

# Hip Fracture Patient Pathways and Agent-based Modelling



Alison O'Connor  
*Co-PI*



Damien Ryan  
*Clinical Director  
Emergency Care*



Gauri Vaidya  
*Computational Scientist*



Stephen Ryan  
*Data Scientist*



Paul Harford  
*Analyst*



Meghana Kshirsagar  
*PI*



Fergal Cummings  
*Consultant*



Carrie Garavan  
*ALERT Co-ordinator*





Alison O'Connor  
*Co-PI*



2009

Advanced Materials  
Aeronautical Engineering





Alison O'Connor  
*Co-PI*



European Space Agency  
2010



2009

Advanced Materials  
Aeronautical Engineering





Alison O'Connor  
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European Space Agency  
2010



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Aeronautical Engineering



2011

Industry Consultant





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European Space Agency  
2010



Imperial College London  
2015



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2011

Industry Consultant





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2011

Industry Consultant



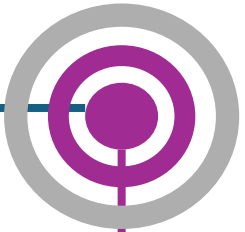
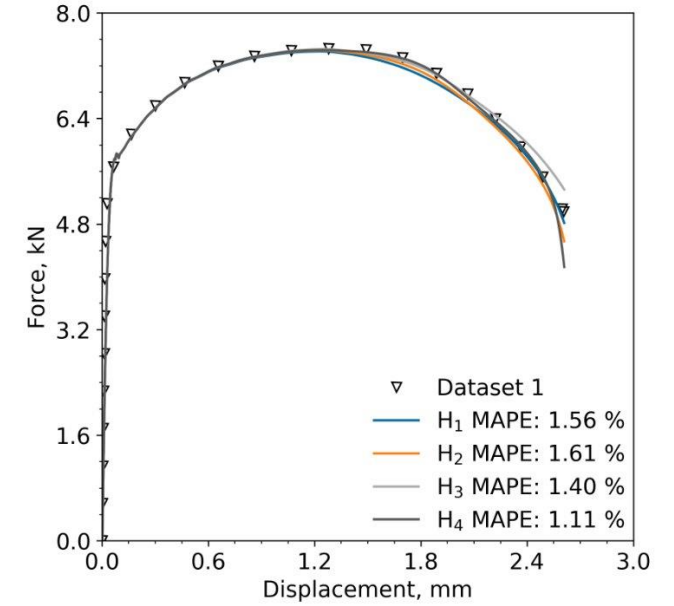
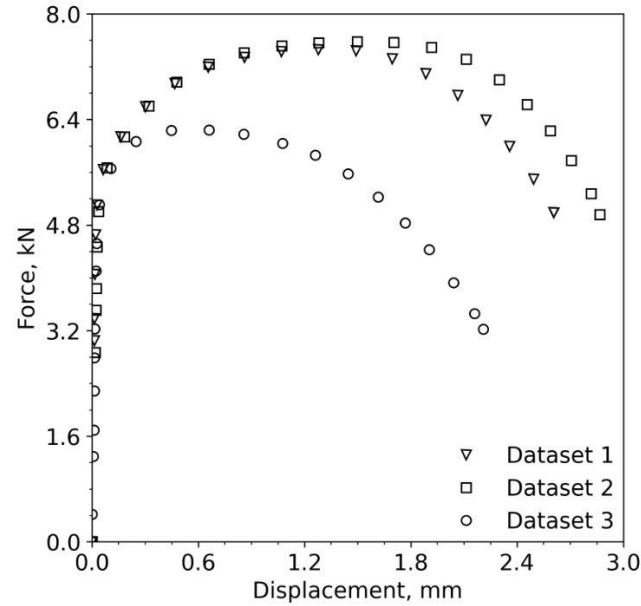
2021

Marie Skłodowska-Curie  
Actions



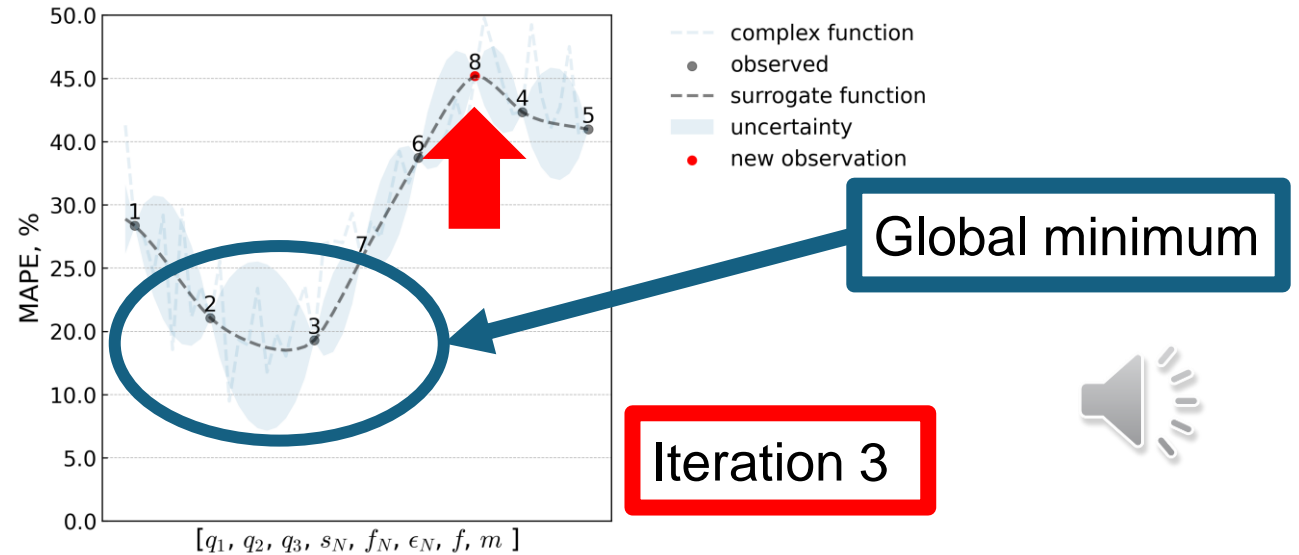


Alison O'Connor  
Co-PI



2021

Marie Skłodowska-Curie Actions





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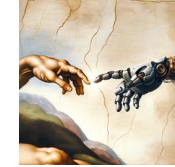
Alison O'Connor  
Co-PI



European Space Agency  
2010



Imperial College London  
2015



Computer Science  
2023



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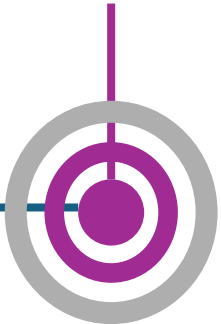




