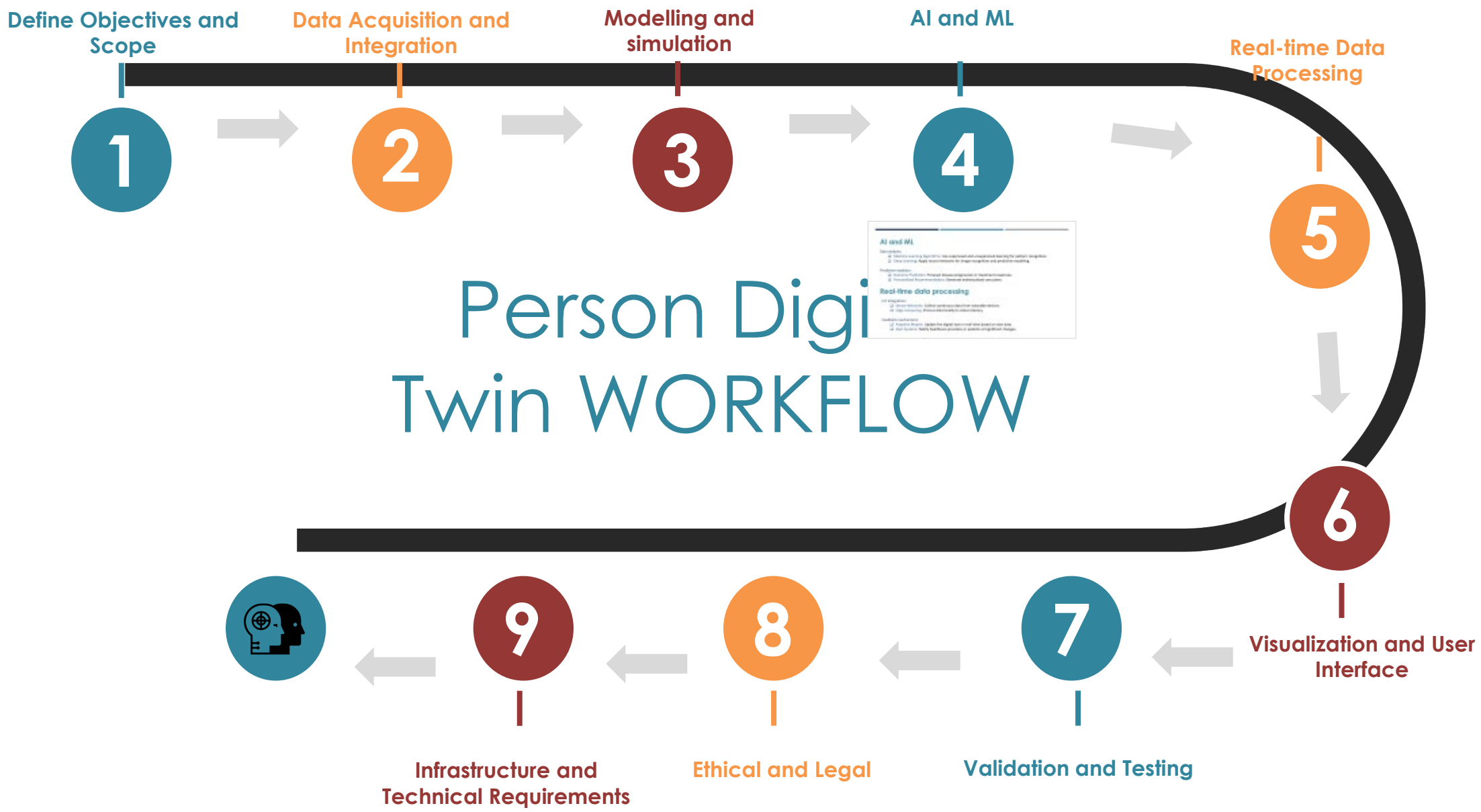
- Mathematical models
- Multiscale modelling

Software tools:

- Simulations platforms: Utilize tools like ANSYS, Simulia (by Dassault Systèmes), or open-source platforms like Unity.
- Programming languages: Python, MATLAB, or C++ for custom model development.

https://www.youtube.com/watch?v=x_sZWFWYOR4&ab_channel=SiemensHealthineers

Person Digi Twin WORKFLOW



AI and ML

Data analysis:

- Machine Learning Algorithms: Use supervised and unsupervised learning for pattern recognition.
- Deep Learning: Apply neural networks for image recognition and predictive modeling.

Predictive analytics:

- Outcome Prediction: Forecast disease progression or treatment responses.
- Personalized Recommendations: Generate individualized care plans.

