



# Seungyeon's Research Portfolio

Human Centered Data/ AI, and Design

# About Me



## Seungyeon Baek

### Education

- Bachelor's Degree in Hansung University, Korea [Mar 2015 – Feb 2019]
- Master's Degree in Hansung University, Korea [Mar 2019 – Aug 2021]
- Master's Degree in Texas Tech University, USA [Jan 2022 – Dec 2023]

### Course Highlights

Safety and Health Management, Cognitive Engineering, Biomechanics, Data Mining, Information Theory, Digital Signal Processing

### Research Interests

Human Centered Interaction/ AI/ Design

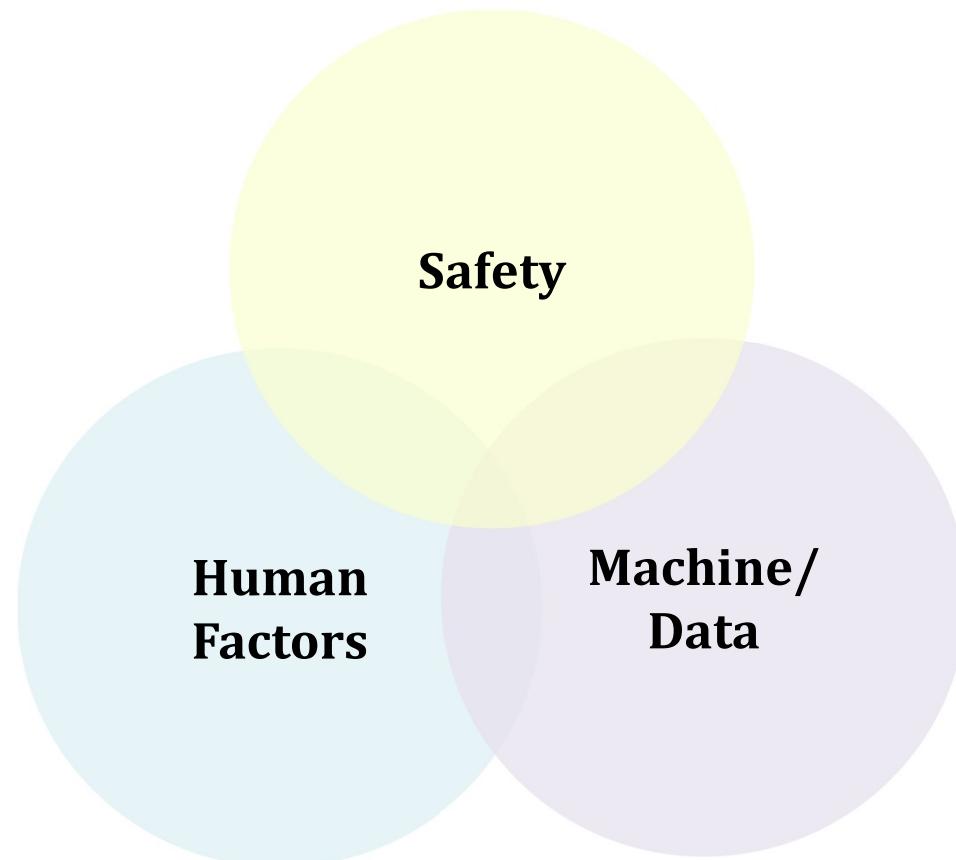
Analyzing intricate data flows

- reducing uncertainty and enabling resilience in algorithmic flows

# About Me

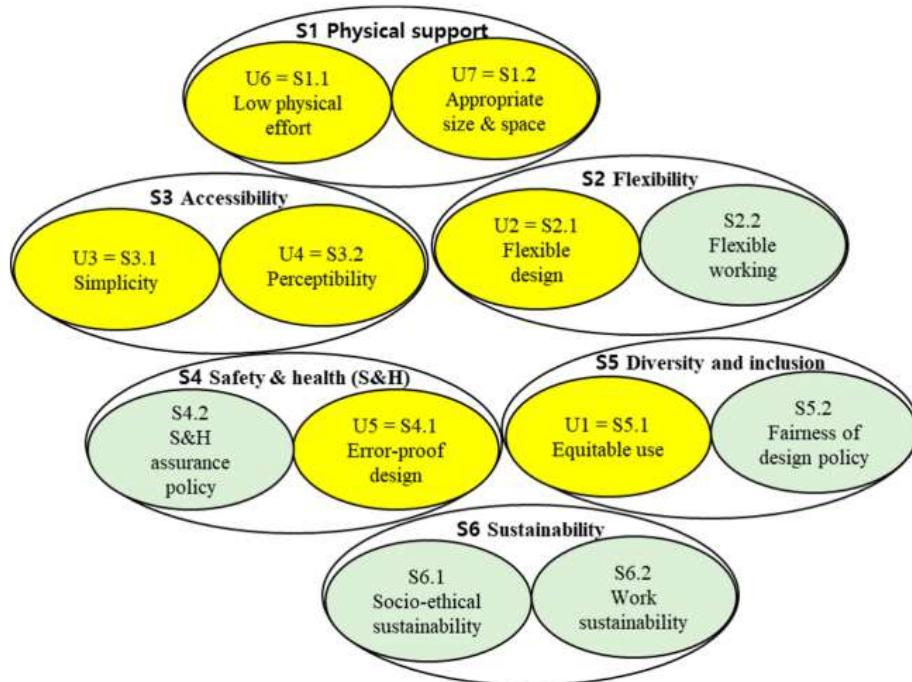


# Research Identity



# MS Thesis : User-Centered Design with Safety

- Universal Safety Design (USD) and Sustainability  
: Comparison of Guidelines between Universal Design (UD) and USD