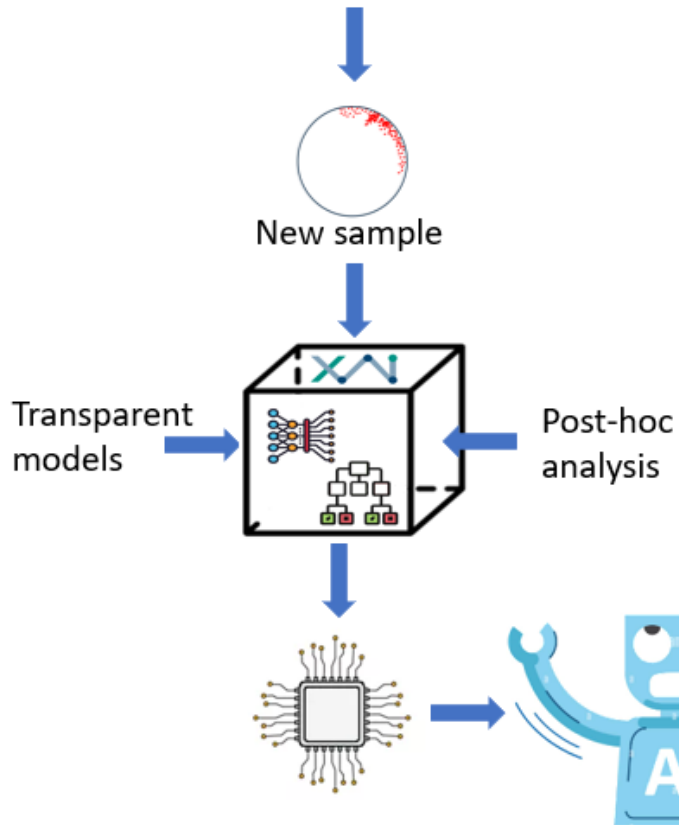
Alison O'Connor  
Co-PI



Computer Science  
2023



## Explainable Artificial Intelligence (XAI)



New sample is classified as 'Damage II' with  $x\%$  certainty based on these contributing features:

The damaged region exceeds  $\gamma\%$  of the surface area this sample is deemed **unacceptable**.

My robot lets me know **how and why** decisions are selected!

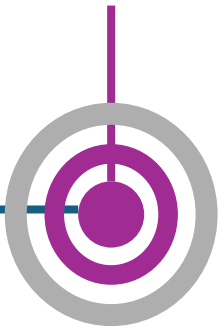




Alison O'Connor  
Co-PI



Computer Science  
2023



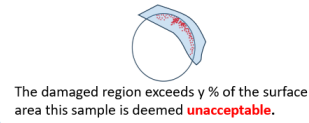
05/11/2024



Explainable Artificial Intelligence (XAI)



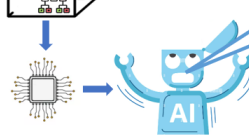
New sample is classified as 'Damage II' with x % certainty based on these contributing features:



The damaged region exceeds y % of the surface area this sample is deemed unacceptable.

Transparent models

Post-hoc analysis



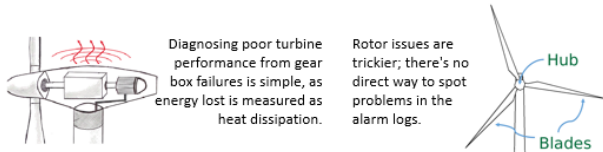
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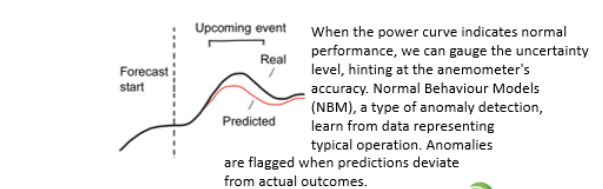
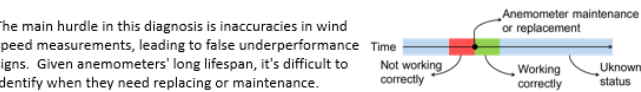
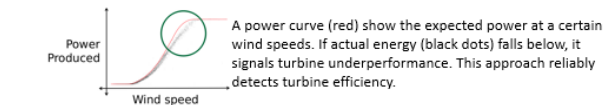
# Biocomputing and Developmental Systems (BDS) Group

[bds.ul.ie](http://bds.ul.ie)

## Wind Turbine Rotor Side Underperformance Through Power Curve Analysis



This research will develop a data-driven AI model to identify failures in rotor-side components of wind turbines after diagnosing underperformance.



HealthInfo24, [alison.oconnor@ul.ie](mailto:alison.oconnor@ul.ie)

## Automatic Design of Digital Circuits

Design Specification → Grammar → Grammatical Evolution (GE) → Synthesizable HDL Code

Architecture Description → IO Description → Use Machine Learning to automatically design digital circuits from high level descriptions.

Face-and-Route (PhR) → Gatelevel Netlist → Logic Synthesis → Backend design of the IC

Functional Verification (Field Programmable Gate Array)

Fabricated IC using TSMC 65nm technology.

(intel) sfi Fondúireacht Eolaíochta Éireann / Science Foundation Ireland

## WACT

WIRELESS AUTOMATIC COMPILER TUNING

Improve Wireless software performance by identifying optimal compilation options

Treat compiler flag optimisation as a machine-learning problem in software engineering

Source Code → LLVM Compiler → Code Binaries → Execute/Analyze/Instrument/Measure

Search Engine: Genetic Algorithms, Reinforcement Learning, Deep Learning, Bayesian Optimisation

Performance Measurements (CPU cycles, Cache misses, etc.)

Profiling and generating heatmaps, Minimize measurement bias, Coverage analysis



Alison O'Connor  
Co-PI



European Space Agency  
2010



Imperial College London  
2015



Computer Science  
2023



2009

Advanced Materials  
Aeronautical Engineering



2011

Industry Consultant



2021

Marie Skłodowska-Curie  
Actions



2023

National  
Challenge  
Fund



## Donnelly: 'Children waiting for spinal surgeries have been failed by their own country'

Donnelly told The Journal that he still has not been given a “satisfactory answer” as to why waiting lists have not come down.

### Irish children on long scoliosis surgery lists given overseas lifeline



### Father-of-three dies from suspected asthma attack during two hour ambulance wait

Ian McCarthy's death is one of a number of fatalities raised by National Ambulance Service staff who have serious concerns about its emergency response system, Noteworthy can reveal.



