Aha! Gauge Equivariance

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Draft 1.01
2020 January 12

I recommend reading this entire article in its entirety:

Publication: Quanta Magazine
Article: An Idea From Physics Helps AI See in Higher Dimensions
URL: https://www.quantamagazine.org/an-idea-from-physics-helps-ai-see-in-higher-dimensions-20200109/

Quanta Magazine's articles are extraordinarily well-written, and cover interesting topics, that read well and resonate.

ITEM

This from the article in Quanta Magazine. The article is about AI deep learning pattern or features recognition. Here's the quote that jumped out:

> These approaches still weren't general enough to handle data on manifolds with a bumpy, irregular structure — which describes the geometry of almost everything, from potatoes to proteins, to human bodies, to the curvature of space-time. These kinds of manifolds have no "global" symmetry for a neural network to make equivariant assumptions about: Every location on them is different.
>
> An infographic showing an edge-detecting filter passing over the surface of a cylinder along two different paths, and ending up in two different orientations.
>
> The challenge is that sliding a flat filter over the surface can change the orientation of the filter, depending on the particular path it takes. Imagine a filter designed to detect a simple pattern: a dark blob on the left and a light blob on the right. Slide it up, down, left or right on a flat grid, and it will always stay right-side up. But even on the surface of a sphere, this changes. If you move the filter 180 degrees around the sphere's equator, the filter's orientation stays the same: dark blob on the left, light blob on the right. However, if you slide it to the same spot by moving over the sphere's north pole, the filter is now upside down — dark blob on the right, light blob on the left. The filter won't detect the same pattern in the data or encode the same feature map. Move the filter around a more complicated manifold, and it could end up pointing in any number of inconsistent directions.
>
> Luckily, physicists since Einstein have dealt with the same problem and found a solution: gauge equivariance.

The key, explained Welling, is to forget about keeping track of how the filter's orientation changes as it moves along different paths. Instead, you can choose just one filter orientation (or gauge), and then define a consistent way of converting every other orientation into it.

With various things we're taught, or pick up, or experience, or ways we orient in the world, and the domains of life (the mental, the existential, the social, the societal, the experiential, the physical), and the subjects, things, people, and various situations and topologies we encounter, and our sense of time, it may be that, indeed, "Every location on them is different" and "...sliding a flat filter over the surface can change the orientation of the filter, depending on the particular path it takes." and "data on manifolds".

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Postulate: Psychiatry's answer to various realistic situations: psychiatric meds.
Postulate: The above holds true, and disorientation results in a significant percent of society.
Postulate: Many in mainstream society turn to psychiatry in case of disorientation.
Postulate: Mainstream society is a significant percent of society.
Postulate: Mainstream society coerces a percent of outliers-of-behavior to use psychiatric meds (and not rely on re-orientation, explanation, or instruction).
Postulate: Mainstream society coerces a percent of those facing disorientation to use psychiatric meds (and not rely on re-orientation).
Result: 25% of us are on psychiatric meds.

ITEM

"If you are in the business of recognizing cats on YouTube and you discover that you're not quite as good at recognizing upside-down cats, that's not great, but maybe you can live with it," he said. But for physicists, it's crucial to ensure that a neural network won't misidentify a force field or particle trajectory because of its particular orientation. "It's not just a matter of convenience," Kondor said — "it's essential that the underlying symmetries be respected."

Those psychiatrists must be trained in mind, with all their schooling, to use crude CNNs, if that, that would overlook fields and trajectories, even particles, in actual fact! :-)

They need to step up their scientific game, imho!!!

They're certainly overlooking underlying symmetries, even anti-symmetries, with all their schooling – and the DSM. Ouch! How'd they attain they're status???

ITEM

Cohen can't help but delight in the interdisciplinary connections that he once intuited and has now demonstrated with mathematical rigor. "I have always had this sense that machine learning and physics are doing very similar things," he said. "This is one of the things that I find really marvelous: We just started with this engineering problem, and as we started improving our systems, we gradually unraveled more and more connections."

Right! From *Surely You're Joking, Mr. Feynman!* (one should read the entire book, but I'm thinking of "Uncle Sam Doesn't Need <u>You</u>!") in 1986 to physics undergrad and Tufte to *No Ordinary Genius* by Christopher Sykes to Minsky and Zen to Objective-C programming to the experiential-observational, Wittgenstein, others, and Zen to present-state MVO: 2019 Thesis, mvo-p, and 'all of the above' – and all of the above. – Me!

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Enjoy!

Kevin