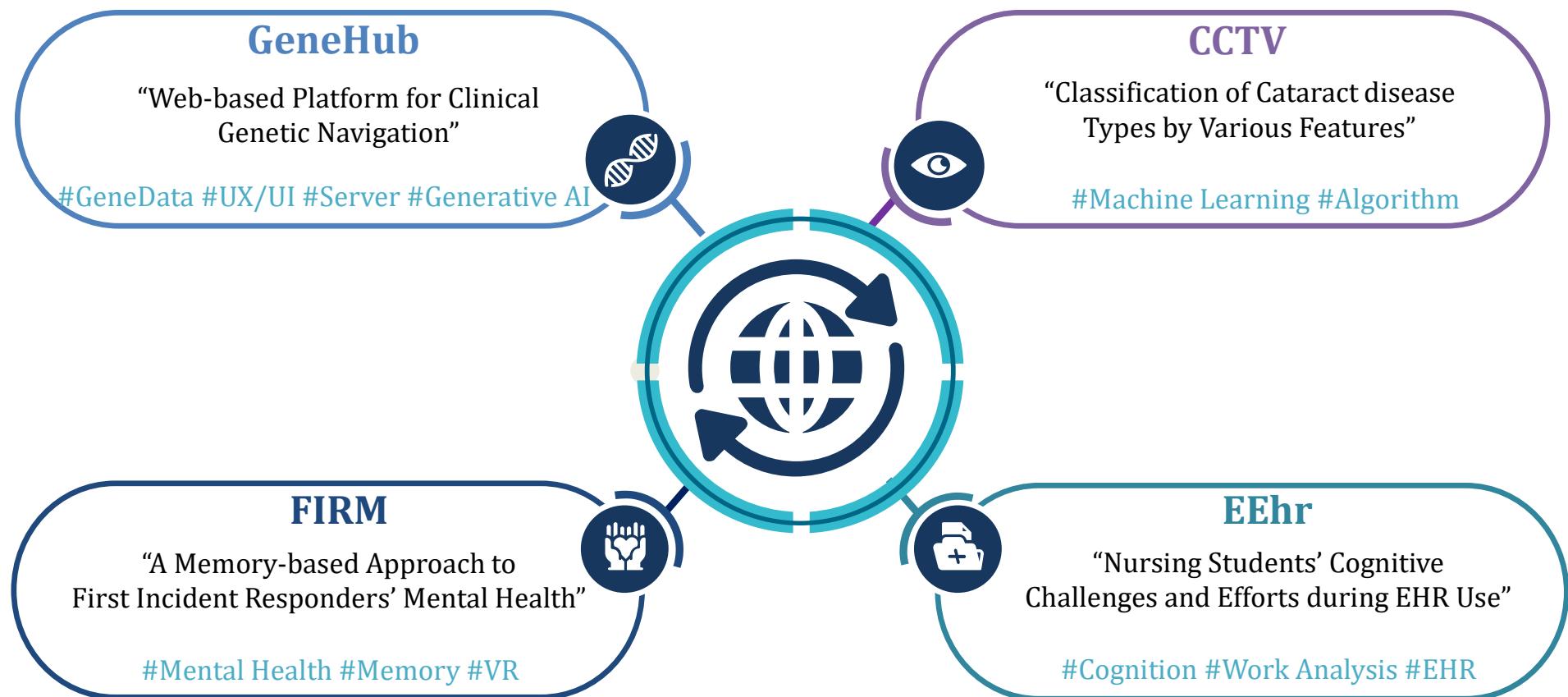
| USD Guidelines              | UD ( $y = f(x_1, x_2, x_3, x_4)$ )                      |         | UD ( $y = f(x_1, x_2, x_3, x_4, x_5)$ )                            |         |
|-----------------------------|---|---------|--|---------|
|                             | B   | p       | B  | p       |
| (Constant)                  | 0.161   | 0.087   | 0.155  | 0.076   |
| Physical support ( $x_1$ )  | 0.240   | 0.001 * | 0.218  | 0.001 * |
| Flexibility ( $x_2$ )       | 0.184   | 0.001 * | 0.155  | 0.001 * |
| Accessibility ( $x_3$ )     | 0.362   | 0.001 * | 0.345  | 0.001 * |
| Safety and health ( $x_4$ ) | 0.184   | 0.001 * | 0.152  | 0.001 * |
| Inclusion ( $x_5$ )         |   |         | 0.101  | 0.001 * |
| Regression model            | $y = 0.161 + 0.240x_1 + 0.184x_2 + 0.362x_3 + 0.184x_4$ |         | $y = 0.155 + 0.218x_1 + 0.155x_2 + 0.345x_3 + 0.152x_4 + 0.101x_5$ |         |
| Statistics for model        | $F = 815.3, p < 0.001 *$                                |         | $F = 762.1, p < 0.001 *$   |         |
| $R^2$                       | 0.952   |         | 0.959  |         |

\* Significant at significance level 0.01.

| Variable             | Sustainability ( $m = f(x_1)$ ) |         | Sustainability ( $m = f(x_2)$ ) |         |
|----------------------|---------------------------------|---------|---------------------------------|---------|
|                      | B                               | p       | B                               | p       |
| (Constant)           | 0.330                           | 0.439   | -0.490                          | 0.134   |
| UD ( $x_1$ )         | 0.948                           | 0.001 * |                                 |         |
| USD ( $x_2$ )        |                                 |         | 1.099                           | 0.001 * |
| Regression model     | $m = 0.330 + 0.948x_1$          |         | $y = -0.490 + 1.099x_2$         |         |
| Statistics for model | $F = 149.5, p < 0.001 *$        |         | $F = 341.2, p < 0.001 *$        |         |
| $R^2$                | 0.478                           |         | 0.675                           |         |

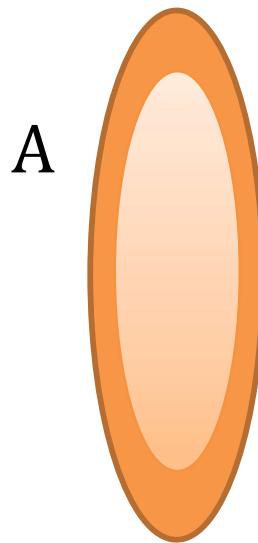
\* Significant at significance level 0.01.

# Leading Projects



# Project : CCTV

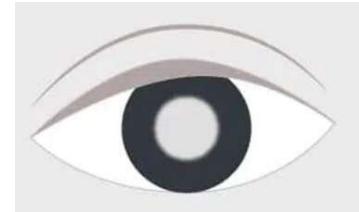
Introduction/ Experiments/ Results/ Conclusion



lens

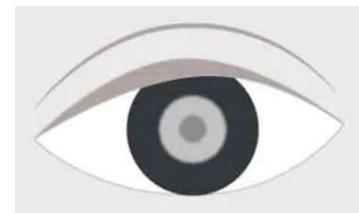
## ▪ Nuclear sclerosis

- “Nucleus” (center) of the lens is affected
- Appears yellow to brown in color
- Aging is often the main cause



## ▪ Posterior subcapsular

- Posterior portion of the lens is affected
- “Grainy” appearance
- Aging, diabetes, steroid use, trauma are causes



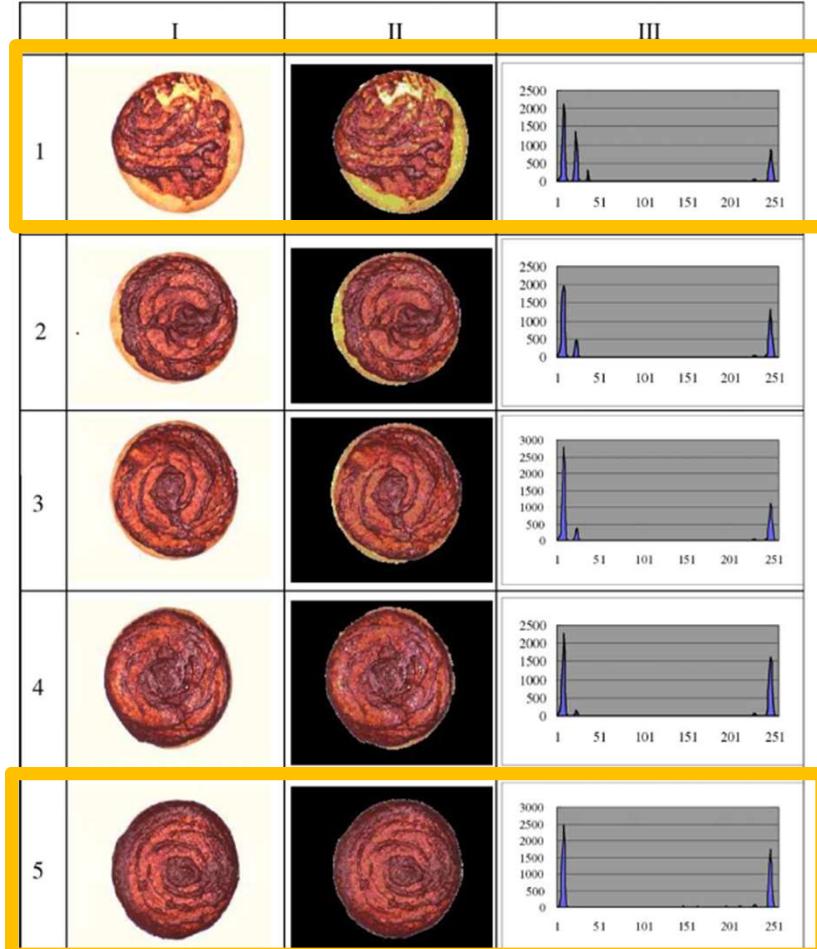
## ▪ Cortical

- Cortex of the lens is affected (Anterior)
- “Spokes”
- Diabetes and aging are common causes



# Project : CCTV

Introduction/ Experiments/ Results/ Conclusion



## ■ Pizza sauce spread classification

### • Color Quantification

Sauce area percentage = (sauce area/ pizza base)\*100  
Heavy area percentage= (heavy zone/sauce area)\*100

### • Dimensionality reduction by principle component analysis

In real implementation, the quantified 256-dimensional vectors are still too large to allow fast and accurate classification. The large feature vectors will increase the complexity of the classifier and the classification error.