## More than 7,000 people taken off UHL patient waiting lists did not get treatment there

By **Bernie English** - January 18, 2024

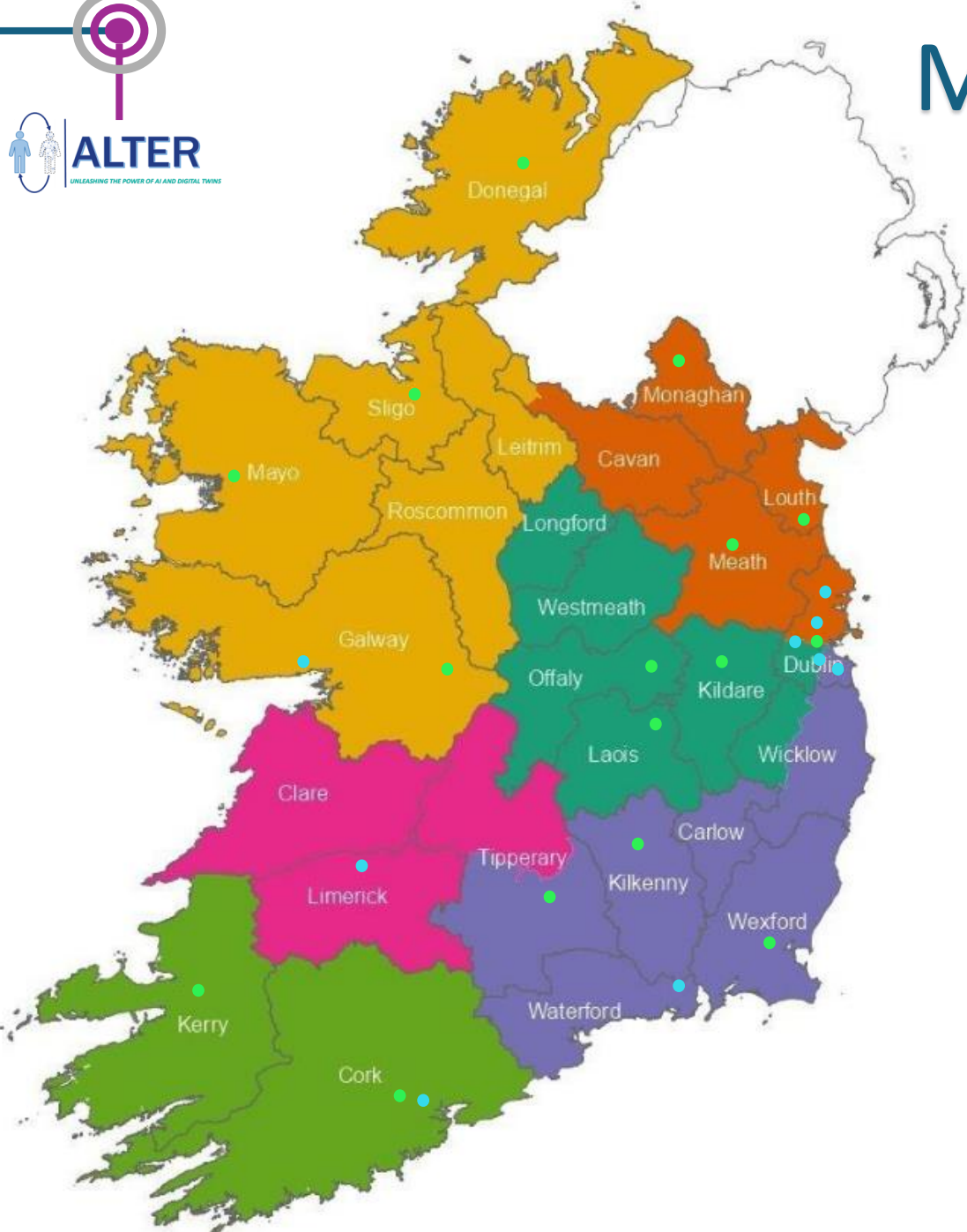


University Hospital Limerick



# Motivation

- Model 4 hospital
- Model 3 hospital



Region	Population	No. facilities
West and North West	778, 873	4
Dublin and North East	851,633	5
Dublin and Midlands	1,372,775	5
Dublin and South East	983,820	4
Midwest	421,421	1
South West	740, 614	3





