



DAISY: Diagnostic AI System for Robot-Assisted A&E Triage

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TAS Showcase

5th – 6th March 2024



TAS Showcase 2024

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Researchers interacting with DAISY at the University of York's Institute for Safe Autonomy

Research Team

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Professor Radu Calinescu, Computer Science, University of York, Principal Investigator/Project Co-lead

Professor Ibrahim Habli, Computer Science, University of York, Co-investigator

Dr Victoria Hodge, Computer Science, University of York, Senior Research Fellow

Billy Lyons, Computer Science, University of York, Research Associate

Dr Chiara Picardi, Computer Science, University of York, Research Associate and Co-investigator

Dr Katie Plant, Faculty of Engineering and Environment, University of Southampton, Co-investigator

Georgia Sowerby, Computer Science, University of York, Research Student

Dr Ioannis Stefanakos, Computer Science, University of York, Research Associate

Dr Bev Townsend, Computer Science/York Law School, University of York, Research Associate and Co-investigator

Motivation

- NHS England has a **shortage** of medical staff and an **aging** workforce ¹
- Increased **stress** is leading to sickness absences ¹
- **Distribution** of doctors is not uniform ¹
- Healthcare worker shortages are experienced everywhere
 - shortfall of 124,000 physicians by 2034 in the United States ²
 - shortage of 1 million healthcare workers in the EU ³

¹BMA - <https://www.bma.org.uk/advice-and-support/nhs-delivery-and-workforce/workforce/nhs-medical-staffing-data-analysis>

²AAMC Report - <https://www.aamc.org/news-insights/press-releases/aamc-report-reinforces-mounting-physician-shortage>

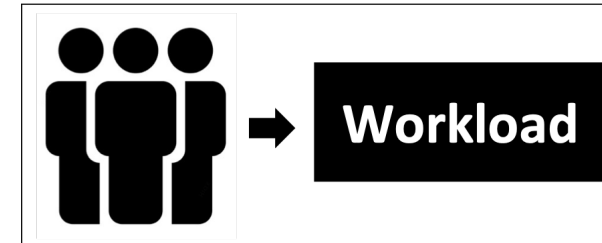
³WHO - <https://www.who.int/europe/news/item/22-03-2023-the-health-workforce-crisis-in-europe-is-no-longer-a-looming-threat---it-is-here-and-now.-the-bucharest-declaration-charts-a-way-forward>

An Increasing Challenge...

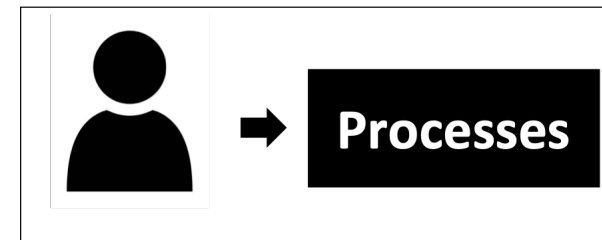
- It takes years to train a clinician
- Yearly intakes are lower than estimated needs
- Alternatives must be explored

Clinicians: What & How?