### • Fuzzy Logic (ambiguous degree calculation)

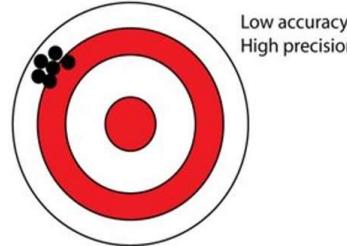
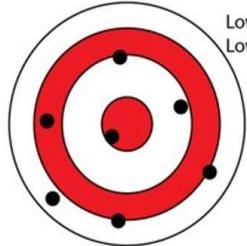
### • Classification using SVM

Sun, D. W., & Brosnan, T. (2003). Pizza quality evaluation using computer vision-- part 1: Pizza base and sauce spread. *Journal of Food Engineering*, 57(1), 81-89.

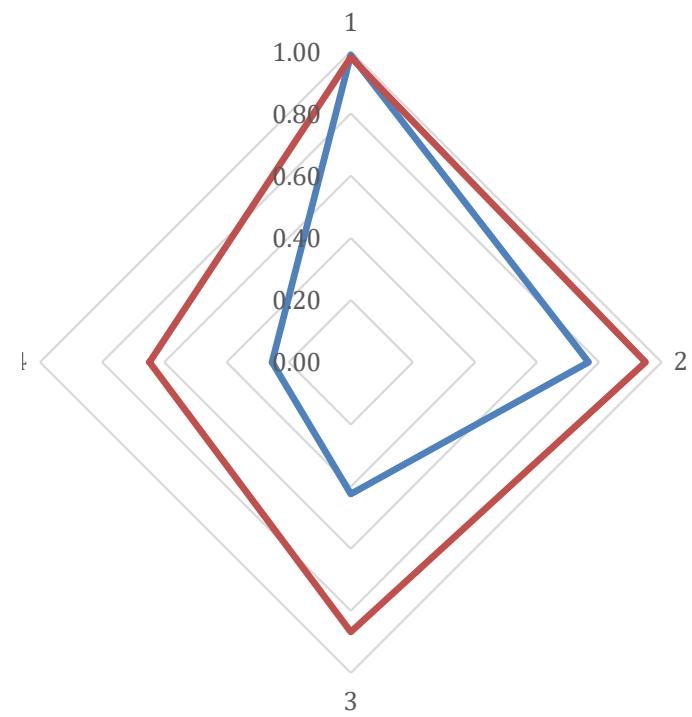
Du, C. J., & Sun, D. W. (2005). Pizza sauce spread classification using colour vision and support vector machines. *Journal of Food Engineering*, 66(2), 137-145