Offaly

Laois

Clare

Tipperary

Limerick

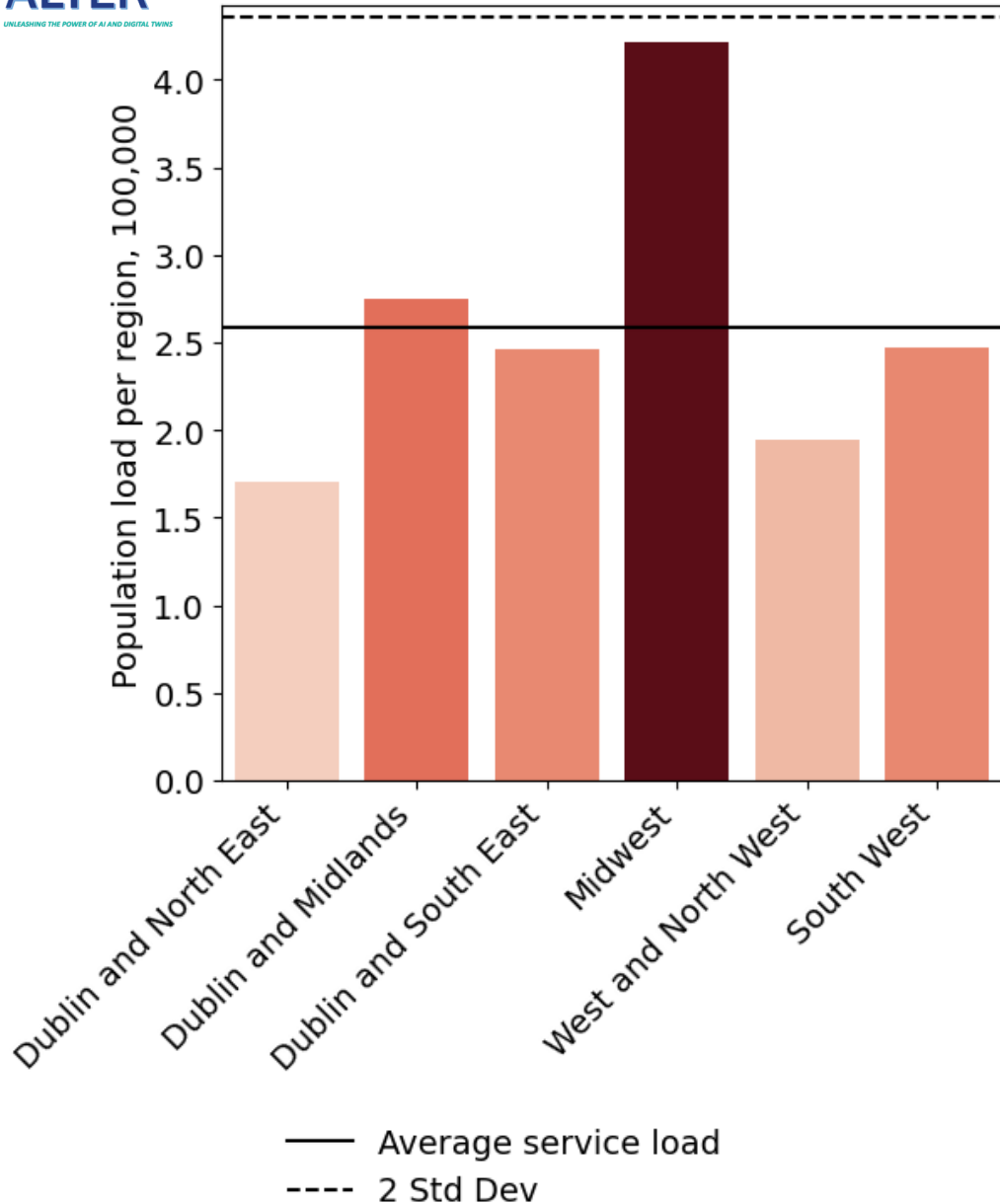
Kilkenny

Kerry

Waterford



# Motivation

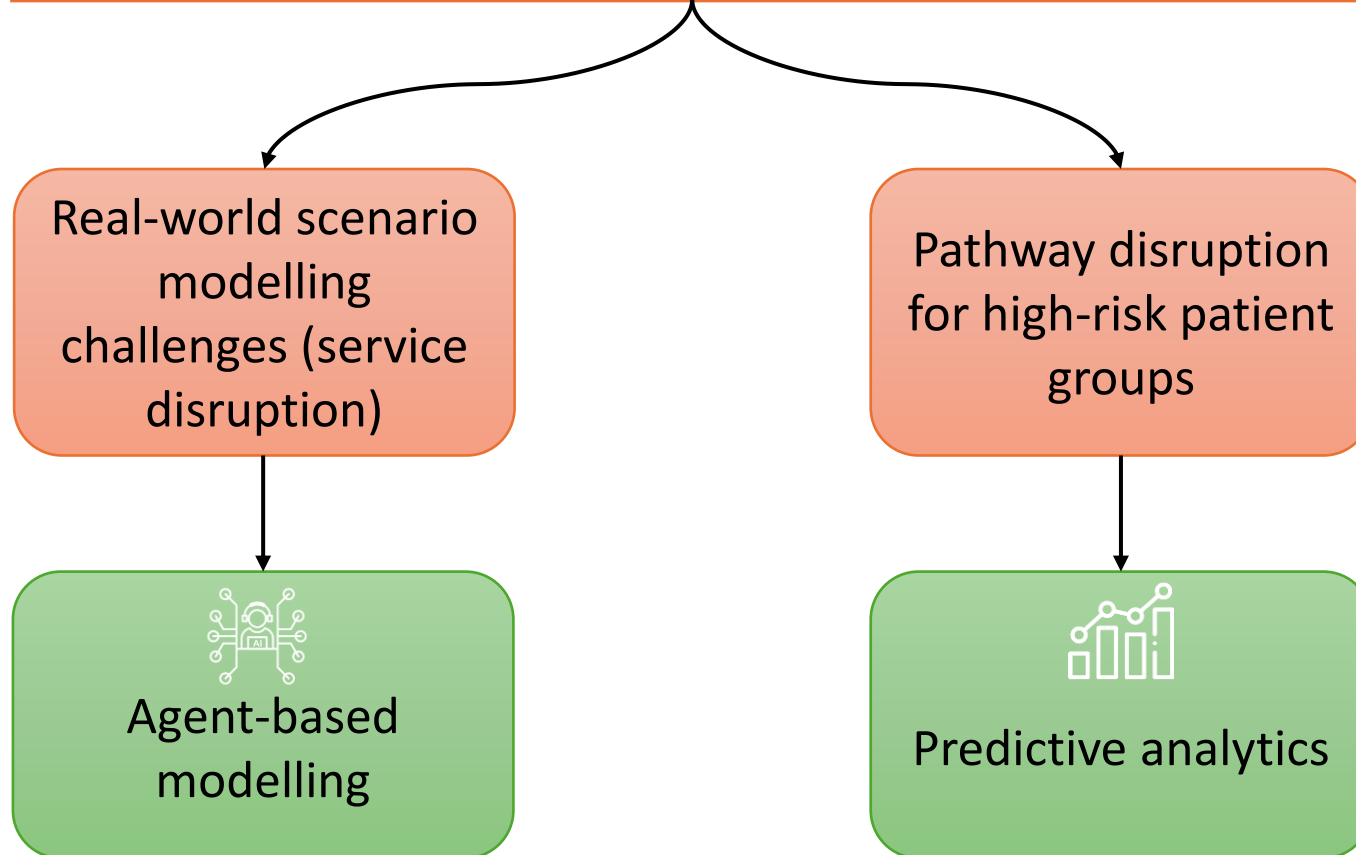


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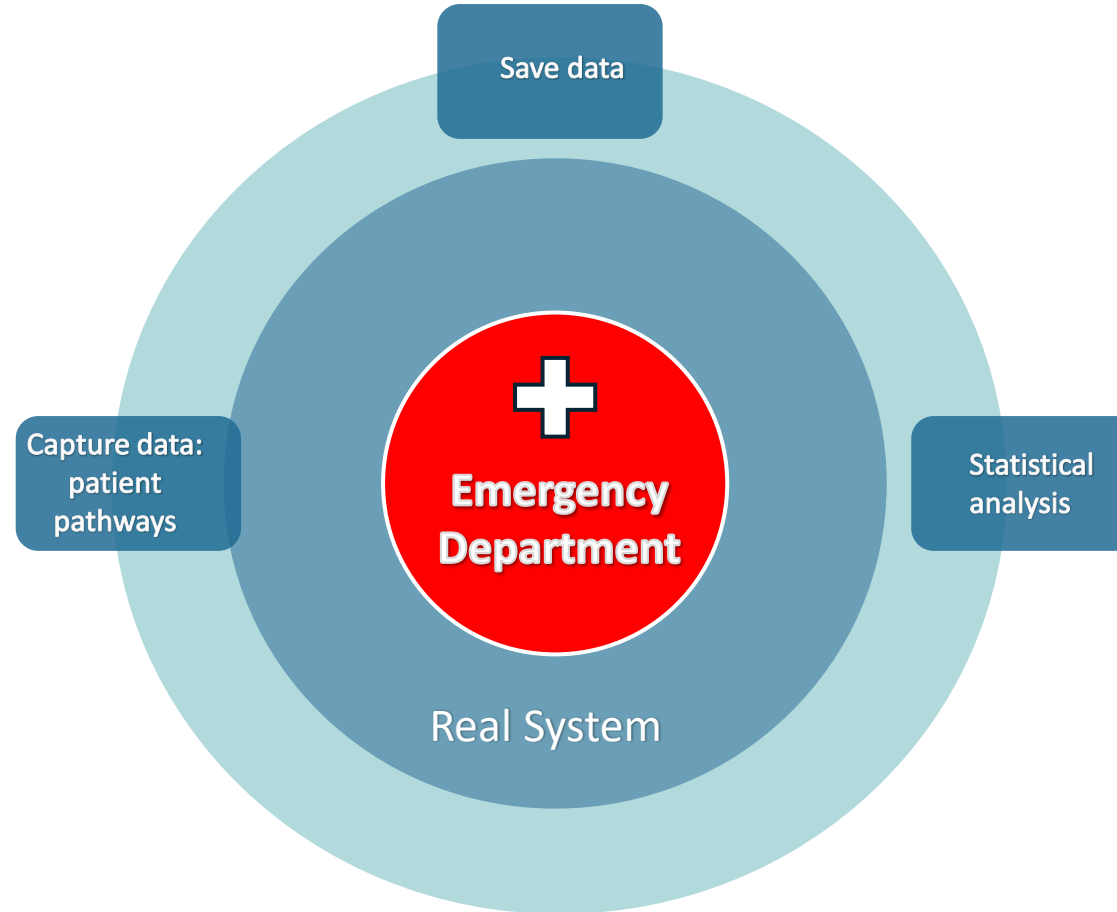