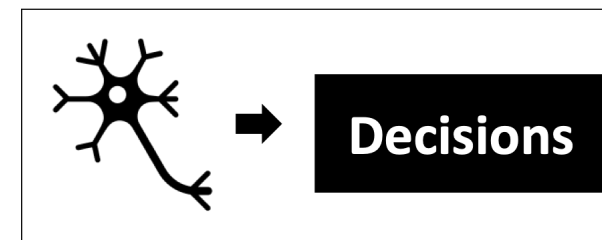
1. Teams to manage **Workload**

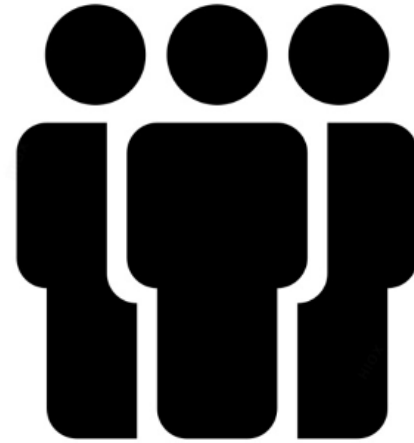


2. Individuals to drive **Processes**



3. Neurons to make **Decisions**



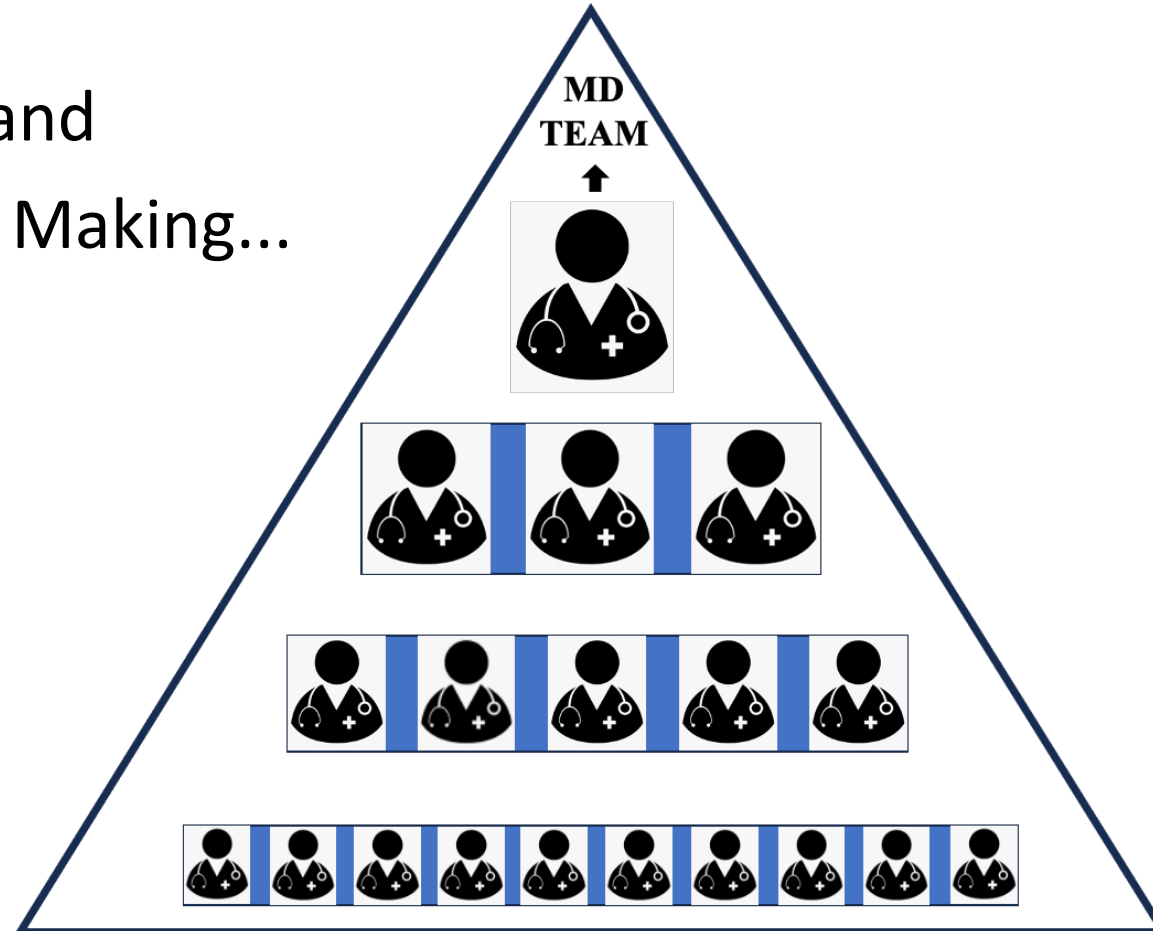


Workload

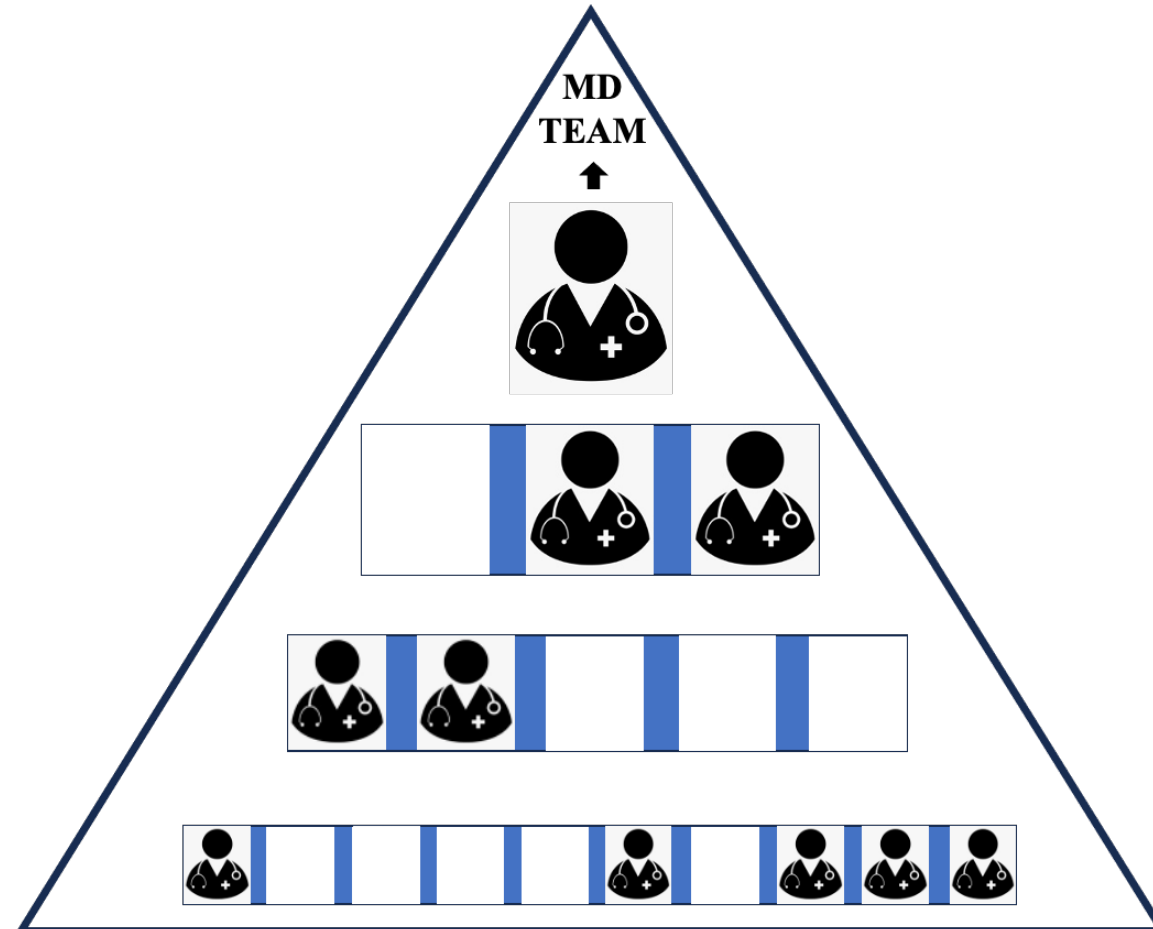
The Team

The Ideal

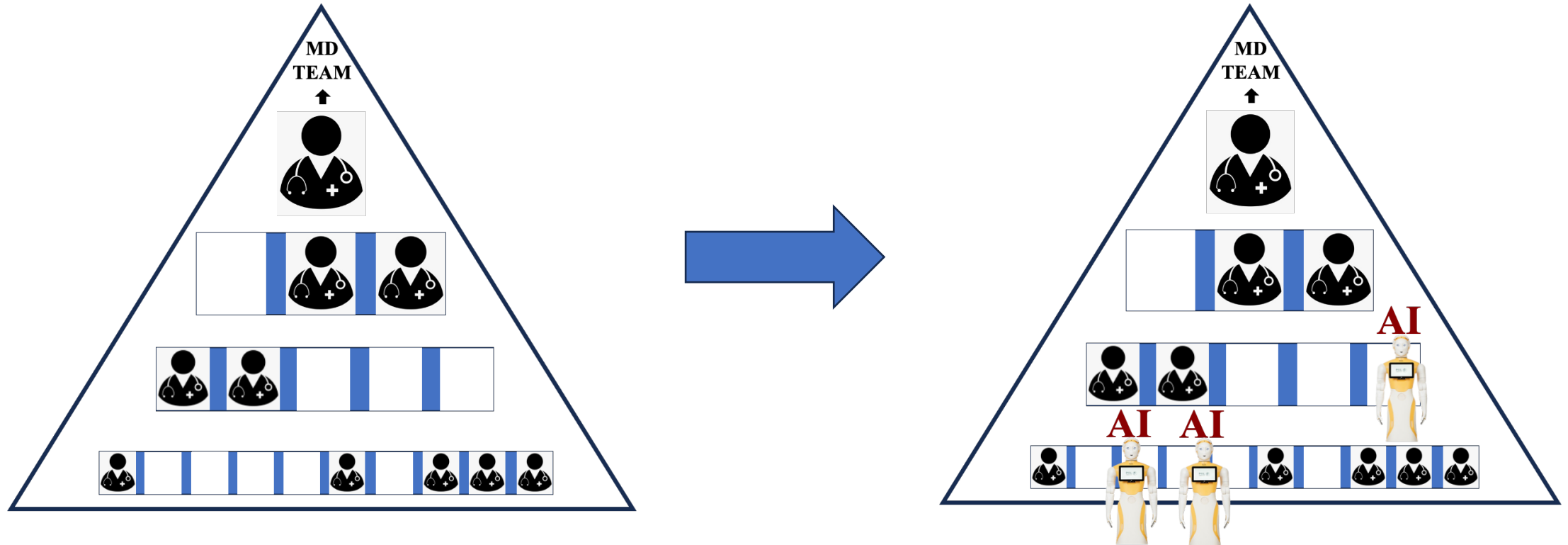
Data Gathering and
Clinical Decision Making...

