**Crutchfield, Ditto & Sinha (2010): “Intrinsic and Designed Computation: Information Processing in Dynamical Systems—Beyond the Digital Hegemony.”** ([pubs.aip.org](https://pubs.aip.org/aip/cha/article/20/3/037101/932297/Introduction-to-Focus-Issue-Intrinsic-and-Designed?utm_source=chatgpt.com))

**🌱 1. Motivation & Scope**

The paper asks: how do **dynamical (nonlinear, often analog) systems** store and compute information—particularly as Moore's Law slows and we explore alternatives to digital CMOS? This intersects with foundational ideas in dynamical systems, probability, logic, communications, and computing.

**2. Defining Two Computational Modes**

* **Intrinsic computation**: How a system naturally processes and stores information through its own dynamics—without external control.
* **Designed computation**: Engineered information processing, where computation is imposed via external inputs or configuration.

The distinction emphasizes that natural systems compute in their own, often unexpected ways.

**3. Focus Issue Contributions**

The paper introduces a curated collection of studies exploring:

* **Reservoir and dynamical computing** in systems like optical or spin networks.
* **Synchronization and control**—how observers can tune into the hidden states of complex processes (via information-theoretic approaches).
* **Chaos computing**—utilizing nonlinear circuits (e.g. Chua’s circuit) to implement logic gates and reconfigurable logic through a system’s chaotic behavior. ([cambridge.org](https://www.cambridge.org/core/books/once-and-future-turing/designed-versus-intrinsic-computation/E94ACA1FA02E76BDB7C6803B1A0759D1?utm_source=chatgpt.com), [pubmed.ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov/20887067/?utm_source=chatgpt.com), [csc.ucdavis.edu](https://csc.ucdavis.edu/~cmg/papers/Crutchfield.CHAOSIntro2011.pdf?utm_source=chatgpt.com), [arxiv.org](https://arxiv.org/abs/1007.5354?utm_source=chatgpt.com), [frontiersin.org](https://www.frontiersin.org/journals/computational-neuroscience/articles/10.3389/fncom.2015.00049/full?utm_source=chatgpt.com))

**4. Core Themes & Insights**

* **Computational mechanics**: Provides tools (e.g. ϵ\epsilon-machines) to quantify intrinsic information processing by a system.
* **Emergence**: Simple interacting components can produce complex, unpredictable behavior—offering computation beyond conventional logic.
* **Analog as fundamental**: Emphasizes that computation isn't exclusive to bit-based systems; analog, stochastic, and natural systems contribute rich computational capacity.

**5. Why It Matters**

* **Designing new computing architectures**: As CMOS scaling stalls, leveraging dynamical and analog systems offers a path forward.
* **Engaging fundamental theory**: Ties into deep questions: What *is* computation? How does it emerge in nature?
* **Bridging disciplines**: Connects physics, computer science, and complex systems theory.

**🧠 TL;DR**

Crutchfield et al. broaden the idea of computation beyond engineered digital systems, revealing that computation can be intrinsic: emerging from natural dynamics, noise, chaos, and oscillation. The focus issue they introduce dives into both **observation** (how to uncover computation where it already exists) and **design** (how to harness it for new computing paradigms).