# Stakeholder Engagement



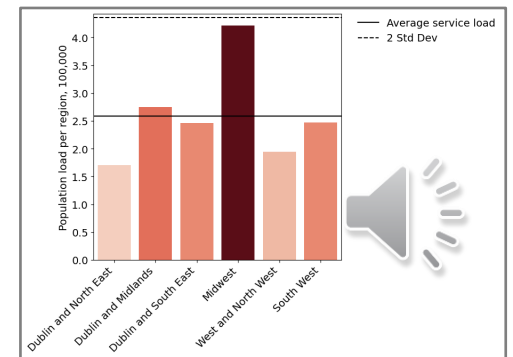
# Proposal



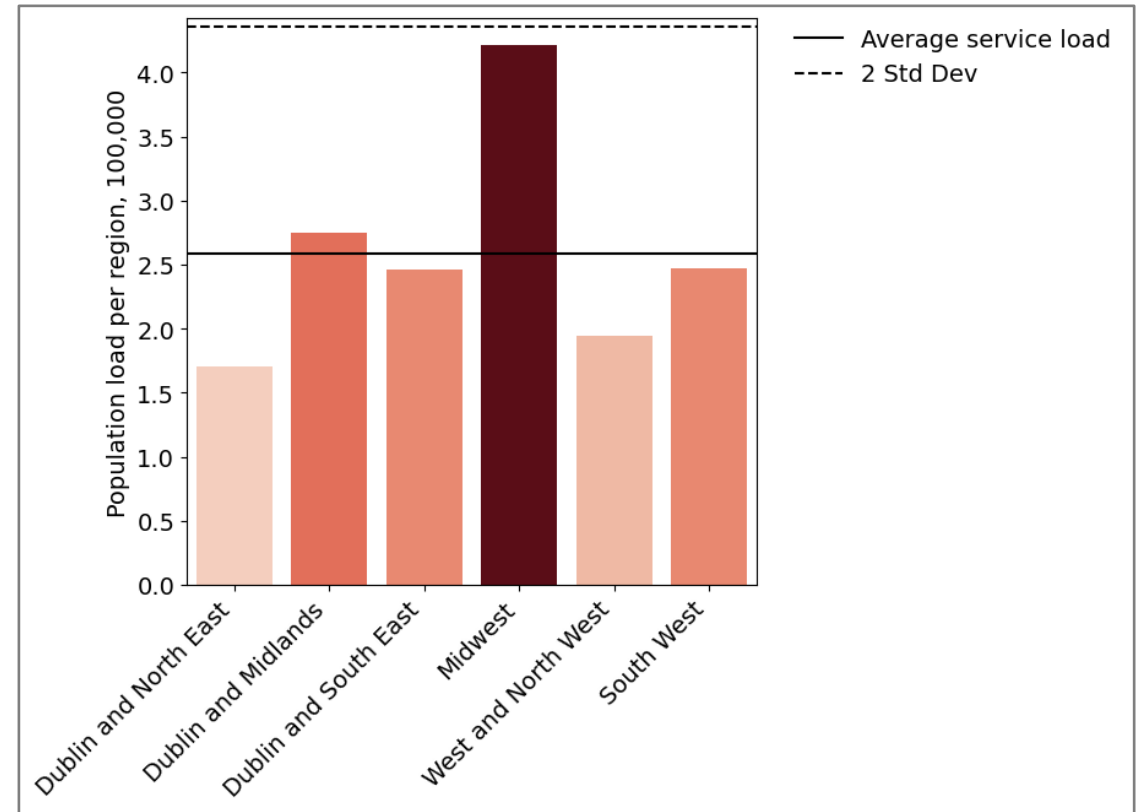
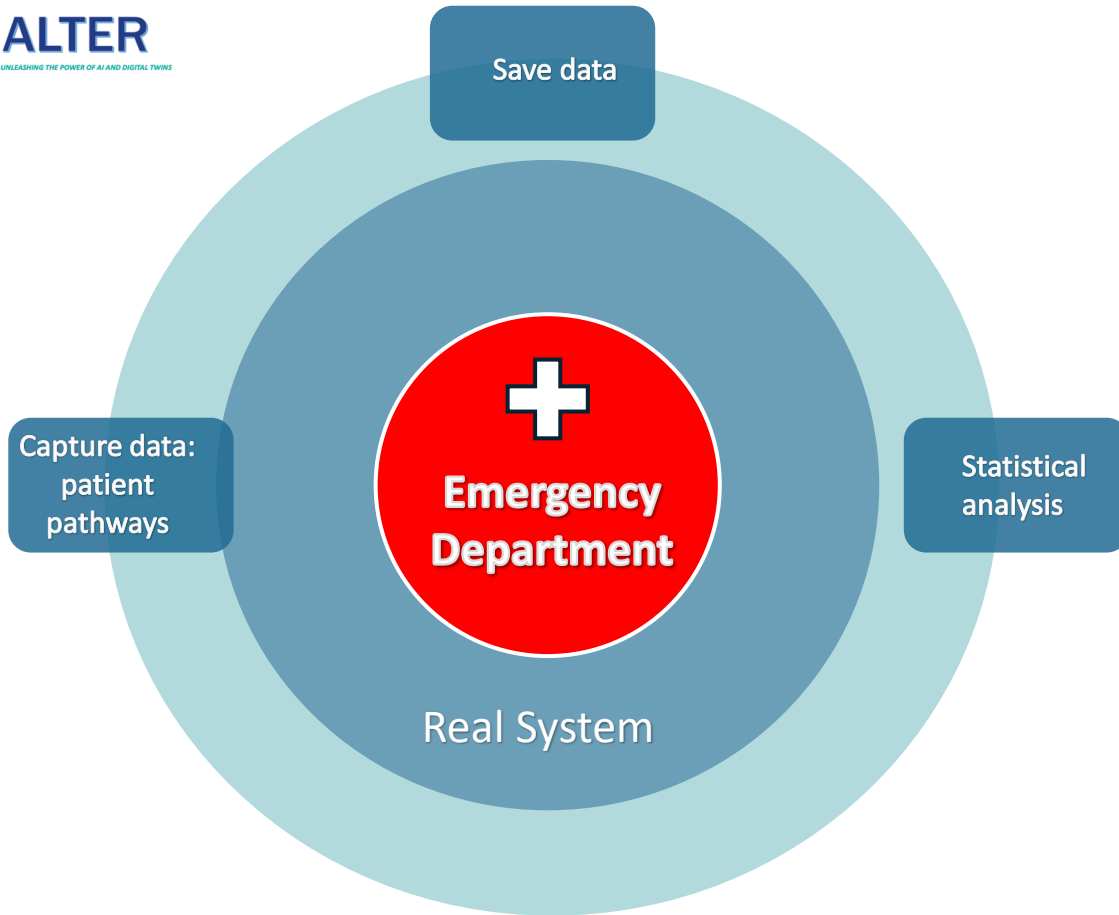
## Donnelly: 'Children waiting for spinal surgeries have been failed by their own country'