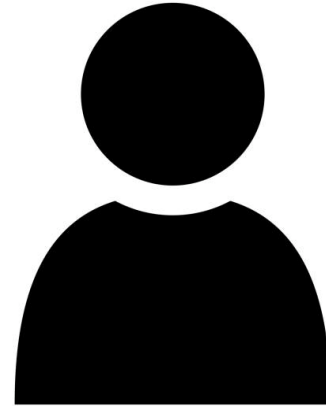


The Deficit



Our Solution

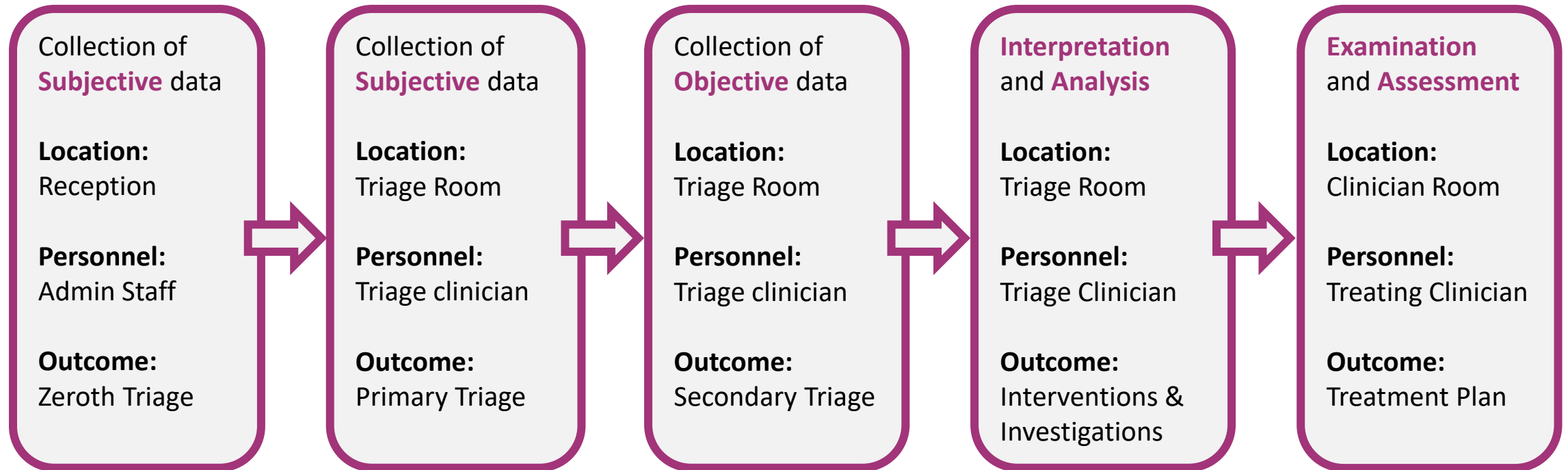




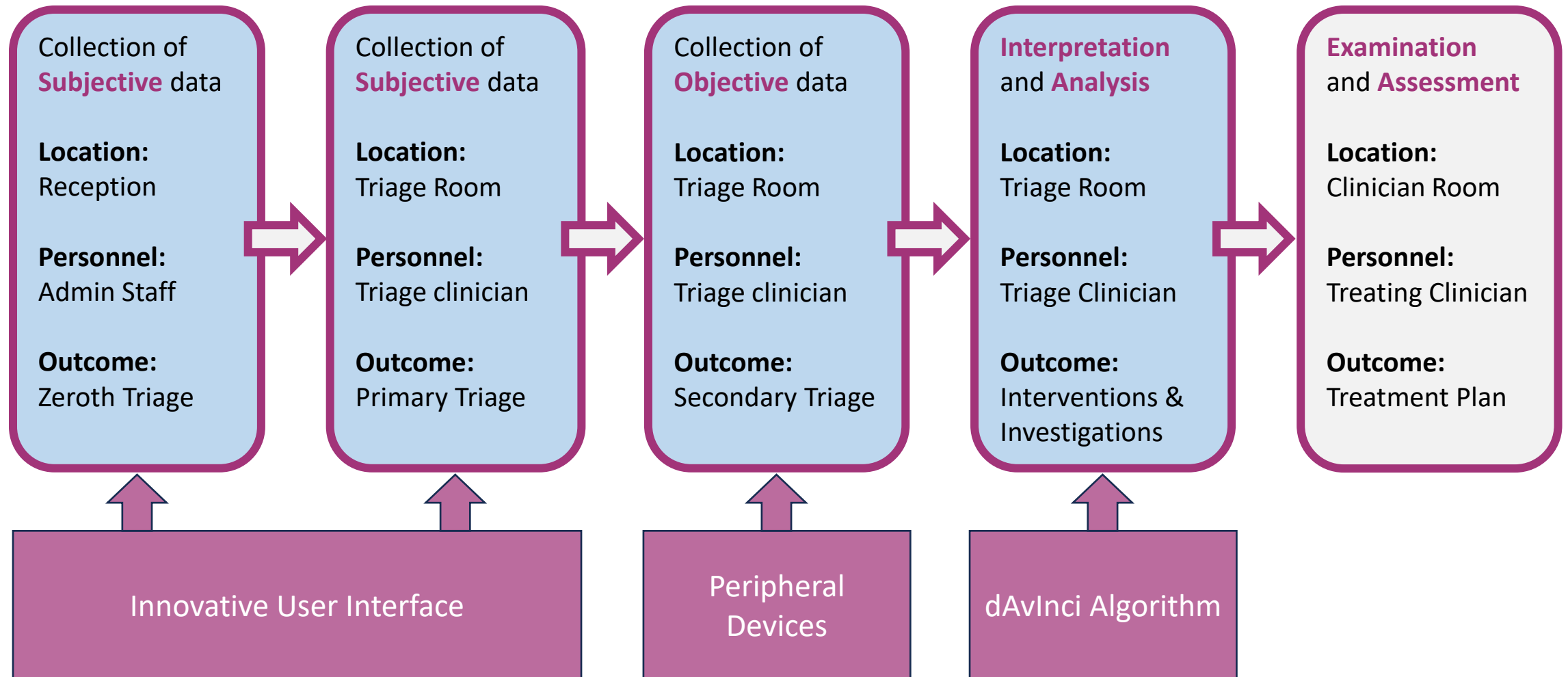
Processes

The Individual

The Hospital Triage Process



The Hospital Triage Process





Decision

The Neurons

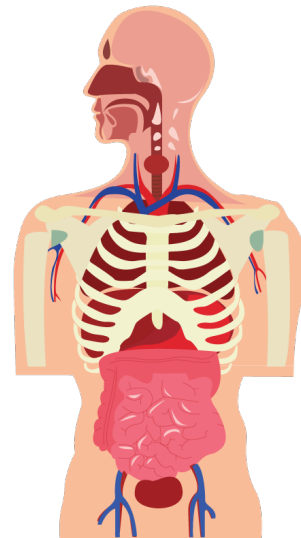
dAvInci (Diagnostic Algorithm for Intelligent Clinical Intervention)

Demographic

Anatomical

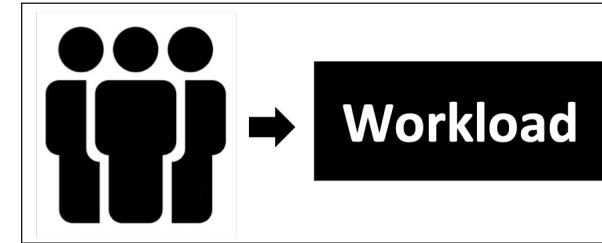
Subjective

Objective

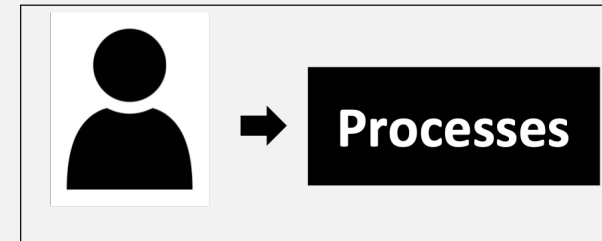


'AI System' Supports 'Whole System'

