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Augmented Reality for Quantum Mechanics

Visualizing Particle Physics for CERN

The first time I saw augmented reality was on the yelp monocle app. I knew right away it would be perfect for particle physics. I had no experience with quantum mechanics other than reading about entanglement on Wikipedia during my employ as a waiter. I was at community college but knew I had to get the vision into the minds of the folks at CERN. Easy, right?

Well, after a degree in cognitive science and 3 years of designing augmented reality interfaces in Silicon Valley, I'm a little closer! I'll pull my thoughts from the report I wrote for the Electric Power Research Institute at the end of 2017 where I found that CERN OpenLab had "… mapped 16 information communication technology challenges in the coming years (CERN accelerating science), two of which may be applicable to energy implementations":

- Use Case 3.1.3: Fast Inference Systems for "Trigger" Systems
- Use Case 3.1.4: Anomaly Detection and the Search for New Physics

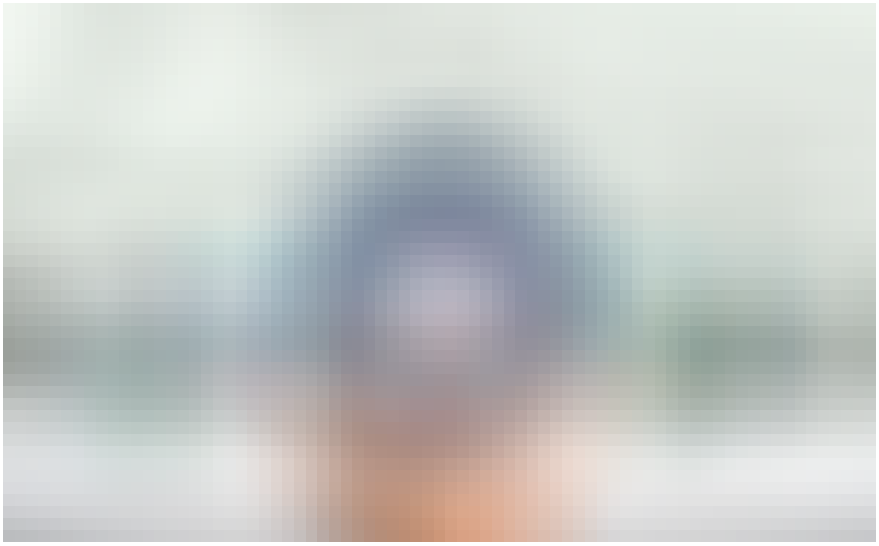
In this section of the paper I tried to design an Augmented Reality application leveraging type of artificial intelligence that I'll leave to the reader to peruse in the report. For brevity, let's jump into the interface! The following is a copy paste from the report I wrote:

Hologram #1 Selecting Experiments to Adjust Deep-Learning Algorithms

UX by Micah Tinklepaugh, Graphic by Matt Oakley

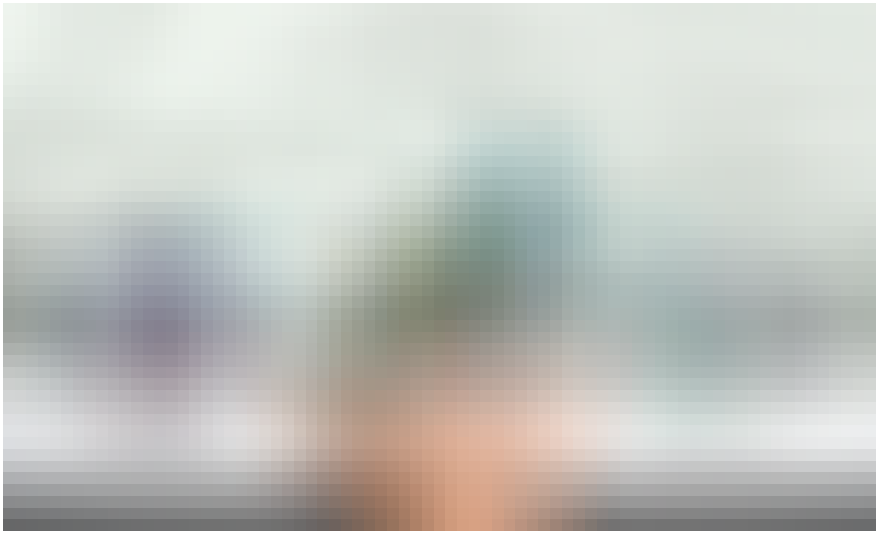
Imagine you are in a control room at the Large Hadron Collider. You see a large scatter plot with three axes displaying various tests indicating various data dimensions for modeled and real experiments across five variables depicted by dimensions X, Y, and Z, as well as color and size. This will allow the scientist to search through hundreds of experiments whether modeled or physically executed on the accelerator, meaning the scientist can update inferences made by the AI based on the results considered more important.