Donnelly told The Journal that he still has not been given a "satisfactory answer" as to why waiting lists have not come down.

## More than 7,000 people taken off UHL patient waiting lists did not get treatment there



# Proposal



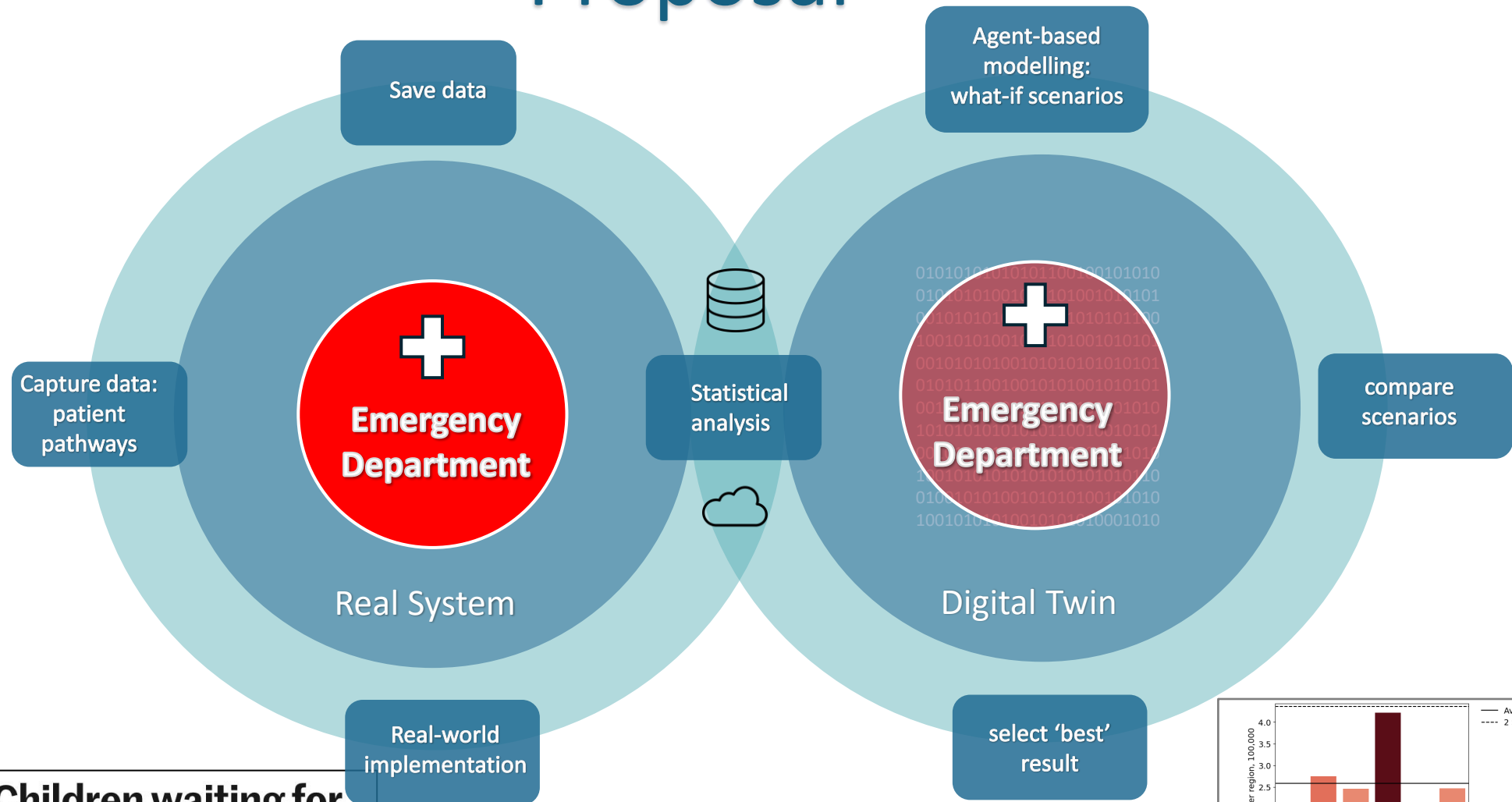
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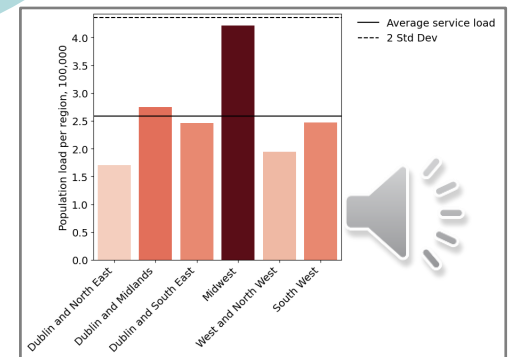
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# Collaboration



