

## 68 3/3/26 – Note on Efficacy of ML and Beautiful Algos

One cool thing about ML is how effective it is in domains where classical algorithms don't work well or are very slow. Computer vision tasks like object recognition are all ML, and ML is very effective and fast in dynamical systems, like simulating fluid flow.

The low dimensional manifold hypothesis offers an idea of why ML has been so successful with very complicated, high dimensional data, that classical algos haven't worked. If true, it also implies that there's, for example, probably extremely nice poly-time approximation algorithms for CFD, since after all, matrix multiplications and thresholds like ReLU are basically a programming language (not turing-complete (but in fact turing complete with recurrence/chain-of-thought/thinking like with autoregressive transformers), but a single forward pass can solve all decision problems in the class TC0 (threshold circuits)) that you can do program search on, using gradient descent and clever ML tricks.

These programs may or may not be human comprehensible. I think they are, mechanistic interpretability has had remarkable success in teasing apart circuits in LLMs and toy models, like networks that perform addition. So there's probably an algorithm for fast CFD that we can actually understand and appreciate the beauty of. I'd like to see it.