# Project : CCTV

Introduction/ Experiments/ Results/ Conclusion



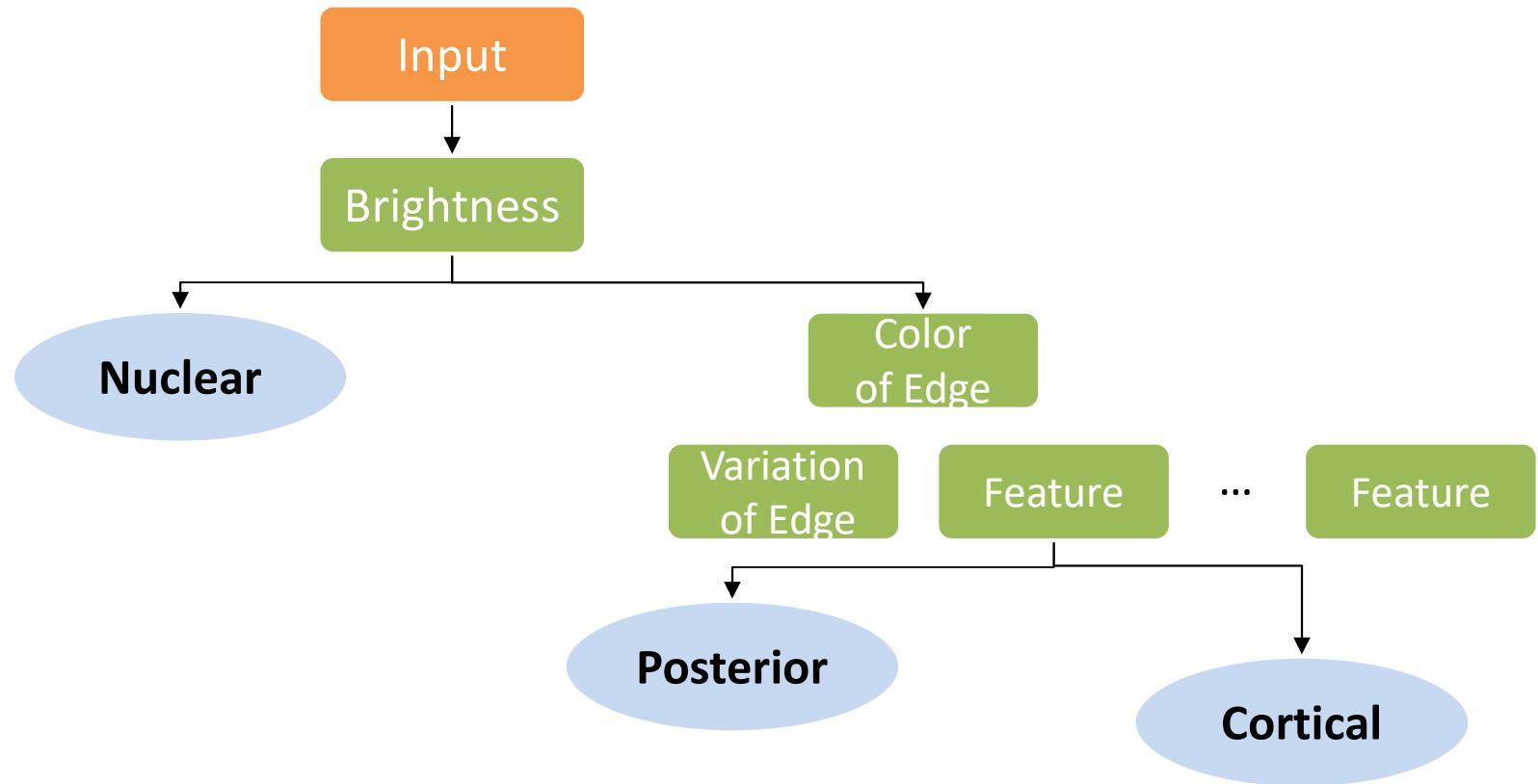
— cortical — posterior



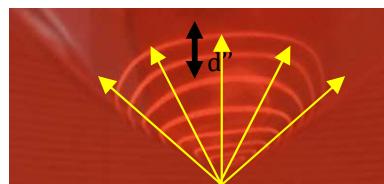
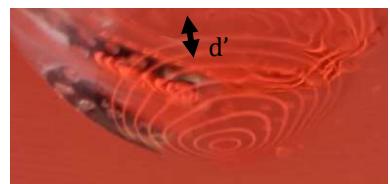
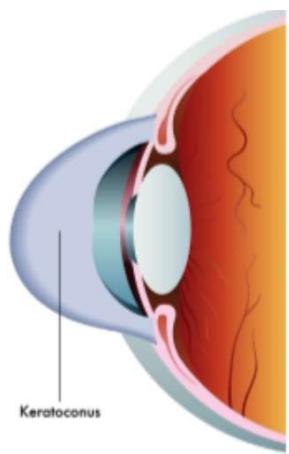
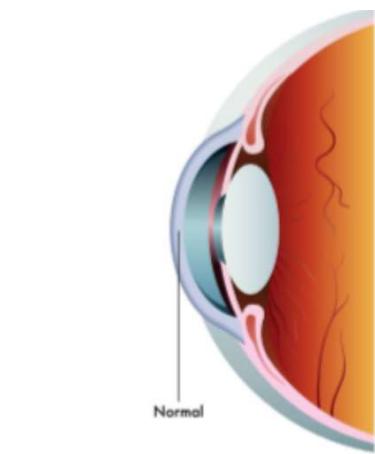
# Project : CCTV

Introduction/ Experiments/ **Results**/ Conclusion

- Decision tree algorithm for machine learning

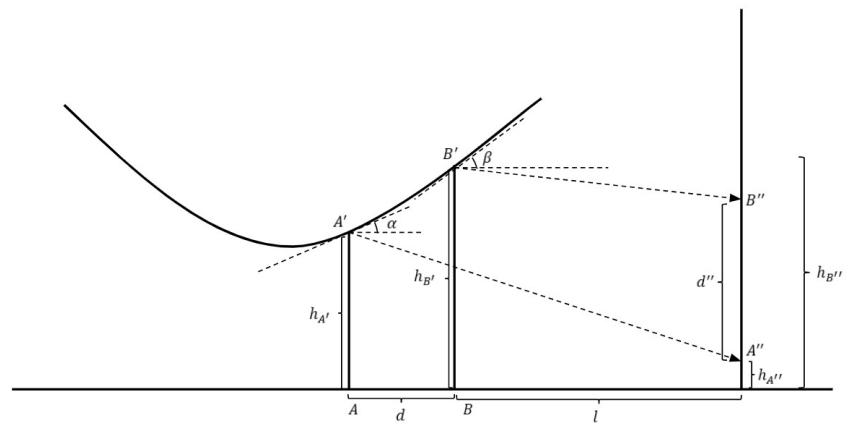
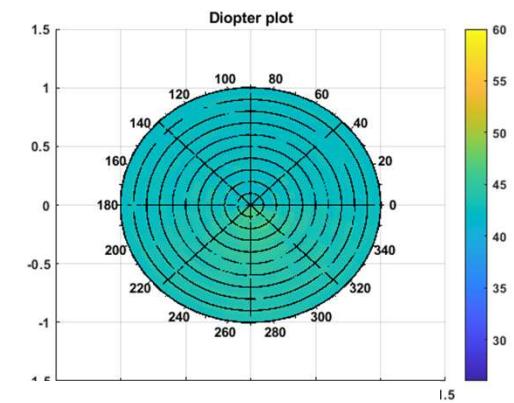
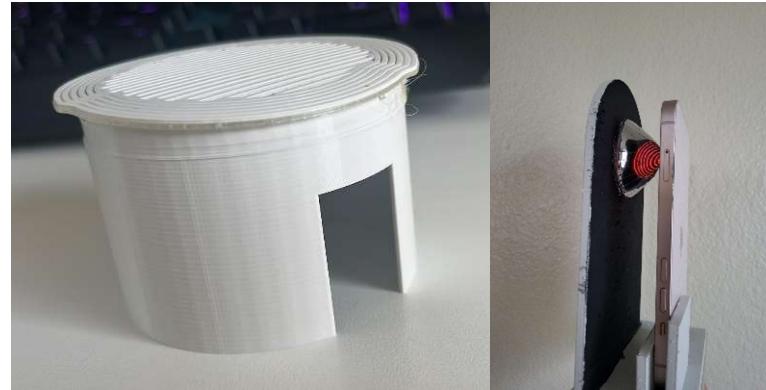


# Projects : Keratoconus



Normal

Abnormal



$$d'' = (h_{B'} - h_{A'}) + l \left( \tan 2\alpha - \frac{1}{\tan 2\beta} \right) + d \tan 2\alpha \quad 11$$

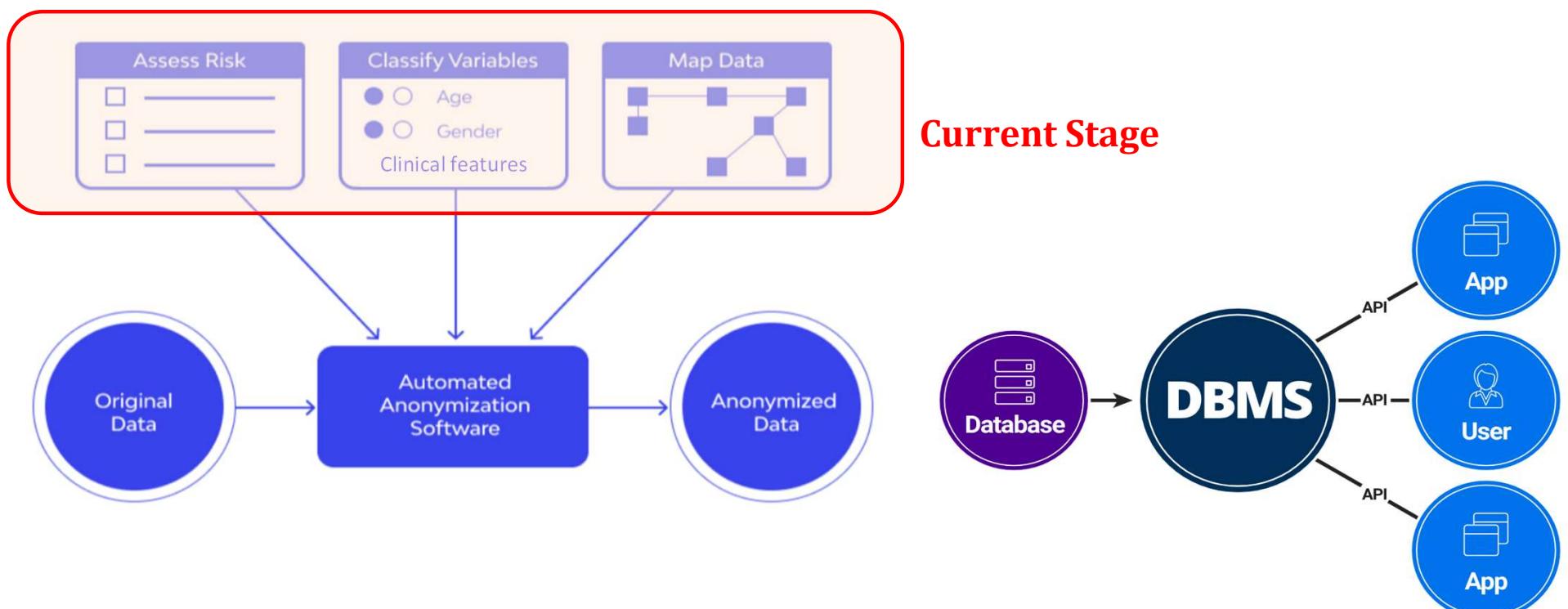
# Project : GeneHub

- A free-to-use site that presents simplified, clinically oriented information on the symptoms and treatments of genetic conditions
  - Collate existing information on genetic conditions into an accessible, clinically specific database

