



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

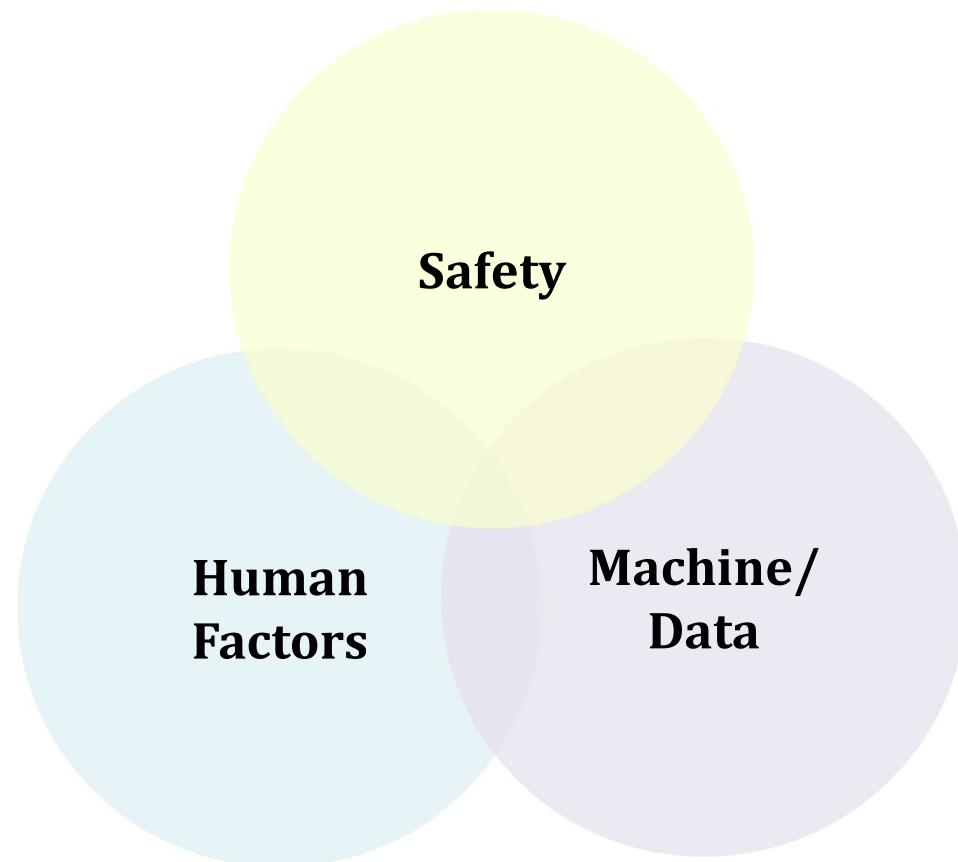
Analyzing intricate data flows

- reducing uncertainty and enabling resilience in algorithmic flows

About Me

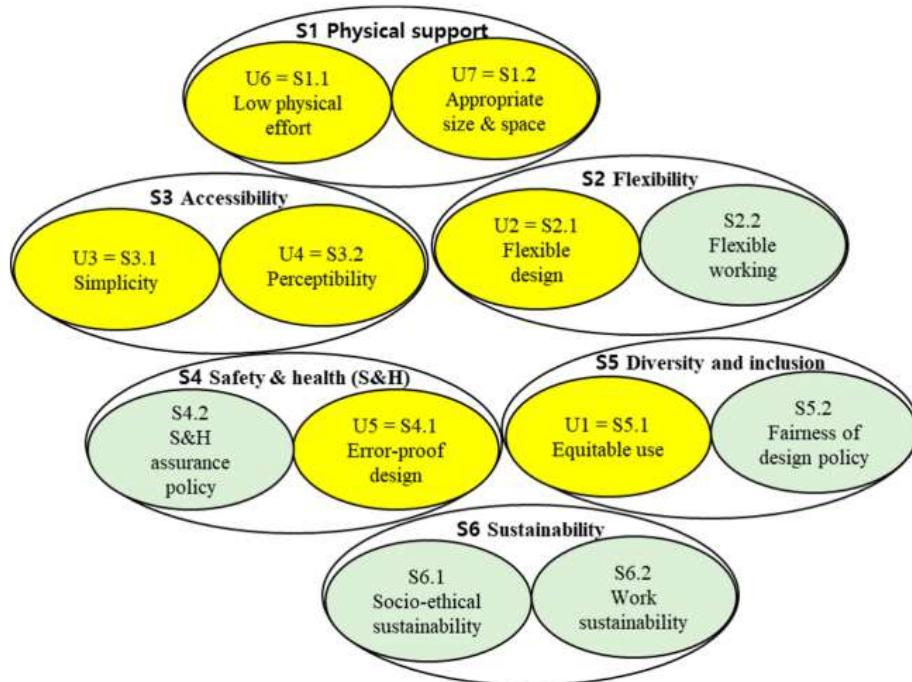


Research Identity



MS Thesis : User-Centered Design with Safety

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



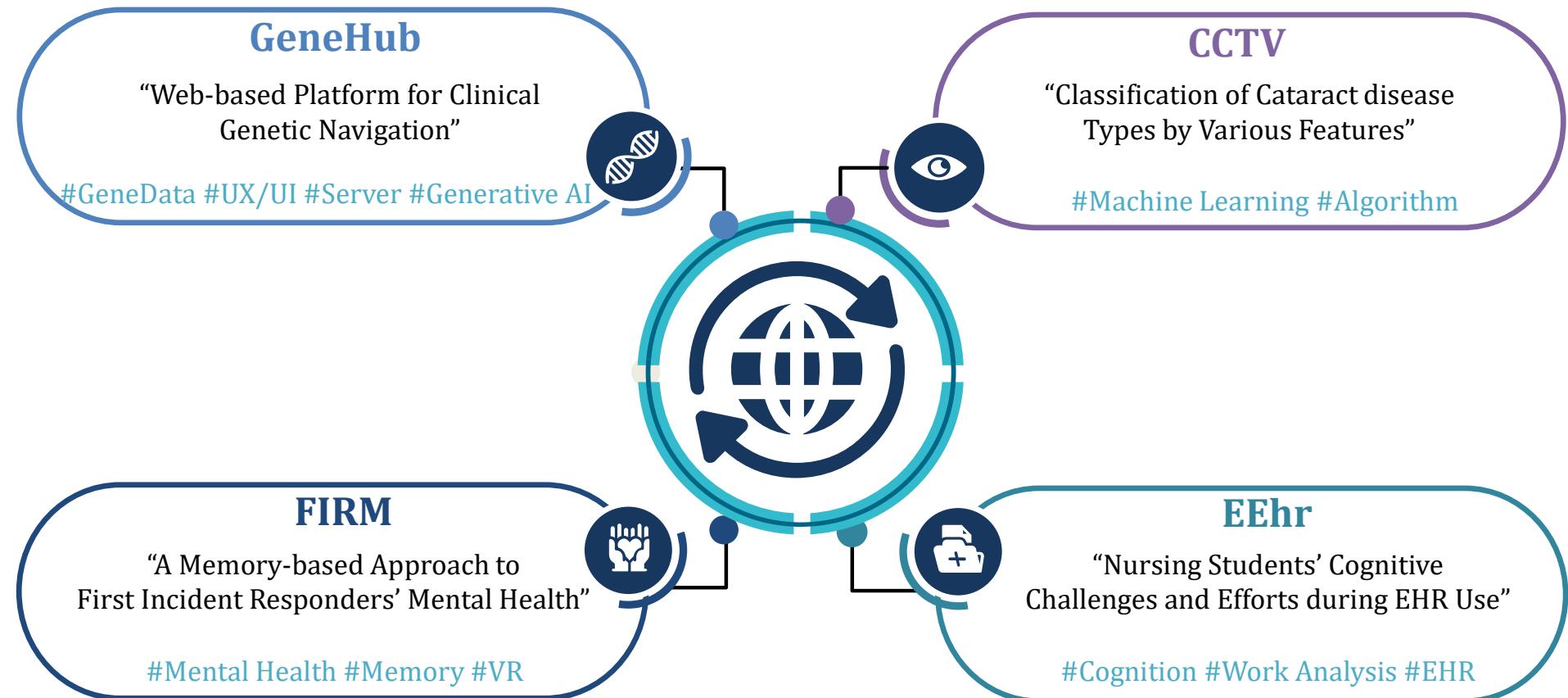
USD Guidelines	UD ($y = f(x_1, x_2, x_3, x_4)$)		UD ($y = f(x_1, x_2, x_3, x_4, x_5)$)	
	B	p	B	p
(Constant)	0.161	0.087	0.155	0.076
Physical support (x_1)	0.240	0.001 *	0.218	0.001 *
Flexibility (x_2)	0.184	0.001 *	0.155	0.001 *
Accessibility (x_3)	0.362	0.001 *	0.345	0.001 *
