Towards Super-Human Decision Making: A Framework for Decision Support Delivery

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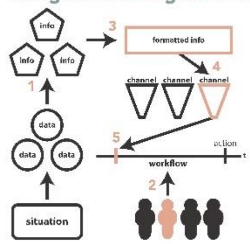
VISION

Background: 5 Rights of Decision Support



A decision support system should get:

1. the right **information**
2. to the right **person**
3. in the right **format**
4. through the right **channel**
5. at the right **point in workflow**

Previous Work

Right #1: extracting actionable information[3]
Right #2: pre-defined mapping (operator to system)[2]
Rights #3-5 (Decision Support Delivery): specialized approaches in healthcare[5], aviation[4], military[1], etc.

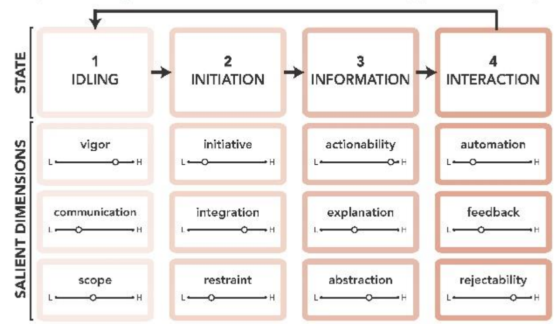
Research Question & Proposed Solution

Q: How can we unify the findings into a domain agnostic framework to better meet the last three Rights of Decision Support?

A: By identifying the key design dimensions in the state cycle of a decision support delivery event.

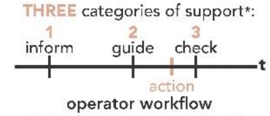
STEPS

Step 1: Design Framework for Decision Support Delivery



Step 2: Support Taxonomy

THREE categories of support*:



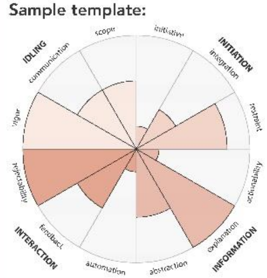
*adapted from Parasuraman et al.'s model[4]

Step 3: Quantification

Experimental process:

1. Create design templates
2. Implement DSS's
3. Determine exemplar for each category of support

Sample template:



NEWS

Step: 1☑ 2☑ 3☐

Current Work:
Journal paper to present design framework

Up Next:
Labor & Deliery Simulation DSS Experiments

CONTRIBUTIONS

This work contributes to the field by:

1. Unifying the disjoint findings on DSS design from various domains
2. Providing a framework for discourse in troubleshooting and improving DSS's
3. Working to bridge the gap between intelligent systems and human operators

Key References

1. Chai, H., & Du, Y. (2012, August). A framework of situation awareness based on event extraction and correlation for military decision support. In Mechatronics and Automation (ICMA), 2012 International Conference on (pp. 192-196). IEEE.
2. Klann, J. G., Szolovits, P., Downs, S. M., & Schadow, G. (2014). Decision support from local data: creating adaptive order menus from past clinician behavior. Journal of biomedical informatics, 48, 84-93.
3. Liao, S. H. (2005). Expert system methodologies and applications—a decade review from 1995 to 2004. Expert systems with applications, 28(1), 93-103.
4. Parasuraman, R., Sheridan, T. B., & Wickens, C. D. (2000). A model for types and levels of human interaction with automation. Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on, 30(3), 286-297.
5. Van Der Sijs, H., Aarts, J., Vulto, A., & Berg, M. (2006). Overriding of drug safety alerts in computerized physician order entry. Journal of the American Medical Informatics Association, 13(2), 138-147.

Acknowledgements

Thank you to Professor Julie Shah, Matthew Gombolay, Jessie Stickgold, and the 6.UAR staff.

SuperUROP 2015–2016
MIT School of Engineering

186

Robert McIntyre

Aldehyde-Stabilized Cryopreservation

A technique for whole-brain nanoscale brain-banking

aurellem.org/ASC

Vision

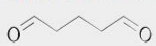
To create a **brain banking** technique which can:

1. Preserve whole brains of any size.
2. Preserve brains indefinitely.
3. Preserve nanoscale details such as synapses.
4. Be compatible with common neuroanatomical stains and tests.

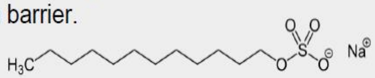
Aldehyde-stabilized cryopreservation (ASC) is the first brain-banking technique to meet all four of these criteria.

Steps

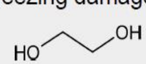
- Deliver **glutaraldehyde**, a chemical fixative, via **perfusion** to crosslink proteins and rapidly stabilize the brain's structure.



- Use **sodium dodecyl sulfate (SDS)**, a surfactant, to permebalize the brain's blood brain barrier.

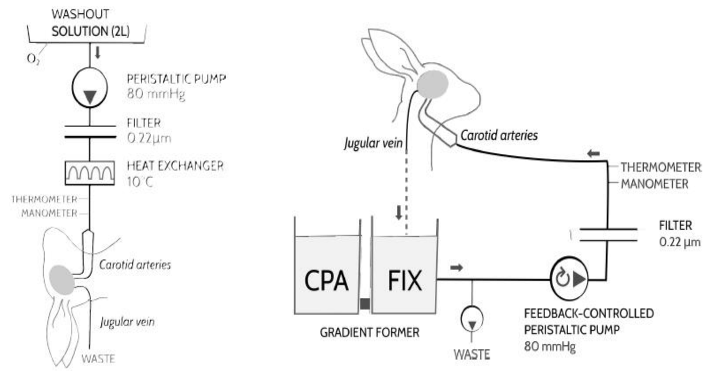


- Slowly add **ethylene glycol**, a cryoprotectant, to prevent freezing damage.