Alison O'Connor  
*Co-PI*



Damien Ryan  
*Societal Impact Champion*



Fergal Cummings  
*Consultant*



Venkatesh Kannan  
*Process Mining Engineer*



Gauri Vaidya  
*Computational Scientist*



Stephen Ryan  
*Data Scientist*



Paul Harford  
*Analyst*



Meghana Kshirsagar  
*PI*



Carrie Garavan  
*ALERT Co-ordinator*



Evan Smith  
*Research Fellow*



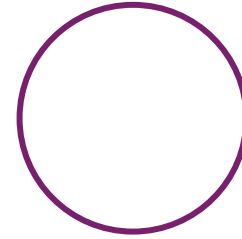


# Interoperability

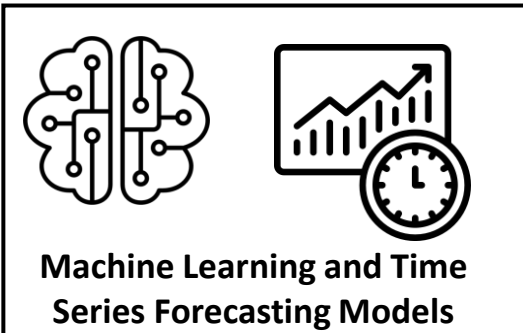


Agent Based Modelling

Met Éireann Weather Data



Ambulance Records



Machine Learning and Time Series Forecasting Models



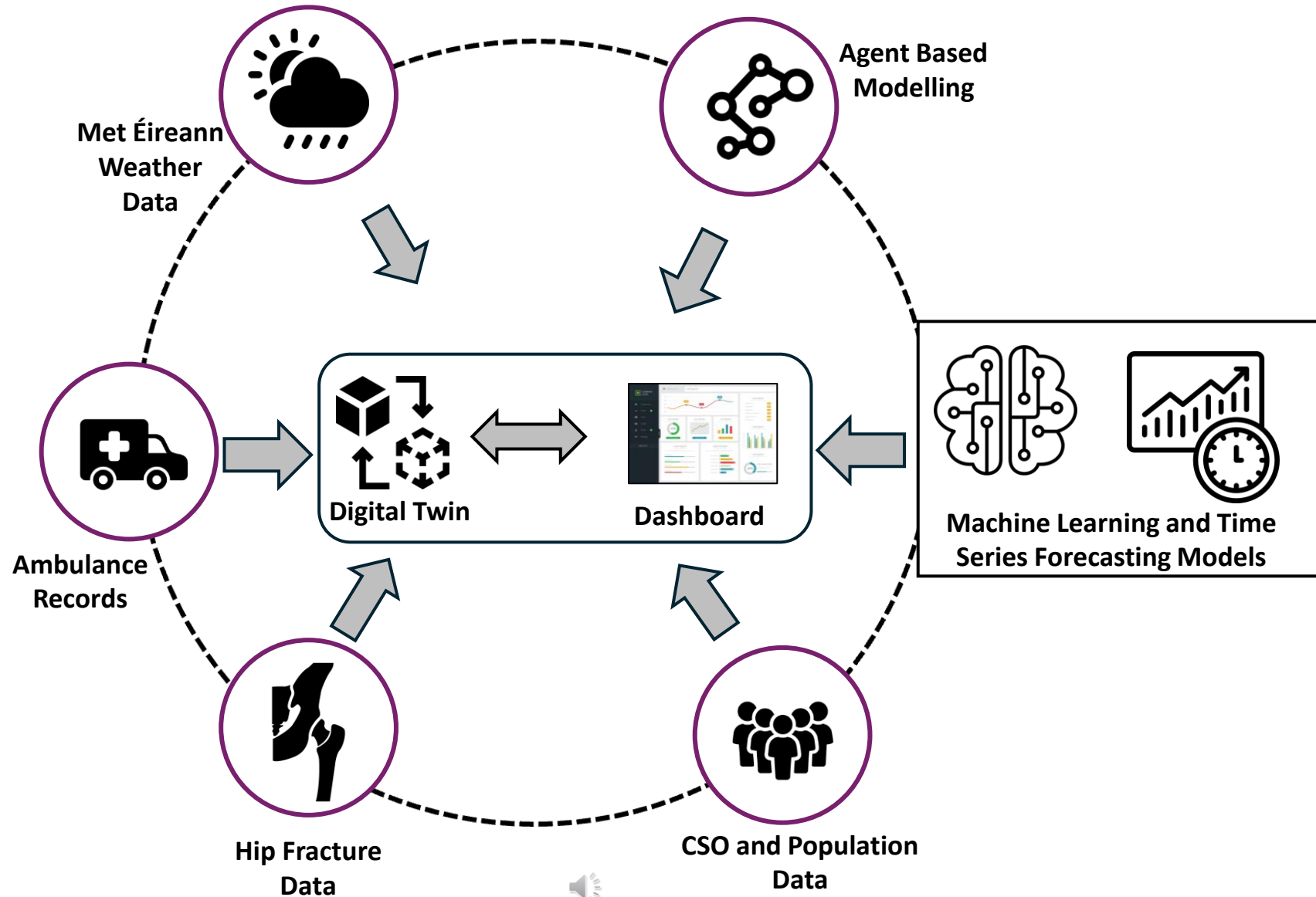
Hip Fracture Data



CSO and Population Data



# Interoperability



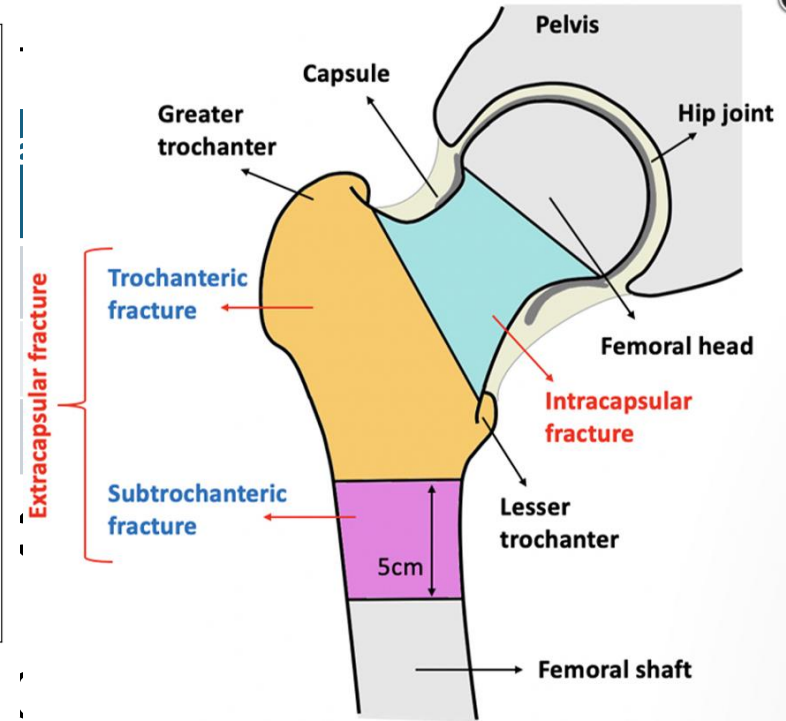
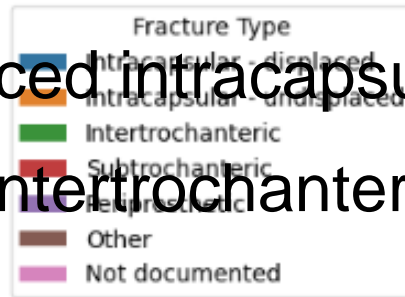
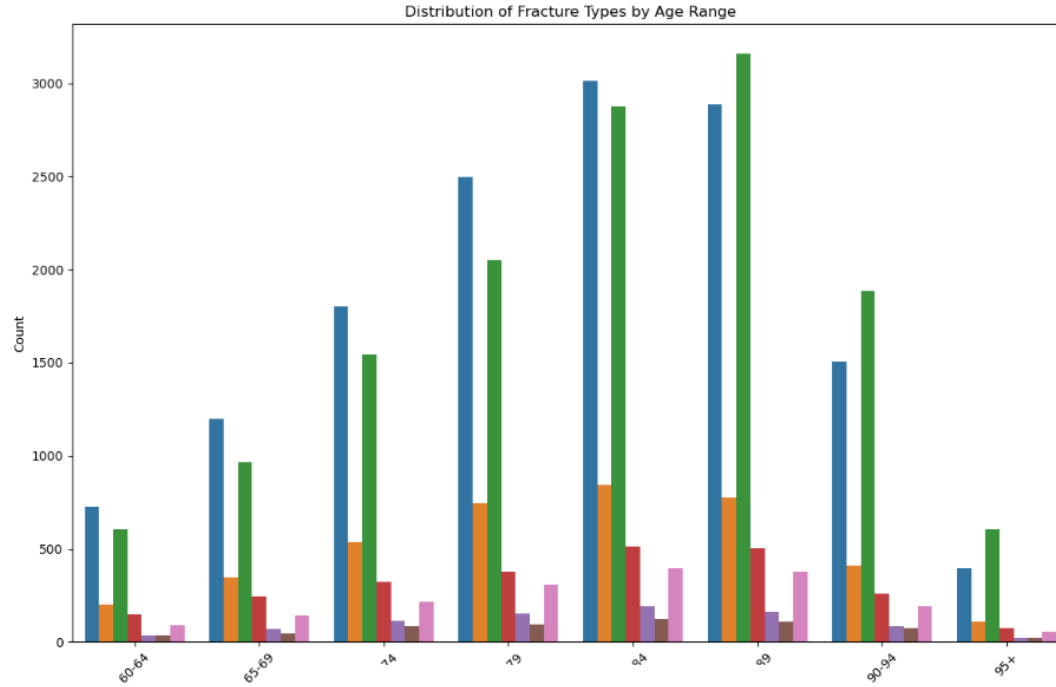




# Preliminary Data Analysis



Hip Fracture Data



Displaced intracapsular fractures require prosthetic implant  
 Intertrochanteric fractures no prosthetic implant

Kyriacou, H. and Khan, W.S., 2021.

Intracapsular hip fractures: guidelines and outcomes in the management of hip fracture. *Journal of Perioperative Practice*, 31(4), pp.140-146.

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# Future Work



Hip Fracture Data

Features  $\longrightarrow$

	Admission datetime	Age Range	Trauma Type	Ward Type	Fracture type
Instances $\updownarrow$					

32 x 37309

8 features missing >30% information

Displaced intracapsular fractures require prosthetic implant

Intertrochanteric fractures **no** prosthetic implant



# Future Work



Hip Fracture Data



## SHORT TERM

- Preliminary statistics
- Identify data imputation methods
- Identify correlated features



Features →

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Instances ↓

32 x 37309

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# Future Work



Hip Fracture Data