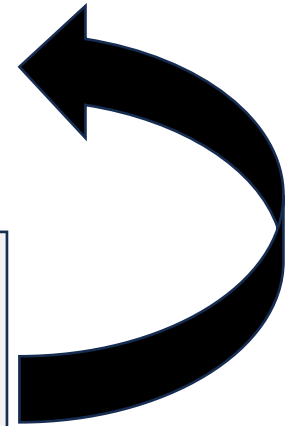
1. Teams to manage **Workload**



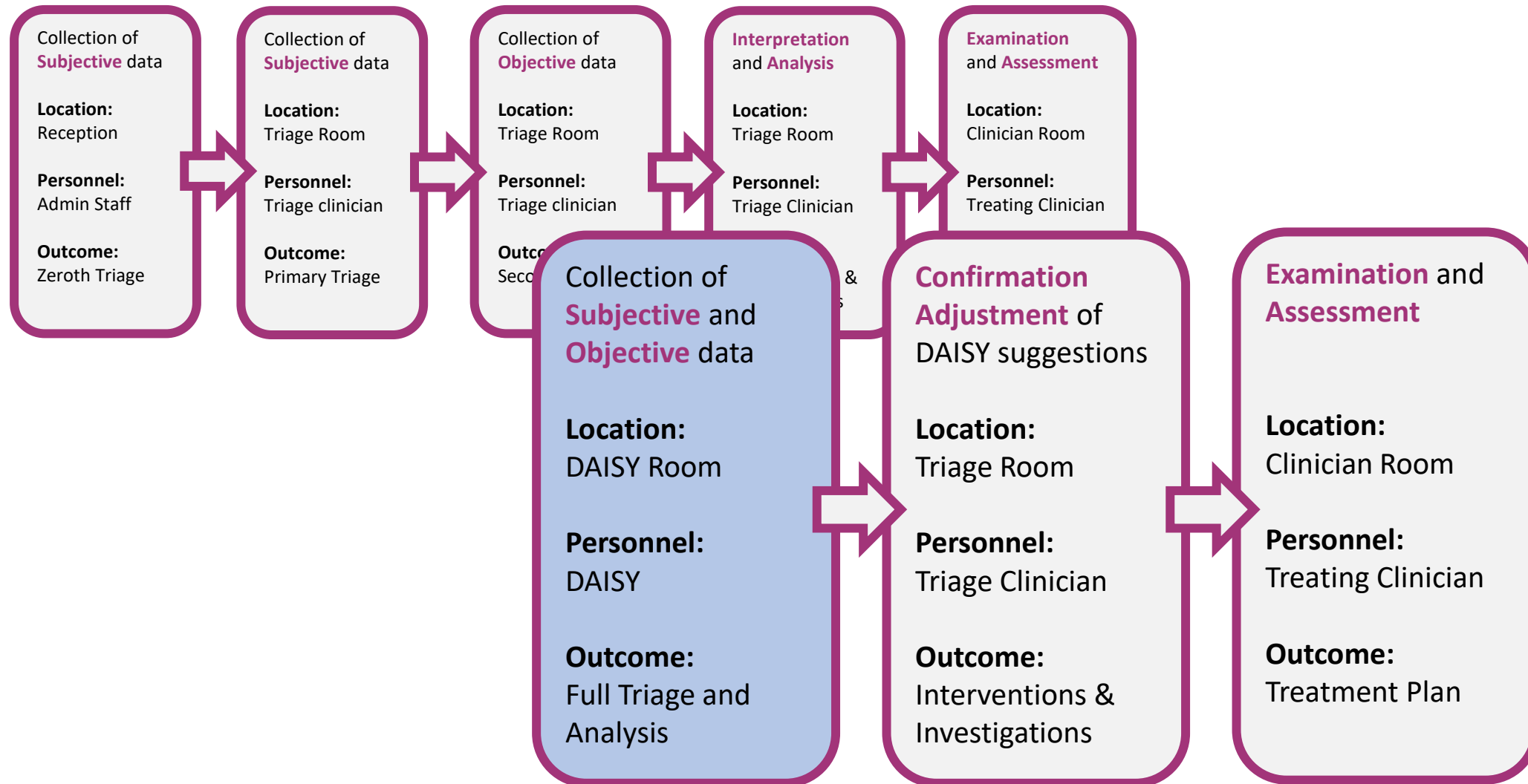
2. Individuals to drive **Processes**



3. Neurons to make **Decisions**



Refined Triage Pathway



Diagnostic AI System (DAISY)