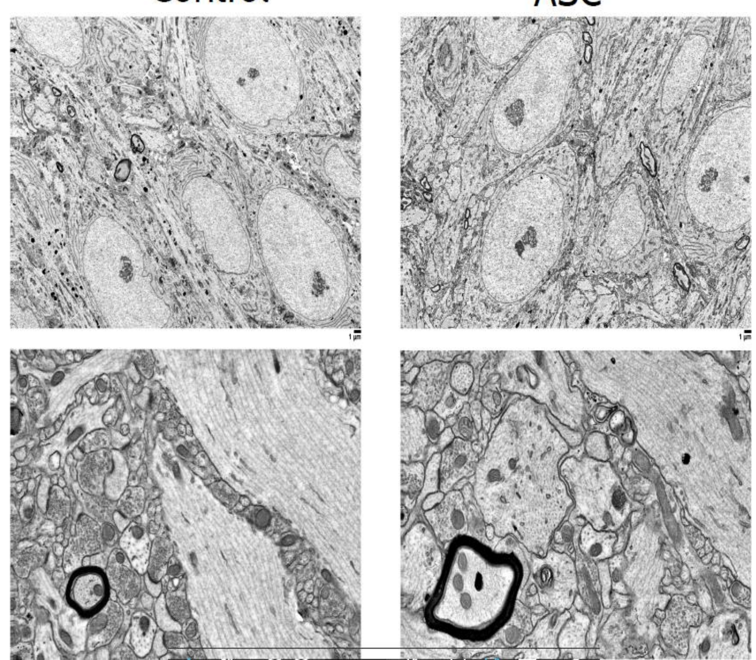


- Store the brain at -135°C indefinitely.

Methods and Results



Control | ASC

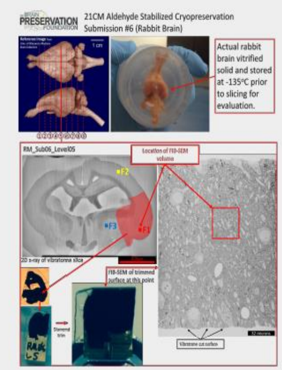


News

- Published in *Cryobiology*.

  McIntyre, Robert L., and Gregory M. Fahy. *Aldehyde-stabilized cryopreservation*. Cryobiology 71.3 (2015): 448-458.

- Using ASC-preserved brains, we won the **Brain Preservation Foundation Small Mammal Prize** Feburary 2016.



Contributions

- Created Aldehyde-Stabilized Cryopreservation (ASC), the first whole-brain nanoscale brain banking technique.

- Showed that ASC enables long term preservation of valulable brain samples.

A Natural Language Understanding System Based on Sequence-Seeking

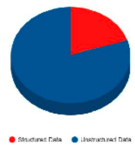
MIT | Massachusetts Institute of Technology School of Engineering

SuperUROP 2015–2016

Josh Haimson, Patrick Henry Winston
MIT EECS Research and Innovation Scholar

Natural Language Understanding

Most Data is Unstructured



Humans Naturally Interact Through Language

Google now

Siri

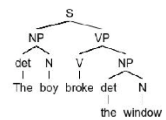
IBM Watson

amazon echo

Natural Language Understanding aims to build computer systems that **communicate through language** and **learn from existing language data**

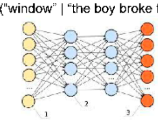
Current Approaches Have Limitations

Computational Linguistics



Statistical Natural Language Processing (NLP)

p("window" | "the boy broke the")

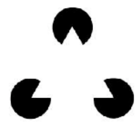


Counterexample: "The boy the ball window broke"

Humans regularly use and understand **ungrammatical** and **ambiguous** language, while most computational systems cannot

Vision: Align Expectations with Perception

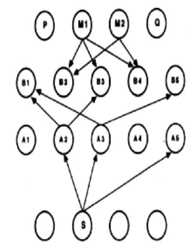
"The whole is *other* than the sum of its parts"

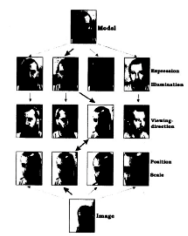


A mental model of a triangle is aligned with the image above so that it is perceived as a triangle rather than circular segments

Research Goal: Demonstrate a Natural Language Understanding system that understands ambiguous language by **aligning models of language with perceived information**

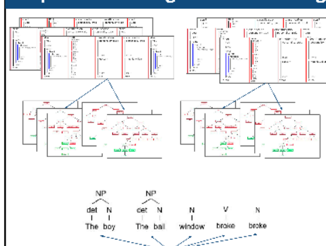
Sequence-Seeking Mimics Perceptual Alignment





The sequence-seeking algorithm finds a **sequence of transformations** from high-level models to perceived information

Sequence-Seeking for Natural Language



"The boy the ball window broke"

Stories provide context

Models learned from stories constrain meaning

Grammar constrains language

Grammar and context provide constraints which are used to find transformations from stories to perceived messages

Anticipated Contributions

Demonstrate a natural language understanding system capable of understanding ambiguous and ungrammatical language

Implement the sequence-seeking algorithm to align models of language with perceived messages

Implement grammar as a bottom-up information stream which constrains language

Implement context as a top-down information stream which constrains possible interpretations

Demonstrate how top-down models can be built from a set of stories