## SHORT TERM

- Preliminary statistics
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Features →

Admission datetime	Age Range	Trauma Type	Ward Type	Fracture type

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32 x 37309

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## MEDIUM TERM

- Assess various ML methods
- Define appropriate model
- Identify explainable AI opportunities



# Future Work



Hip Fracture Data



## LONG TERM

A fully functional DT integrating key healthcare services for optimizing resource utilization within healthcare ecosystem



## SHORT TERM

Preliminary statistics  
Identify data imputation methods  
Identify correlated features



## MEDIUM TERM

Assess various ML methods  
Define appropriate model  
Identify explainable AI opportunities



		Features				
		Admission datetime	Age Range	Trauma Type	Ward Type	Fracture type
Instances	1					
	2					
	3					

32 x 37309

8 features missing >30% information  
Displaced intracapsular fractures require prosthetic implant  
Intertrochanteric fractures **no** prosthetic implant



# Supporting women in STEM research



Meghana Kshirsagar  
*PI*



Alison O'Connor  
*Co-PI*



Gauri Vaidya  
*Computational Scientist*

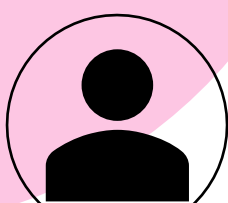
*Lift As You Rise*



Dr Carrie Garavan  
*ALERT Co-ordinator*



Sophie Quinn  
*Software Developer*



Amalija Sandadi  
*Digital Designer*



Dr Damien Ryan  
*Societal Impact Champion*



Prof Fergal Cummings  
*Consultant*



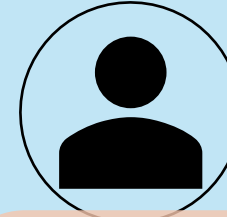
Venkatesh Kannan  
*Process Mining Engineer*



Stephen Ryan  
*Data Scientist*



Steven Lavelle  
*Software Developer*



Bayan Nezamabad  
*Software Developer*



Gerard O'Connell  
*Software Developer*



Evan Smith  
*Research Fellow*



Luke O'Leary  
*Software Developer*



Paul Harford  
*Analyst*



Aakash Singh  
*Data Analyst*

# Thank You!

## ALTER