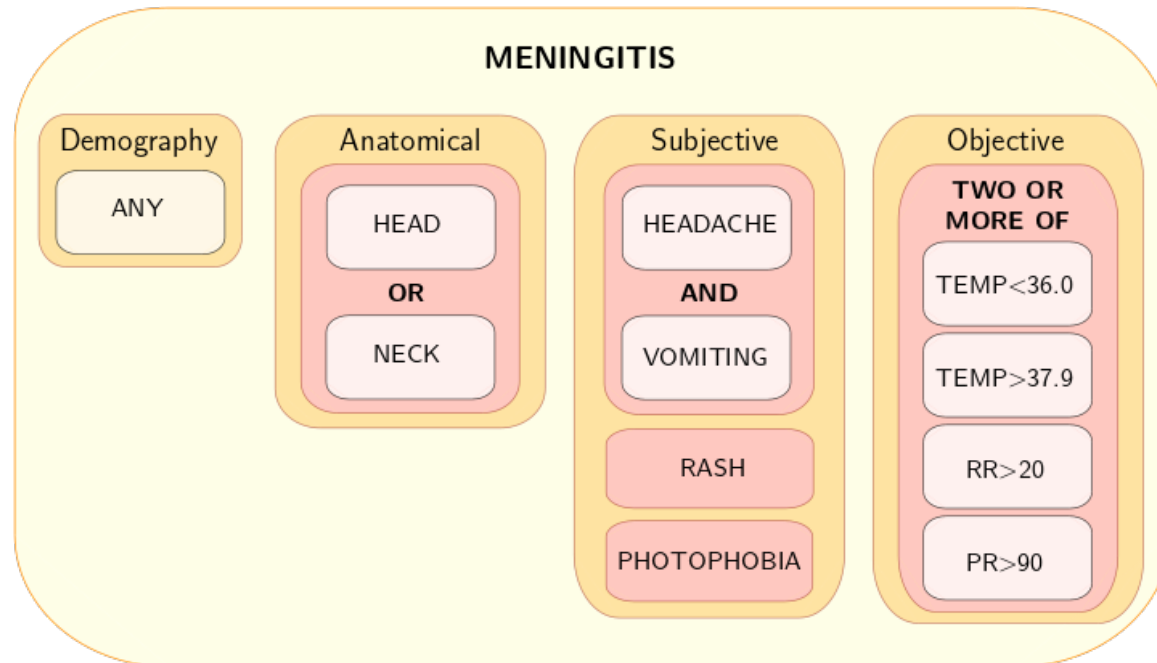




Technical Solution

Assessment Rule Example

Consider the following example for the detection of Meningitis:



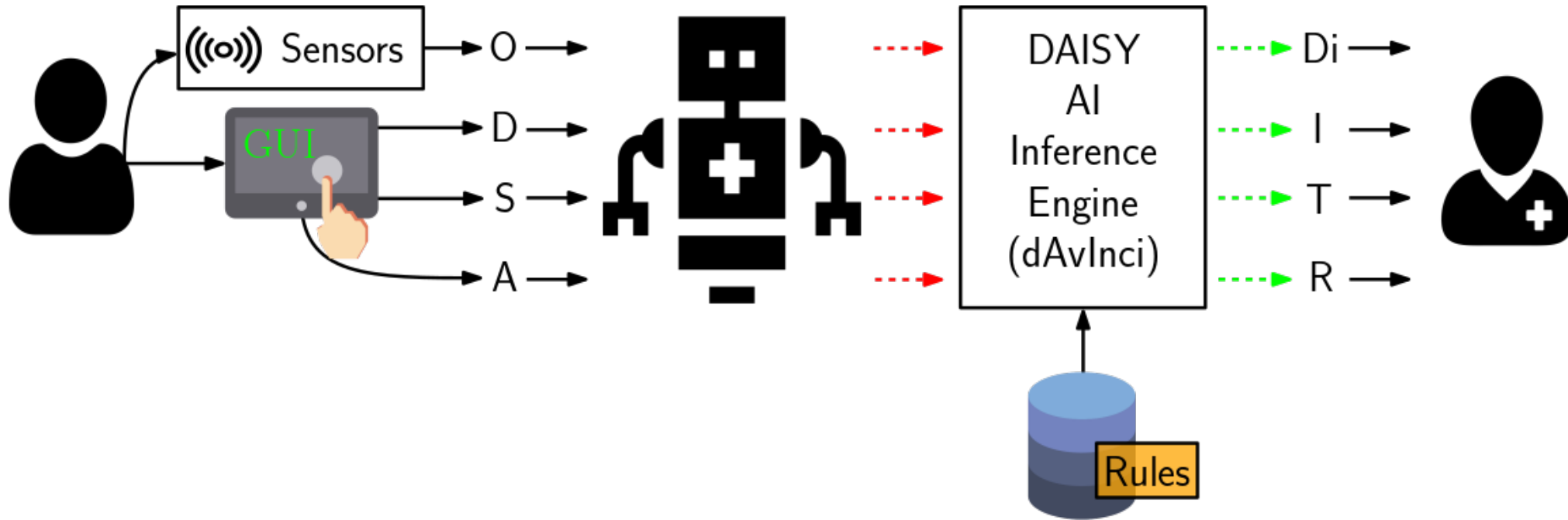
$dem(\text{meningitis}, D) = \text{true}$

$anat(\text{meningitis}, A) = \text{head} \vee \text{neck}$

$subj(\text{meningitis}, S) = (\text{headache} \wedge \text{vomiting}) \vee \text{rash} \vee \text{photophobia}$

$obj(\text{meningitis}, O) = (T > 37.9 \vee T < 36) \wedge PR > 90$
 $\vee (T > 37.9 \vee T < 36) \wedge RR > 20$
 $\vee (PR > 90 \wedge RR > 20)$