The image shows two screenshots of the GeneHub website. The left screenshot is the homepage, featuring a large blue DNA helix background. It has a search bar with placeholder 'Search Symptom/Syndrome/Genetic name' and a dropdown menu with options like 'All', 'Student', 'Doctor', 'Pharmacist', and 'Research'. Below the search bar is a button labeled 'Search'. The right screenshot shows a 'Featured Research' section with three cards: 'Parkinson' (SNCA, LRRK2), 'Zellweger Syndrome' (PEX1, PEX6, PEX26), and 'Huntington' (HTT). Each card lists symptoms and a 'See details' button. To the right of these cards is a detailed page for 'Cystic Fibrosis'. This page includes a diagram of the human torso with red highlights on the lungs and trachea, a 'Clinical Description' section with symptoms like persistent coughing up sputum and repeated lung infections, and a 'Treatments' section listing medications like Ivacaftor, Lumacaftor, Glyburide, and Sumatriptan. There are also sections for 'Similar Diseases' (Kartagener Syndrome, Alpha-1 antitrypsin deficiency) and 'References' (GeneCards, MedlinePlus, Cystic Fibrosis Foundation).

# Project : GeneHub

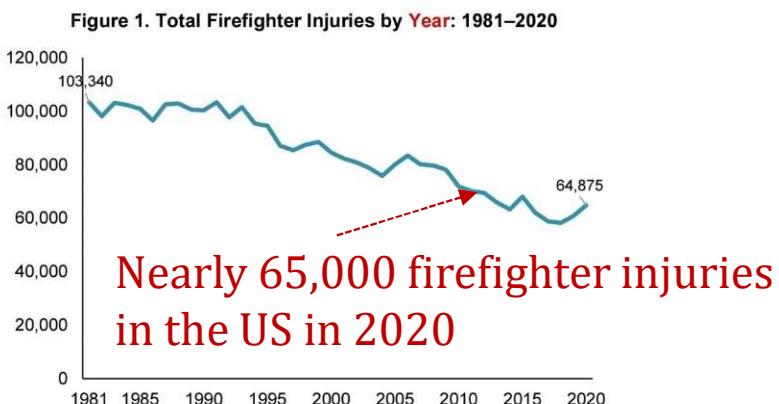
Front-end development and basic back-end functionalities are operational. Active work continues on the database architecture and data population.



# Project : FIRM

## Introduction/ Experiments/ Results/ Conclusion

- Challenges to First Responders



- Highly stressful, demanding, and risky work
- Depression and Anxiety, PTSD, Suicide/suicidal ideation
- Cognitive Behavior Therapy (CBT), Exposure Therapy,...

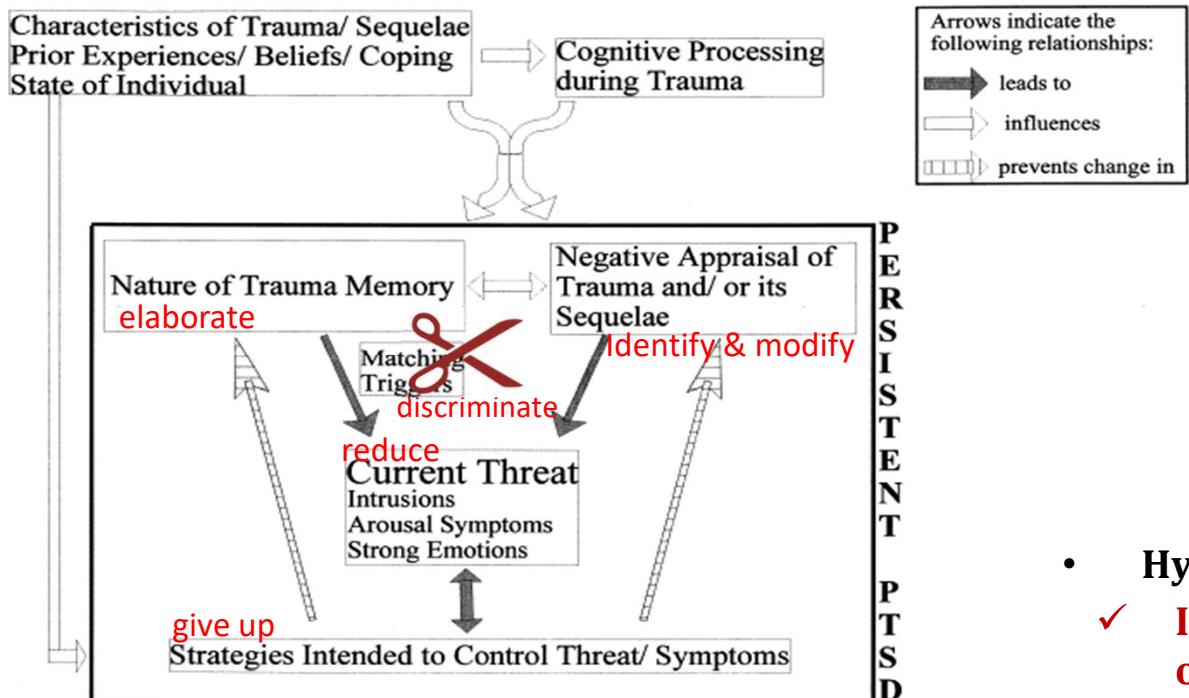
- Research Gap: Limitations of previous efforts for first responders' mental health

- ✓ Focused on improving individuals' coping capacity for future events
- ✓ The effects may be transient (i.e., not lasting long) and depend on individuals' commitment to the interventions ('seriousness')
- ✓ Focused on tackling symptoms, not the causes of mental health issues

# Project : FIRM

## Introduction/ Experiments/ Results/ Conclusion

- Ehlers & Clark (2000)'s cognitive model of PTSD



Change in the negative appraisals and trauma memory is prevented by problematic behavioral and cognitive strategies

- Hypothesis
  - If the traumatic memory is masked or suppressed by other external stimuli, will it reduce the psychological symptoms and emotions?

# Project : FIRM

**Introduction/ Experiments/ Results/ Conclusion**

- Research Objectives
  - First responders relentlessly experience high-stress situations
  - First responders have suffered from significant mental health issues
  - Existing interventions for first responders' mental health are not directly targeted at the causes of mental health problems (=traumatic event memory)

 **To investigate the effect of following external stimuli on the memory of an initial traumatic event**

# Project : FIRM

Introduction/ Experiments/ Results/ Conclusion

- Misinformation Effect (Loftus, 1978)
  - Understanding how external information can distort our recollections
  - Our memories are not perfect recordings of the past. They are constantly being reconstructed and reinterpreted, making them vulnerable to external influences.