Safety and health (x_4)	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	

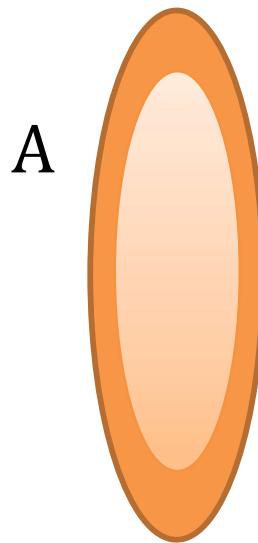
* Significant at significance level 0.01.

Leading Projects



Project : CCTV

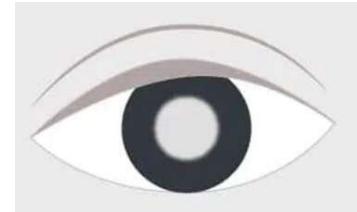
Introduction/ Experiments/ Results/ Conclusion



lens

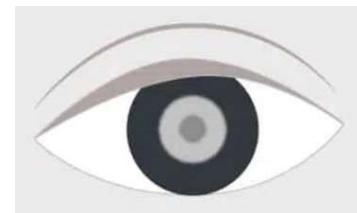
▪ Nuclear sclerosis

- “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



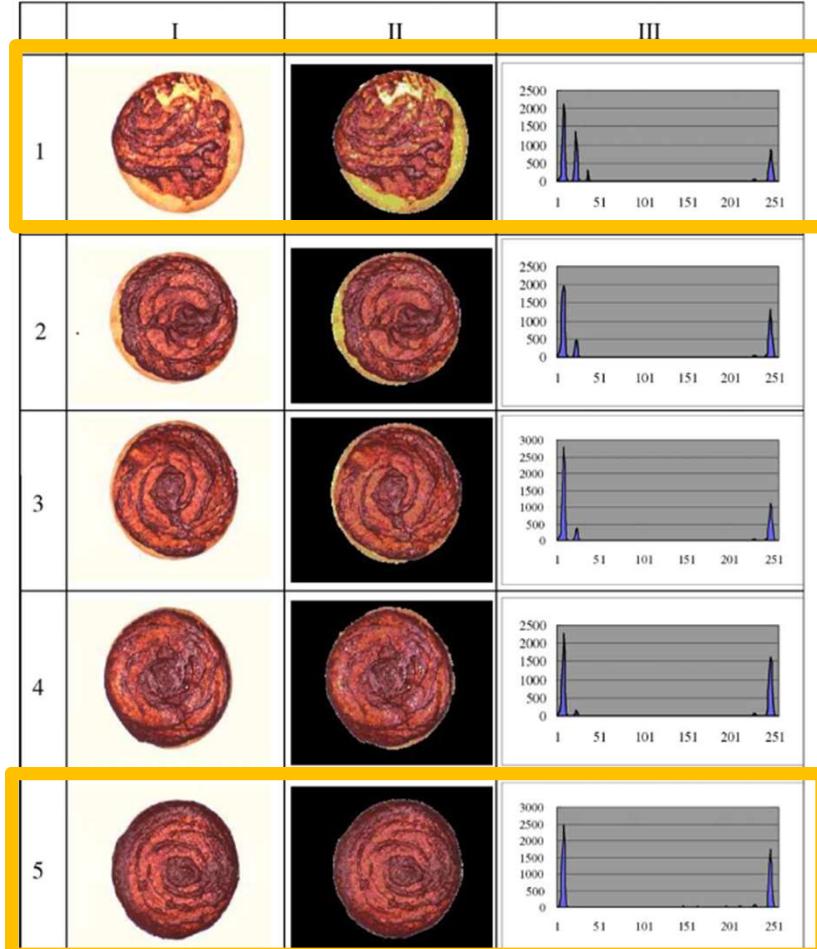
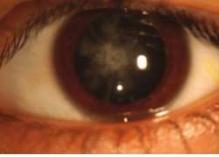
▪ Cortical

- 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

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

- 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.