DAISY Solution Abstracted



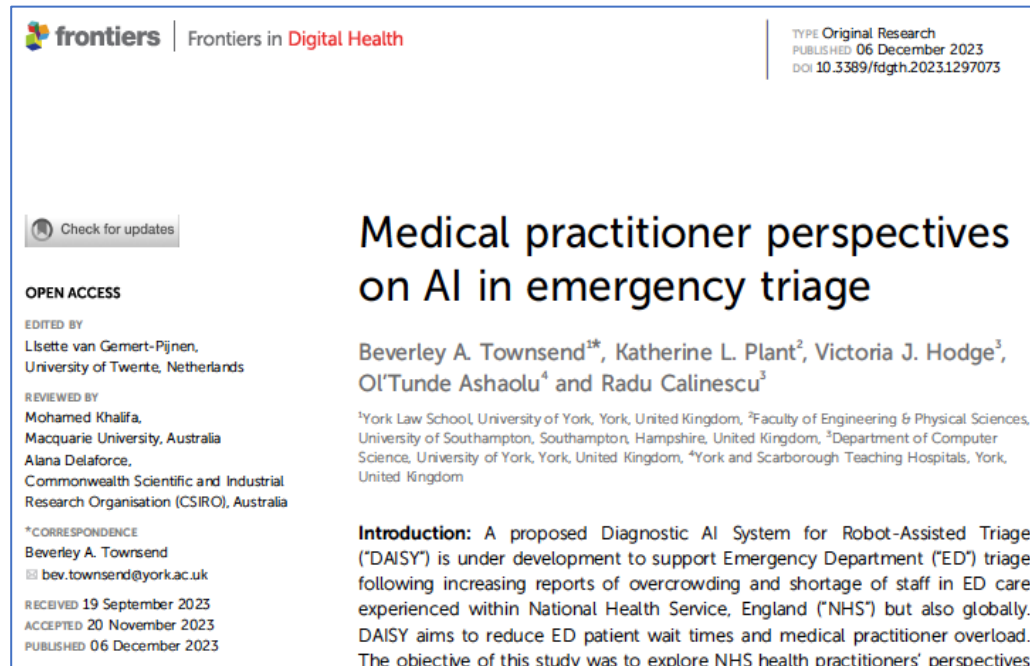
Demonstration



DAISY: A video illustration

Evaluation

1. Medical practitioners' survey



frontiers | Frontiers in Digital Health

TYPE Original Research
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Check for updates

Medical practitioner perspectives on AI in emergency triage

Beverley A. Townsend^{1*}, Katherine L. Plant², Victoria J. Hodge³, Ol'Tunde Ashaolu⁴ and Radu Calinescu³

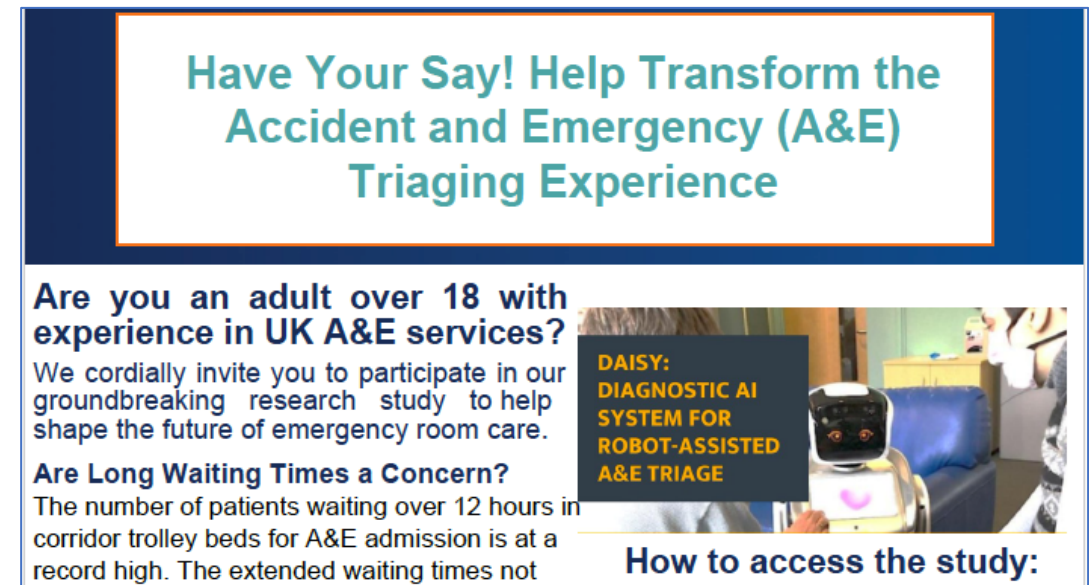
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Introduction: A proposed Diagnostic AI System for Robot-Assisted Triage ("DAISY") is under development to support Emergency Department ("ED") triage following increasing reports of overcrowding and shortage of staff in ED care experienced within National Health Service, England ("NHS") but also globally. DAISY aims to reduce ED patient wait times and medical practitioner overload. The objective of this study was to explore NHS health practitioners' perspectives

OPEN ACCESS
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2. Patient and Public Involvement exercise @ York Hospital

3. UK-wide online public study



Have Your Say! Help Transform the Accident and Emergency (A&E) Triage Experience

Are you an adult over 18 with experience in UK A&E services?
We cordially invite you to participate in our groundbreaking research study to help shape the future of emergency room care.