- **Encoding:** Misleading information can be incorporated into the initial encoding of an event, blending with actual memories
- **Retrieval:** When retrieving memories, we may misinterpret ambiguous cues and incorporate them into our recollections
- **Consolidation:** Over time, repeated exposure to misinformation can strengthen its integration into the memory network

# Project : FIRM

Introduction/ Experiments/ Results/ Conclusion

Create  
Memory

VR Exposure



Memory Test



- **Experimental Elements:**

Long term/ Short term, Creation, Immersive, Central/ Peripheral, Time, Emotion ... - *In progress* -

# Project : EE-r

Introduction/ Experiments/ Results/ Conclusion

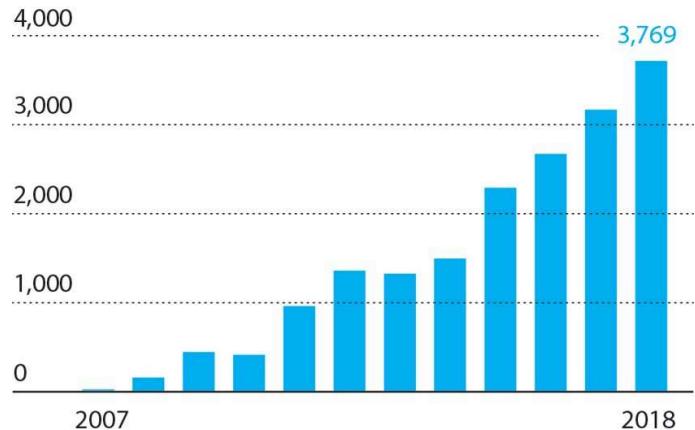


Source: <https://khn.org/news/death-by-a-thousand-clicks/>

## DANGER SIGNS

**Safety events owing to EHR and other health IT issues have been steadily rising. Even so, experts say cases are widely underreported.**

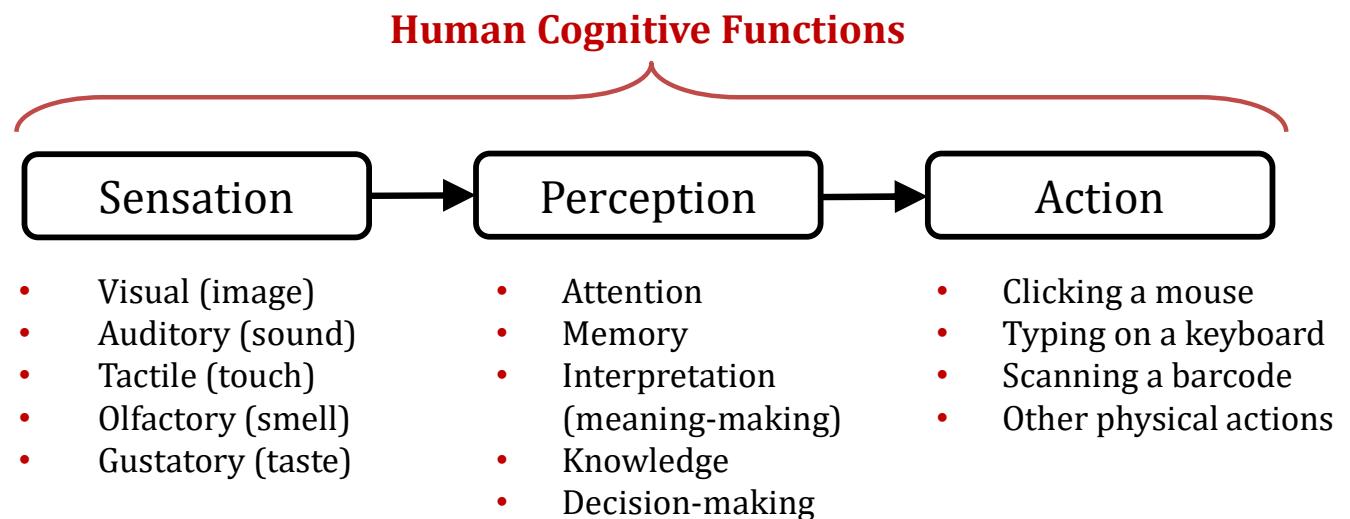
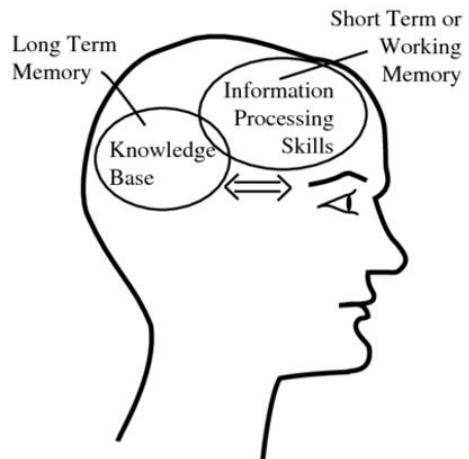
SAFETY-RELATED INCIDENTS LINKED TO EHR OR OTHER IT