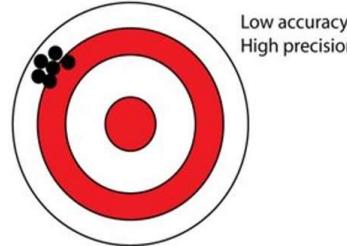
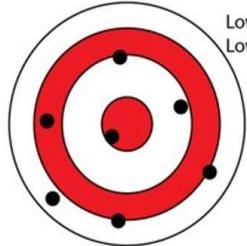
- Fuzzy Logic (ambiguous degree calculation)
- Classification using SVM

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.

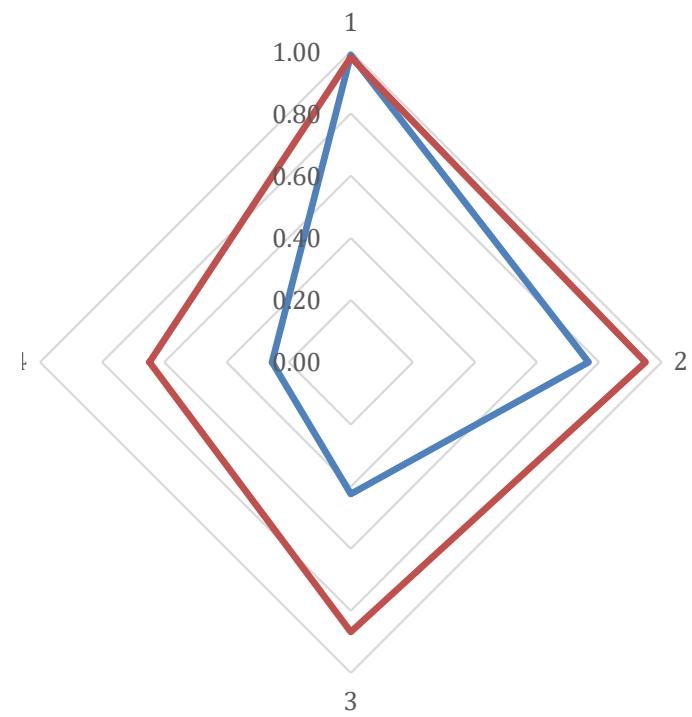
Du, C. J., & Sun, D. W. (2005). Pizza sauce spread classification using colour vision and support vector machines. *Journal of Food Engineering*, 66(2), 137-145