Are Long Waiting Times a Concern?
The number of patients waiting over 12 hours in corridor trolley beds for A&E admission is at a record high. The extended waiting times not

DAISY: DIAGNOSTIC AI SYSTEM FOR ROBOT-ASSISTED A&E TRIAGE

How to access the study:

4. Testing of technical solution (next slides)

Preliminary Evaluation: solution testing

- **Correctness** evaluation
 - Synthetic dataset comprising 6237 patient entries for testing the triage capabilities of our solution
 - 81.74% of the generated reports confirmed as producing correct assessments (16995 out of 20790)
- Issues identified:
 - Multiple terms for similar/same illness
 - Incomplete ruleset and ranking system

Example of multiple terms:

Pneumonia (Community Acquired)

Respiratory Tract Infection

Chest Infection

Lower Respiratory Tract Infection

Preliminary Evaluation: solution testing

- **Usability** evaluation
 - Invited 12 participants with technical background to use a prototype of the system
 - Used their feedback to improve solution
- Need to invite more users in our usability evaluation from more diverse backgrounds

DAISY USABILITY EVALUATION QUESTIONS, WHERE 1.STRONGLY DISAGREE, 2.DISAGREE, 3.NEUTRAL, 4.AGREE, 5.STRONGLY AGREE.

Question	Average Score
Evaluating step 1: Inputting information	
I found the DAISY system easy to use	4
I would probably need the support of a technical person to use this DAISY system part	2
I felt confident using the DAISY system	3.67
I thought there was too much inconsistency in the DAISY system	1.92
I felt frustrated using the DAISY system	2.17
I felt satisfied using the DAISY system	4
I felt the mental demand for this activity was reasonable and manageable	3.75
Evaluating step 2: Medical equipment	
I found the medical equipment easy to use	3.33
I would probably need the support of a technical person to use the medical equipment	3.42
I felt confident using the medical equipment	3.33
I thought there was too much inconsistency in the medical equipment	2.08
I felt frustrated using the medical equipment	2.08
I felt satisfied using the medical equipment	3.5
I felt the mental demand for this activity was reasonable and manageable	3.67
I felt the physical demand for this activity was reasonable and manageable	3.83
Thinking about the system overall and its output	
I feel suspicious of the DAISY system	2
I am confident in the DAISY system	3.25
The DAISY system has high integrity	3.5
I can trust the DAISY system	3.42
The DAISY system provides security	3.8
The DAISY system is reliable	3

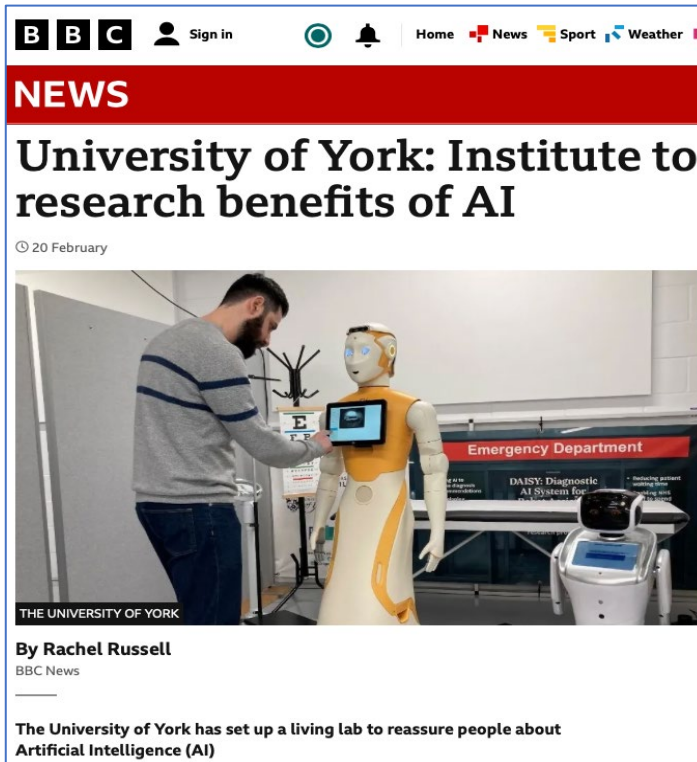
Next Steps

- Feasibility clinical trial at Scarborough Hospital
- Setup of recently acquired ARI robot¹
- Hybrid-AI extension
 - Bayesian reasoning for domain knowledge
 - Machine learning for non-verbal cues
 - cough, jaundice, etc.



¹PAL Robotics - ARI social robot
<https://pal-robotics.com/robots/ari/>

DAISY in the media




BBC Sign in Home News Sport Weather

NEWS

University of York: Institute to research benefits of AI

© 20 February



THE UNIVERSITY OF YORK

By Rachel Russell
BBC News

The University of York has set up a living lab to reassure people about Artificial Intelligence (AI)



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Minister visits Institute for Safe Autonomy to understand AI and robotics in public services

Posted on 11 July 2023

The Secretary of State for Science, Innovation and Technology visited the University of York's Institute for Safe Autonomy to see the latest technological advancements in the development of AI and robotics.



Secretary of State for Science, Innovation and Technology, Chloe Smith had her health vital signs to demonstrate the DAISY project.



THE TIMES MENU

Tuesday February 20 2024, 11.00pm, The Times



Dr Ioannis Stefanakos of the University of York has his blood pressure checked by DAISY, an AI-equipped robot designed to provide triage and assistance in A&E

Publications

Beverley A. Townsend, Katherine L. Plant, Victoria J. Hodge, Ol'Tunde Ashaolu, and Radu Calinescu. Medical practitioner perspectives on AI in emergency triage. *Frontiers in Digital Health* 5:1297073, 2023.

Ol'Tunde Ashaolu, William Lyons, Ioannis Stefanakos, Radu Calinescu, Ibrahim Habli, Victoria Hodge, Chiara Picardi, Katherine Plant, Beverley Townsend. "Autonomous Emergency Triage Support System". *10th Intl. Conf. Computational Science & Computational Intelligence*, 2023.

Visit our DAISY demo at the Showcase – booth 16