SOURCE: QUANTROS

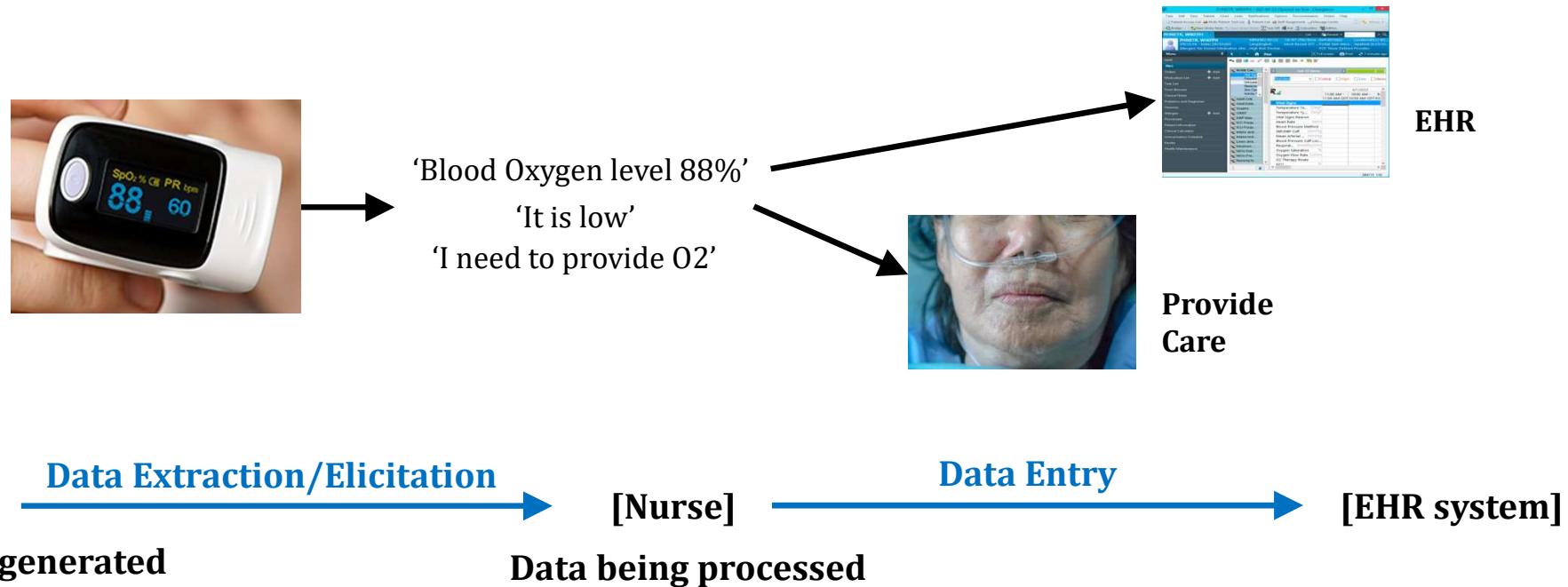
# Project : EE-r

Introduction/ Experiments/ Results/ Conclusion



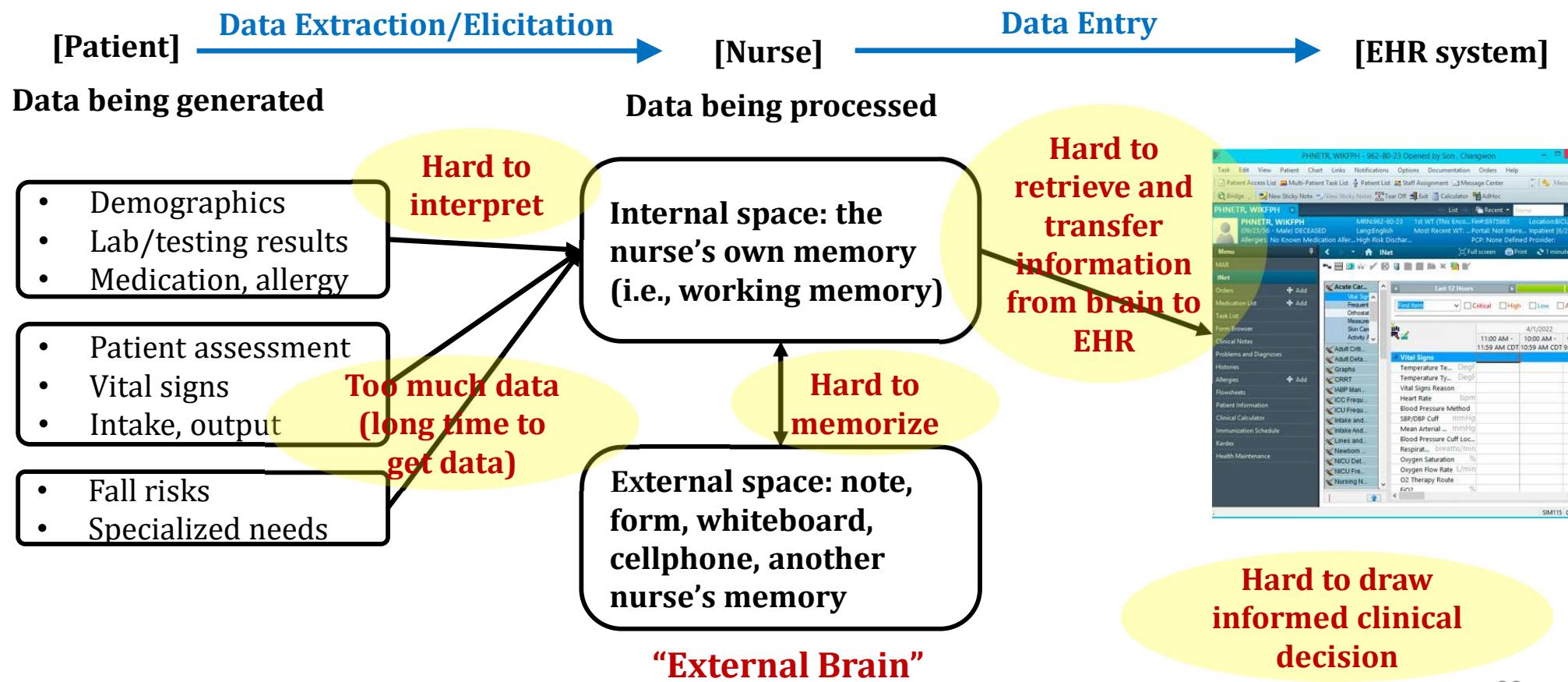
# Project : EE-r

Introduction/ Experiments/ Results/ Conclusion



# Project : EE-r

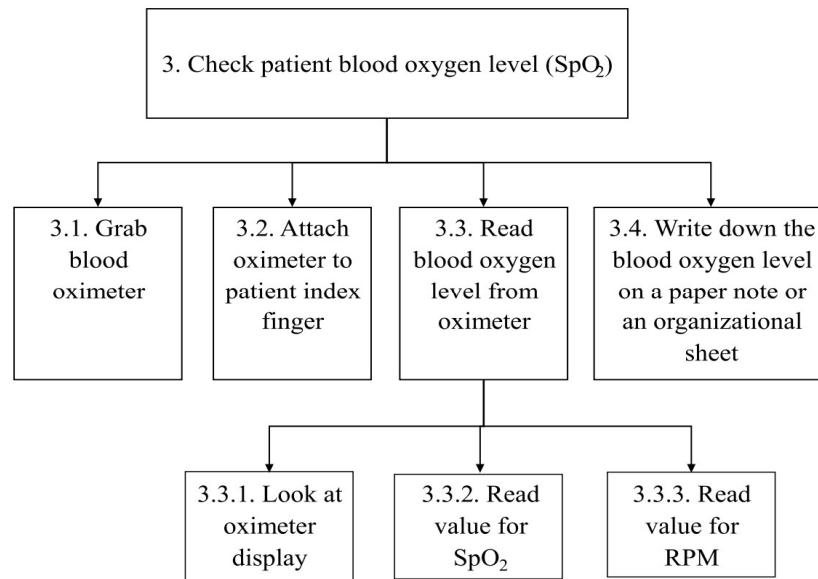
Introduction/ Experiments/ Results/ Conclusion



# Project : EE-r

## Introduction/ Experiments/ Results/ Conclusion

- Mixed Methods : Hierarchical Task Analysis, Thematic Analysis, Content Analysis



[1] Vaughn, A., Son, C., Baek, S., Caballero, S., & Decker, S. (2023, October). A Mixed-Methods Approach to Understanding Nursing Students' Cognitive Challenges and Workarounds during EHR-related Tasks. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (p. 21695067231192633).

[2] Vaughn, A., Son, C., Baek, S., Caballero, S., & Decker, S. (2023). Identifying EHR Novice Users' Cognitive Challenges: Mapping Critical Nursing Tasks Using HTA. In Proceedings of the International Symposium on Human Factors and Ergonomics in Health Care (Vol. 12, No. 1, pp. 24-30).



Thank You 😊

# Additional Projects

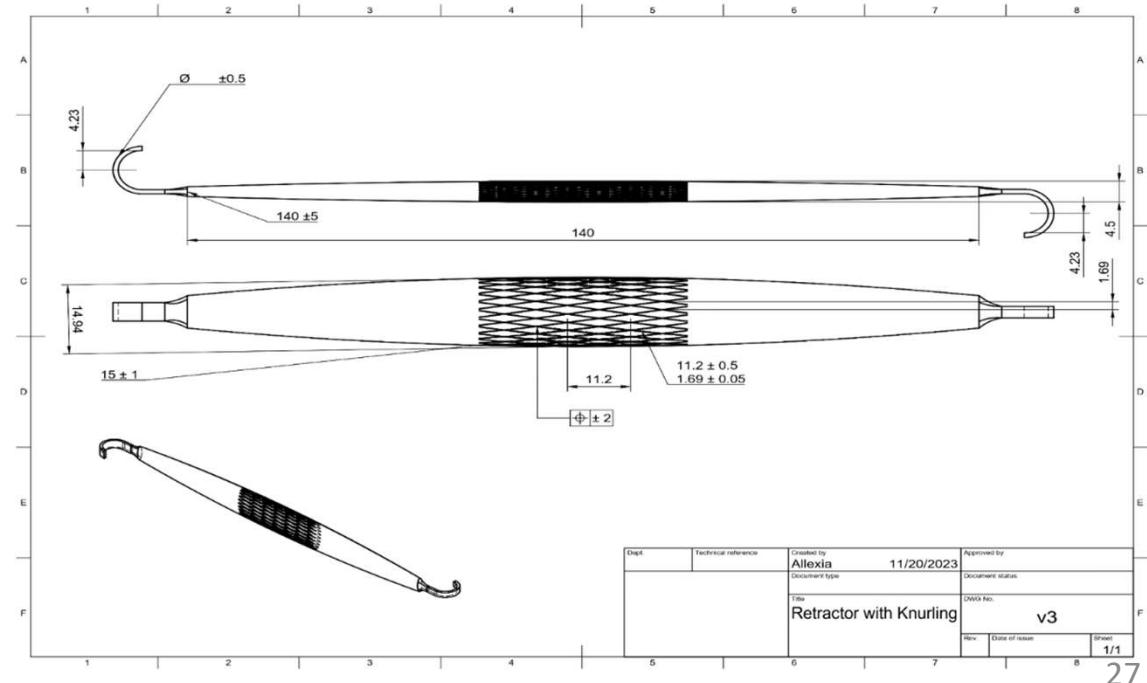
- A Biometric Authentication Technique Using Smartphone Fingertip Photoplethysmography (PPG) Signals, Aug. 2023 – Current
- Inhalation injury grading using transfer learning based on bronchoscopy images and mechanical ventilation period, Jan. 2023 – Current
- Identifying of Fashion trend and matching rate using machine learning, Jan. 2023 – Aug. 2023