Project : CCTV

Introduction/ Experiments/ Results/ Conclusion



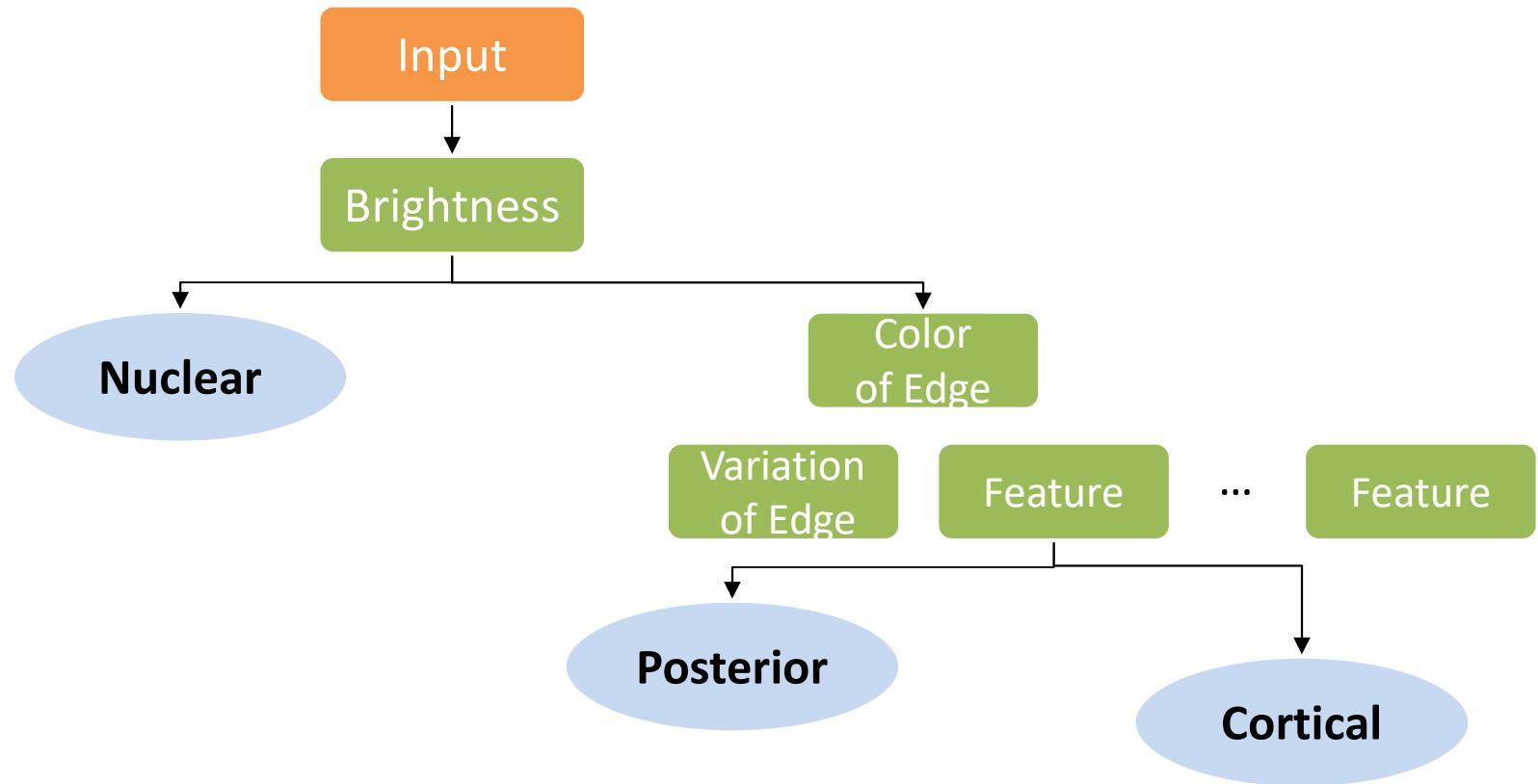
— cortical — posterior



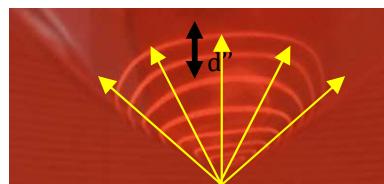
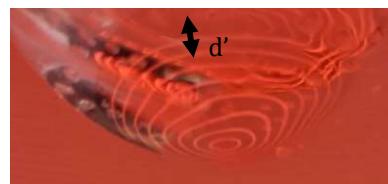
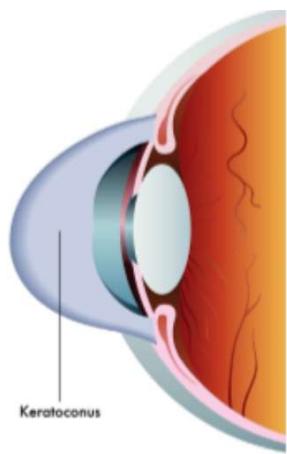
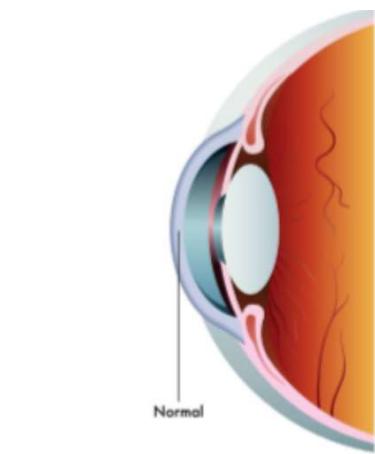
Project : CCTV

Introduction/ Experiments/ **Results**/ Conclusion

- decision tree algorithm for machine learning

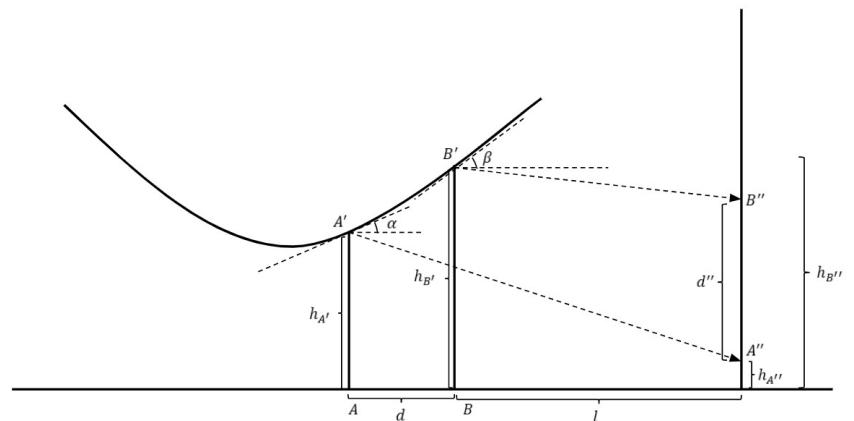
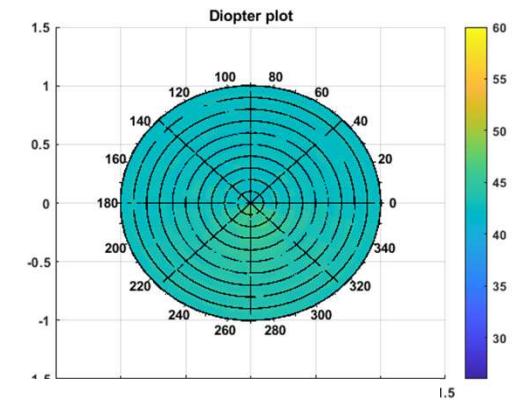
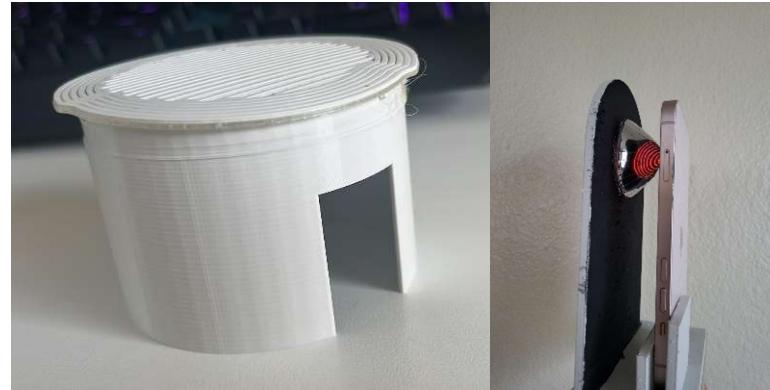


Projects : Keratoconus



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

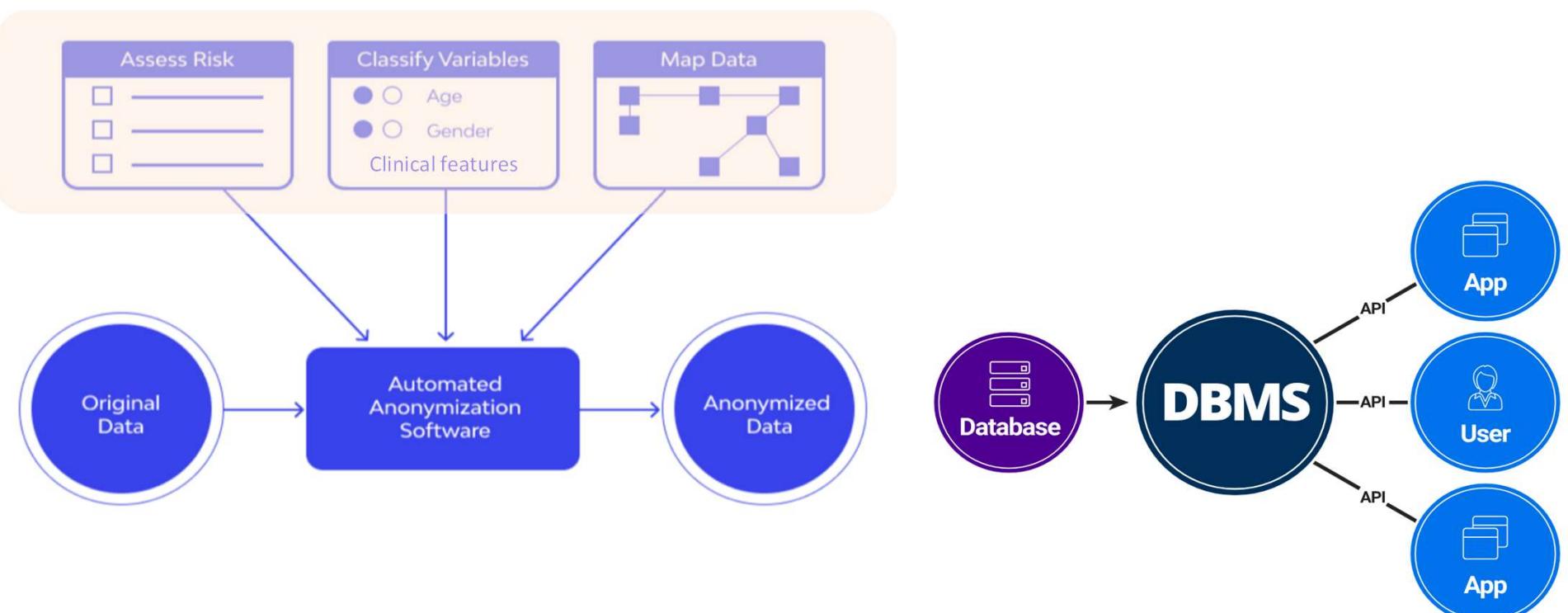
- a free-to-use site that presents simplified, clinically oriented information on the symptoms and treatments of genetic conditions
 - collate existing information on genetic conditions into an accessible, clinically specific database