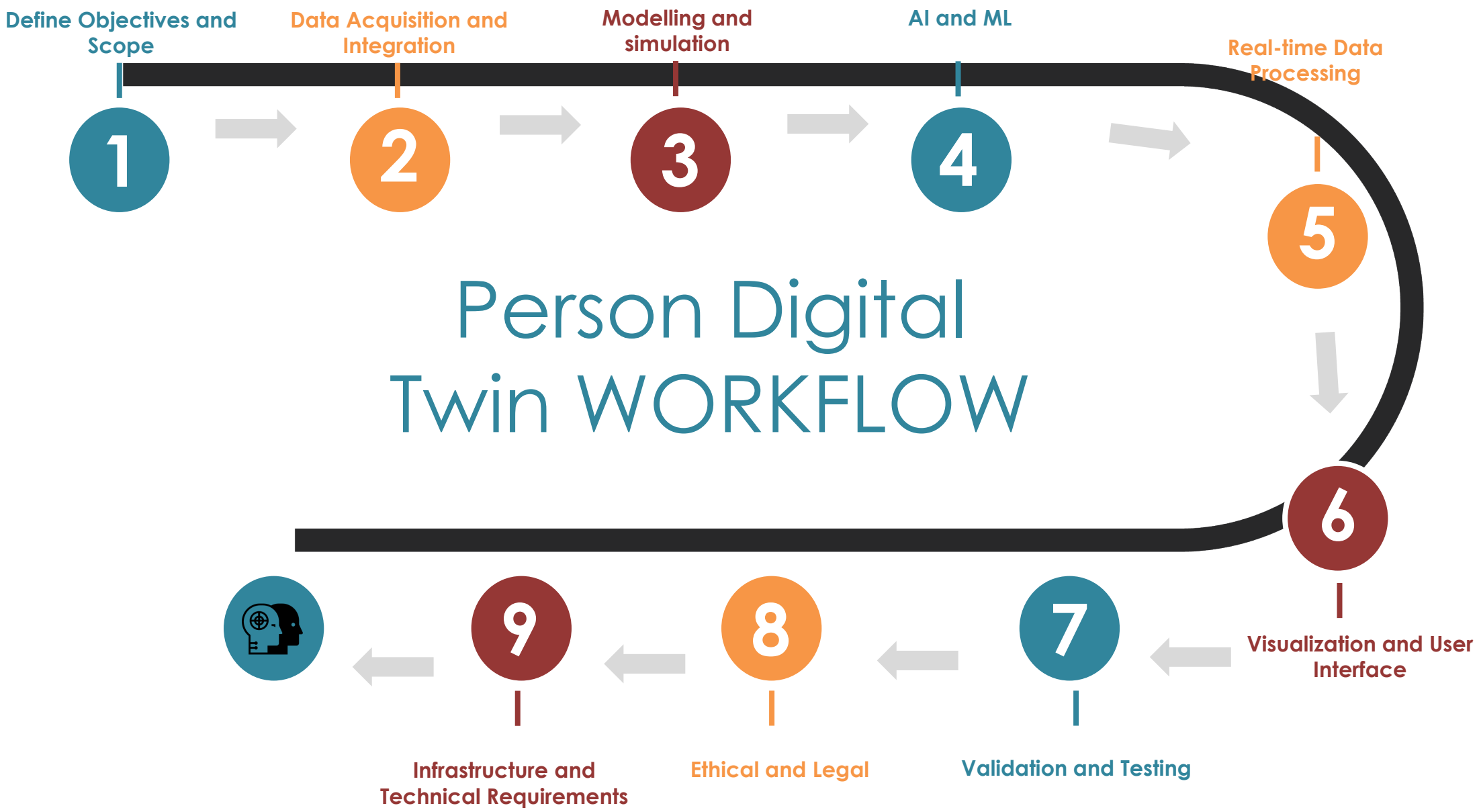
Real-time data processing

IoT integration:

- Sensor Networks: Collect continuous data from wearable devices.
- Edge computing: Process data locally to reduce latency.

Feedback mechanisms:

- Adaptive Models: Update the digital twin in real-time based on new data.
- Alert Systems: Notify healthcare providers or patients of significant changes.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Prediction, monitoring and personalized recomendations
for prevention and relief of dementia and frailty

People suffering from cognitive decline Digital Twin?

Funded by the European Union
NextGenerationEU

COMFORTAGE EU Project overview

COMFORTage strives to establish a pan-European framework for community-based prevention and intervention strategies to facilitate effective lifestyle changes thought the synergies of our Consortium and other stakeholders. Our consortium is compose by:

- 8 Research Institutions/Universities
- 11 Healthcare Organizations & Actors
- 12 Industry and SME partners
- 4 Social Multipliers and Associations
- 4 SSH and Legal Organizations

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Prediction, monitoring and personalized recomendations for prevention and relief of dementia and frailty

COMFORTAGE Digital Twin for personalized dementia care

Purpose identification → Early Diagnosis, Disease progression, Treatment personalization

Data Sources → Neuroimaging data, Cognitive assessments, EHRs, Biomarkers, IoT

Modelling and simulation → Disease progression, Health trajectory, Optimal treatment planning, Cognitive simulation

Visualization and UI → Visual analytics, tools for clinicians, caregivers and individuals, COMFORTAGE VHP platform

Validation and testing → 13 Pilots of distinct scope

Ethical framework → Anonymization, HHRs, Encryption

Digital Twin and Intervention planning

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Thank you for your attention…

Stylianos Kokkas, s.kokkas@iti.gr

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