# Additional Projects

- A Study on the Improvement of Usability of School furniture – Desks and Chairs, Jul. 2019 – Dec. 2019
- Development of De-Identification Solution for Privacy Protection in Personal Big Data, Apr. 2018 – Nov. 2018

# Class Project : Biomedical and Manufacturing design

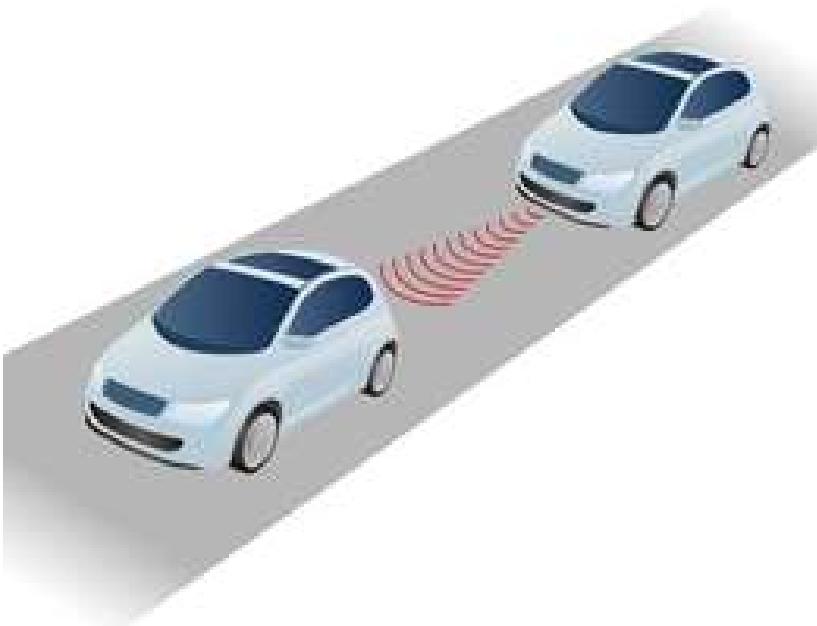
- Ragnell Retractors Revisions  
improvement to surgical retractors to reduce a surgeon's hand slipping when performing orthopedic surgery



# Class Project : Digital Signal Processing

- Measuring vehicle speed and distance using radar signals in Cruise Control

- ✓ Frequency Analysis:



- Mastered **sampling theory** to understand discrete representation of continuous signals.
    - Harnessed the power of **Fourier Transforms** to pinpoint frequencies in complex signals.
    - Extracted crucial information from high-frequency radio waves used in **Adaptive Cruise Control (ACC)** systems.
    - **Signal-to-Noise Ratio (SNR) and Quantization Noise theories** revealed the importance of bit depth for accuracy.

# Class Project : Digital Signal Processing

- Measuring vehicle speed and distance using radar signals in Cruise Control

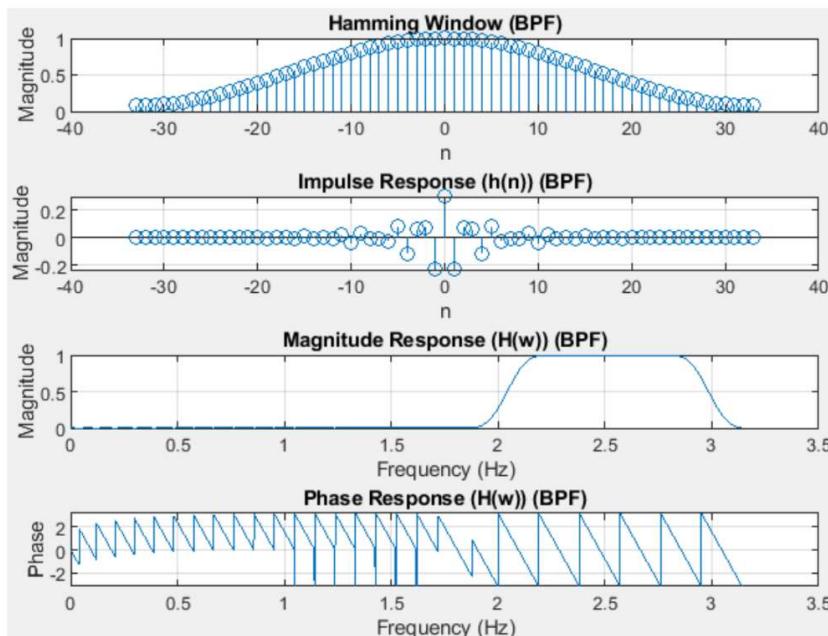


Fig. 8. Hamming window, Impulse and Frequency response of BPF

✓ Bandpass Filters:

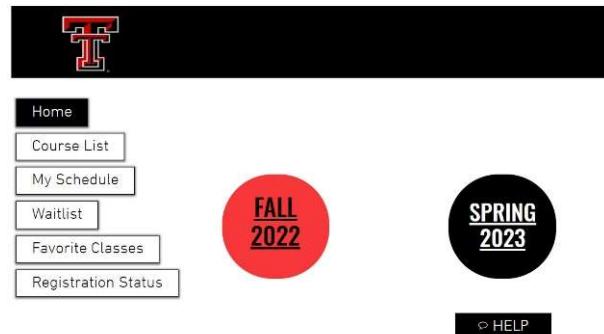
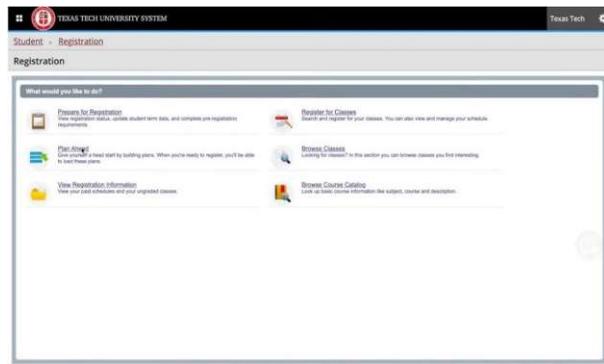
- Explored the creation of **Bandpass Filters (BPF)** derived from **Lowpass Filters (LPF)**
- Witnessed the **trade-off between ideal filter characteristics and computational cost** at higher sample frequencies.

✓ Conclusion:

- Demonstrated the versatility and practical applications of DSP principles.
- Witnessing the real-world application of DSP principles solidified their **importance and potential**.

# Class Project : Human Factors

- Evaluation and Initial Prototype Design of the Texas Tech University Registration System



Mission Statement :  
Looking for inefficiencies in the system

- halting their registration process
- missing out on classes that become filled
- delaying their registration



**design a new system**

A student should be able to register for a class with no assistance from faculty, friends, and/or an academic advisor