The image shows three main sections of the GeneHub website:

- Homepage:** Features a large DNA helix graphic. A search bar at the top right contains the placeholder "Search Symptom/Syndrome/Genetic name". Below the search bar are filter buttons for "All", "Student", "Doctor", "Pharmacist", and "Research". A button labeled "Search" is located to the right of the search bar.
- Featured Research:** Displays three research cards:
 - Parkinson**: Associated with SNCA, LRRK2. Symptoms include Tremors, Bradykinesia, Rigidity, and Postural instability. A "See details" button is present.
 - Zellweger Syndrome**: Associated with PEX1, PEX6, PEX26. Symptoms include Severe hypotonia, Facial dysmorphisms, Hepatomegaly, and Vision and hearing impairment. A "See details" button is present.
 - Huntington**: Associated with HTT. Symptoms include Movement abnormalities, Cognitive decline, Behavioral changes, and Decline in motor skills. A "See details" button is present.
- Cystic Fibrosis:** A detailed page for Cystic Fibrosis. It includes:
 - Primary symptoms:** Persistent coughing up sputum, Repeated lung infections, Greasy stools, Poor weight gain and growth.
 - Clinical Description:** Cystic Fibrosis causes an overproduction of thick, sticky mucus that can damage many of the body's organs. The most common signs include chronic coughing, recurrent lung infections, and digestive system, respiratory, and pancreatic problems.
 - Treatments:** A table showing drug names and their status:

Drug Name	Status
Nexium	Approved
Lumacaftor	Approved
Glyburide	Approved
Bumetanide	Approved
 - Similar Diseases:** Kartagener Syndrome, Alpha-1 antitrypsin deficiency.
 - References:** Links to GeneCards, MedlinePlus, and Cystic Fibrosis Foundation.

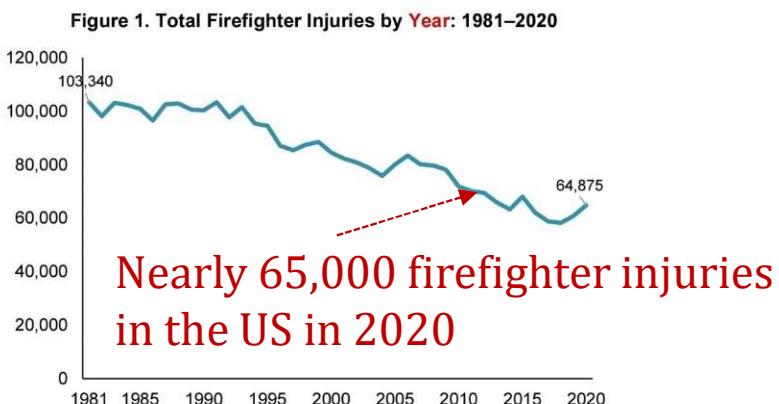
Project : GeneHub



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,...

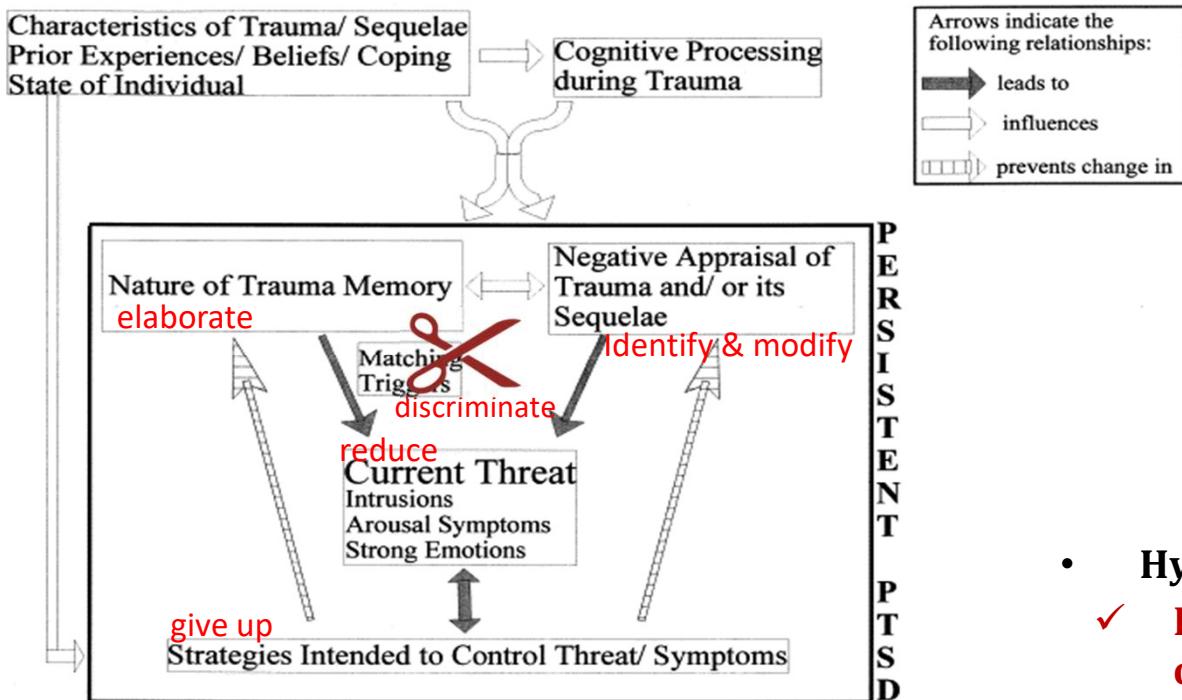
- Research Gap: Limitations of previous efforts for first responders' mental health