Hologram #2: Experiment Success Assessment.



You then see the rotatable 3D model of the CERN particle collisions. This visualization might help the scientist to determine that some parameters in the GAN may need to be altered to collect a different sort of data.

Generative Adversarial Network Training



The last visualization is a picture of the GAN as it reverses samples or performs deconvolutions. The physicist can directly edit the parameters for the GAN to update its ideal states and rewards. “How,” you ask? That remains to be seen. This augmented reality user interface is taking

a first step in starting to depict it, but much more conceptual work needs to be done. This final application state depicts a GAN that creates and recommends various experiment configurations based on perceived signals in a system. The value is that its agents do not have to run through models or train themselves for the years that it would otherwise take because they can make inferences to quickly find the right conditions for the scientists, which frees the scientists to include other non-deterministic influences on the system that the GAN just won't think of itself.

Next Steps

I'm going to Geneva and standing outside of CERN. Seriously. These are the smartest people in the world and they likely have better things to do than talk to me but even breathing in the same air may spuriously increase my chances of structuring serendipity. I used to study in the UC San Diego Geisel library as a 27 year old waiter in community college believing it would get me in. They even rejected me once. But it worked. Why wouldn't this?

I'll make stuff for NASA. Seriously. I work in energy research. I can't just dive into theoretical physics. There are more overlaps between telemetry and monitoring and controlling physical systems for both aerospace and energy applications than for theoretical physics. But there is certainly an overlap between aerospace applications and quantum physics because of the sheer complexity. So solve one problem in set {E, A} and I have credibility to solve problems in {A, P}. It is faster and more probable than getting a PhD in quantum physics with a post doc building AR interfaces—at least that was my underlying assumption in 2013 and it seems to still hold true. Granted, NASA has no idea who I am—nor should they—but I did make this first prototype last week and am starting to have conversations with professors and industry.

I'll use my environment as leverage. Good scientific application design is all around us. Take this design called "Shaking Man" by Terry Allen in the Metreon:

We can see how he depicts past, present, and future—multiple states in time in a way that I've only seen done in works by Picasso and contemporaries such as the 'Girl with the Mandolin':

Pablo Picasso, 1910, Girl with a Mandolin (Fanny Tellier), oil on canvas, 100.3 x 73.6 cm, Museum of Modern Art, New York. Link to the work at the MoMA This image can have no independent copyright as it is simply a faithful reproduction of an old, public domain, two-dimensional work of art published in the United States prior to 1923.
https://en.wikipedia.org/wiki/File:Pablo_Picasso,_1910,_Girl_with_a_Mandolin_(Fanny_Tellier),_oil_on_canvas,_100.3_x_73.6_cm,_Museum_of_Modern_Art_New_York..jpg

The main difference is that Allen's sculpture shows positional change in time relative to an object where as Picasso shows positional changes relative in time relative to the observer's position. Note that neither need to be linear. So my approach is to approach science through the lens of art and vice versa—which is likely a function of society being more interdisciplinary. I'll begin to unpack this idea explicitly in a series reflecting on "Gödel, Escher, Bach: An Eternal Golden Braid" after I

finish my series on "The Society of Mind" by Marvin Minksy . My writing is in much need of editing and further critical introspection.

Have criticisms?

You are not alone! I'd love to hear from you about the ways the visualization method may be redundant or how an alternative could accomplish this better. Though please do not share any intellectual property as I will not read or respond to that here or in email. Only post information you wish to be in public domain.

Special thanks to:

- John Simmins who read the stuff I wrote on Augmented Reality for energy applications on the Space Time Insight blog.
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