Proceedings of the 9th International Conference of Control Systems, and Robotics (CDSR'22)
Niagara Falls, Canada – June 02-04, 2022
DOI: 10.11159/cdsr22.002

Universal Laws and Architectures and Their Fragilities

John Doyle
California Institute of Technology, USA

Abstract - The past year unfortunately highlighted intrinsic and systemic unsustainability and fragilities in our society and technologies. While detailed mechanisms underlying "systemic fragilities" in immune, medical, computing, social, legal, energy, and transportation systems are incredibly diverse, all are enabled by shared universal features of their architectures, which are largely ad hoc historical artifacts. AI has many well-known fragilities, but outside social media has not so far contributed substantially to the catastrophes unfolding in these systems. This is poised to change dramatically. We need to more systematically design architectures that produce more robust and sustainable systems, including allowing higher layer learning and lower layer efficiencies to contribute. I'll sketch the basic concepts of laws, layers, levels, speed-efficiency-accuracy-flexibility tradeoffs (SEAFTs), diversity-enable sweet spots (DeSS), how crucial hardware layer constraints on sparsity, locality, and delay limit system layer functionality, and how proper layering can mitigate this via DeSS. Examples include all our tech nets, layered brains (e.g., throwing and hitting 100mph fastballs), layered immunity augmented by medicine and policy (and insights into the current pandemic), systemic legal fragilities and the 14th amendment, cascading failures in energy, climate change, language and its hijacking in social media, encouraging animal models for social architectures, and wildfire ecosystems.