- ✓ 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

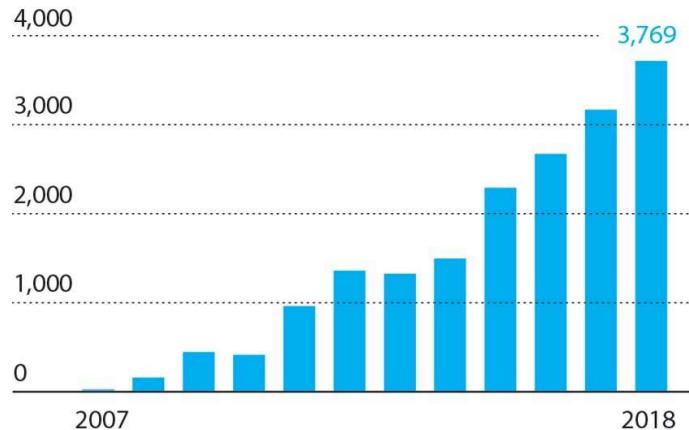


Source: <https://khn.org/news/death-by-a-thousand-clicks/>

DANGER SIGNS

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

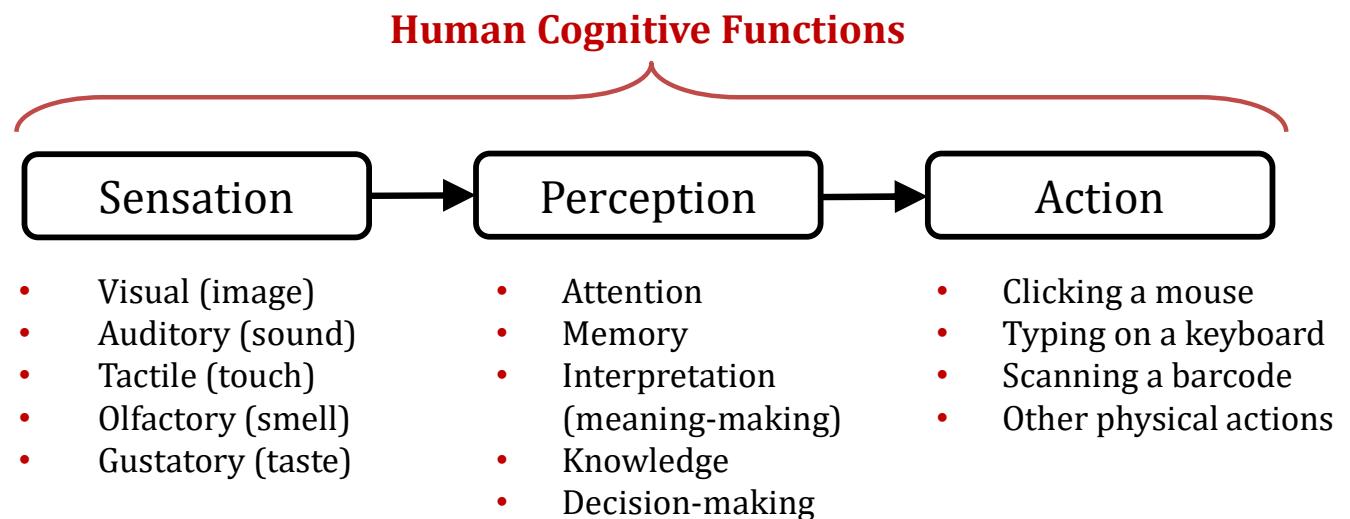
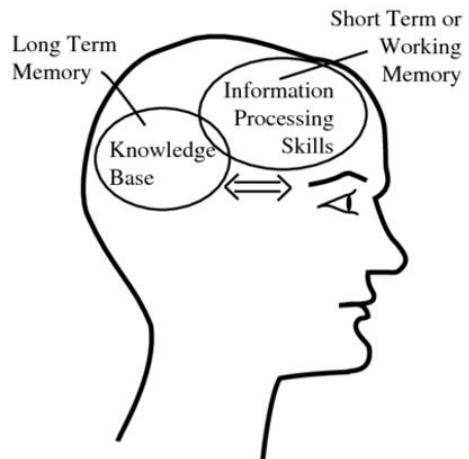
SAFETY-RELATED INCIDENTS LINKED TO EHR OR OTHER IT



SOURCE: QUANTROS

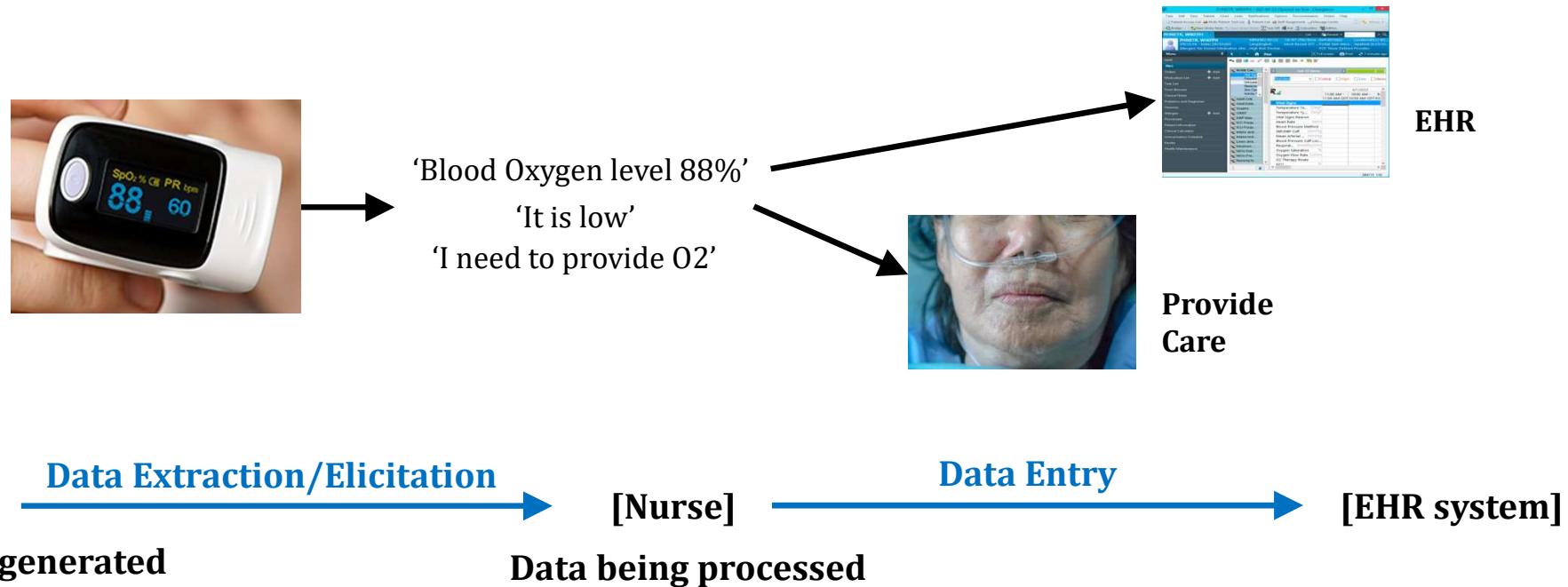
Project : EE-r

Introduction/ Experiments/ Results/ Conclusion



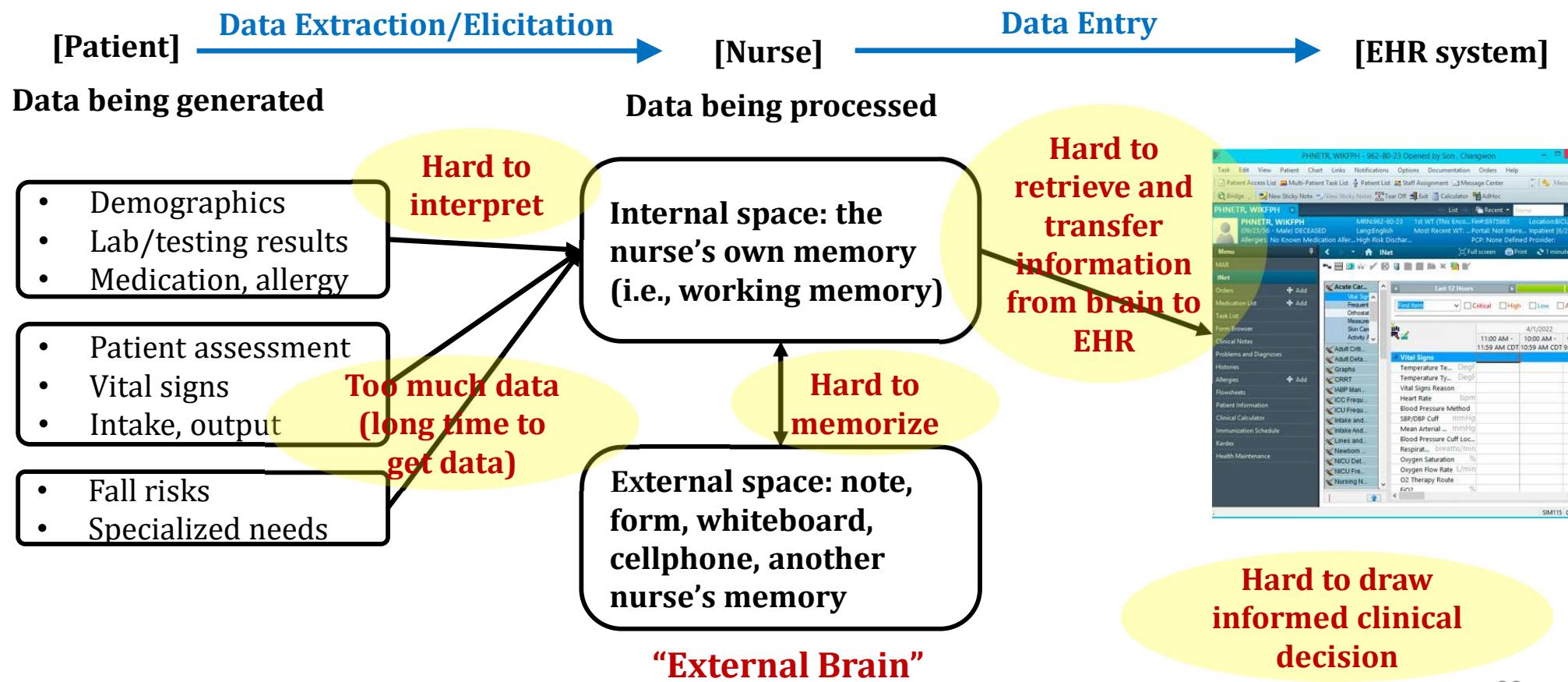
Project : EE-r

Introduction/ Experiments/ Results/ Conclusion



Project : EE-r

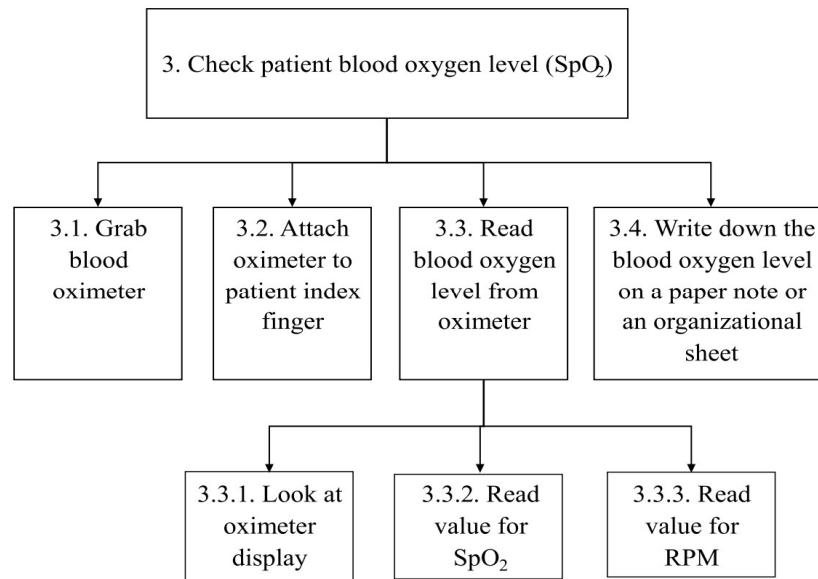
Introduction/ Experiments/ Results/ Conclusion



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

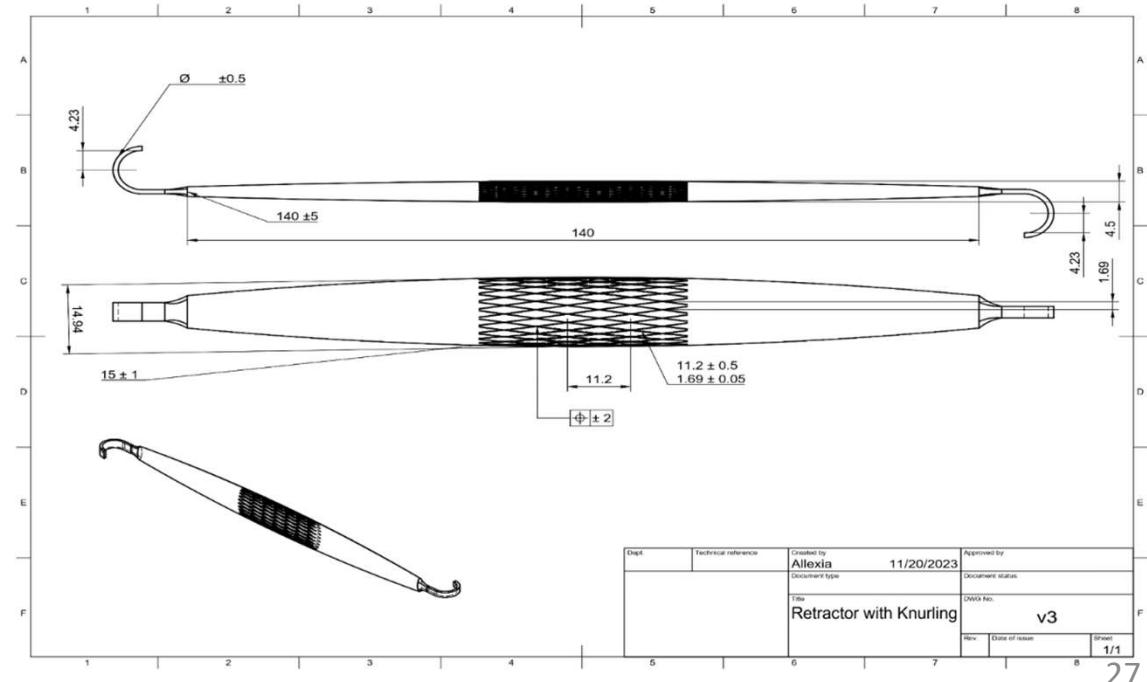
- A Biometric Authentication Technique Using Smartphone Fingertip Photoplethysmography (PPG) Signals, Aug. 2023 – Current
- Inhalation injury grading using transfer learning based on bronchoscopy images and mechanical ventilation period, Jan. 2023 – Current
- Identifying of Fashion trend and matching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

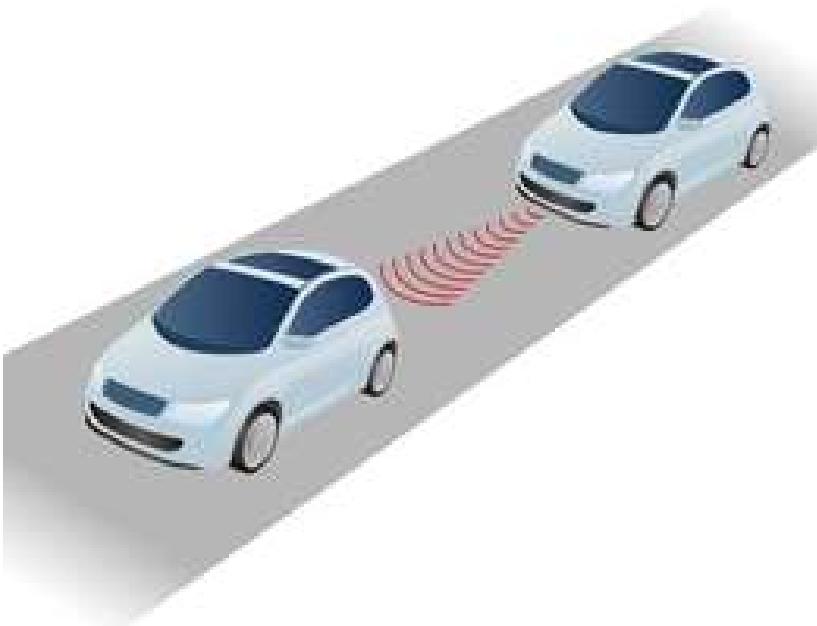
- Ragnell Retractors Revisions
 - improvement to surgical retractors to reduce a surgeon's hand slipping when performing orthopedic surgery



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

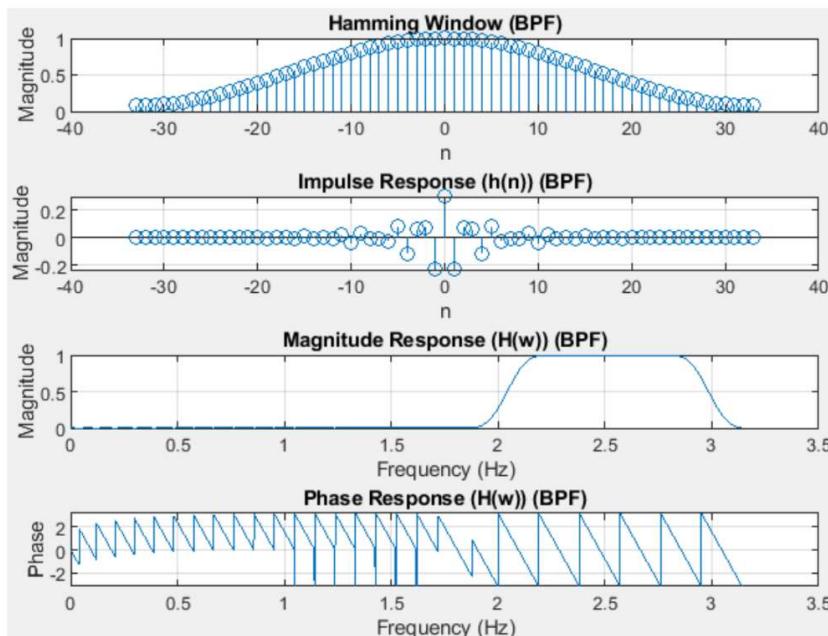


Fig. 8. Hamming window, Impulse and Frequency response of BPF

✓ Bandpass Filters:

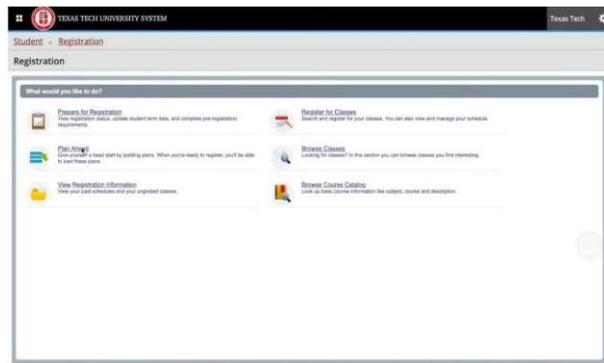
- Explored the creation of **Bandpass Filters (BPF)** derived from **Lowpass Filters (LPF)**
- Witnessed the **trade-off between ideal filter characteristics and computational cost** at higher sample frequencies.

✓ 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