

A MAP for the programmable world

Millennia ago, young couples in Egypt prayed to fertility gods with the hope of receiving the gift of a child. Much later, Native Americans performed ceremonial dances to pray for rain and a bountiful harvest. In the middle of the 19th century, the Central European monk Gregor Mendel selectively crossbred pea plants to control the characteristics of their offspring. While the approaches differ, the aim of these endeavors is the same: to set in place levers of control in order to achieve desirable outcomes, or in the vernacular of today, to program. In each case, humans develop formal rules and then run processes intended to deliver specific results. At every stage, we use the latest tools and knowledge of the times in efforts to achieve control of bodies, minds, and surroundings. Now on the horizon are new kinds of tools for programming our world. These tools leverage ubiquitous data and use computational tools to discern patterns in data, create computational representations of various systems, and tweak them to achieve desirable outcomes.

This map is designed to help you navigate an emerging computational world, to engage with the new tools for programming while, at the same time, to understand the limitations and potential pitfalls of new tools and approaches.



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While the prospect of programming everything may be appealing, we must remain mindful that a century from now our most-advanced tools for decoding and controlling the world may look as primitive as rain dances seem to many scientists today. The computational lens brings with it a set of assumptions and potential pitfalls that we need to keep in mind lest we misuse tools we have barely begun to learn.



OPPORTUNITIES

The diffusion of sensors, communications, and processing power into everyday objects and environments will unleash an unprecedented torrent of data and the opportunity to see patterns and design systems to produce desirable outcomes on a scale never before possible. The era of “everything is programmable” brings in new opportunities for organization and individuals.

- **New Lenses on the World:**

Continuous data streams will create a window onto many complex systems and interactions at unprecedented scope and resolution. We will literally see the world through a new set of eyes.

- **Modeling Everything:**

We will gain new appreciation for complexity and will have access to increasingly sophisticated tools and methodologies for modeling complex systems and phenomena.

- **Programming for Desired Outcomes:**

Computational tools will reveal solutions to problems previously thought to be intractable. We will have the opportunity to deal with challenges by tweaking systems to produce desired outcomes, or by building new ones from the bottom up informed by powerful simulations.

- **Re-thinking Metrics:**

New data will reveal the complexity of multiple phenomena, requiring us to re-think existing, often simplistic, indices with which we measure development, success, and failure—from GDP to corporate success.



ASSUMPTIONS

The computational metaphor for programming the world around us rests on three assumptions:

1. All phenomena, material and non-material, can be described as data within a system, i.e., all systems are computational in nature.
2. The data has an underlying structure and meaning that can be decoded.
3. Once the data is decoded, the system can be computationally manipulated (programmed) to achieve desired conditions.

While those assumptions may hold true for many physical systems, artificial intelligence pioneer Noel Sharkey reminds us that “the idea of mind or brain as computational is merely an assumption, not a truth.”

PITFALLS

We must be mindful of the potential for computational models to become warped mirrors of reality. As we learn to use the new tools of the programmable world, several “rules to live by” emerge:

- **Models are Not Reality:**

Our computational models are only as good as the data feeding them. The map is not the territory. We need to remember that even the best models are approximations of reality and not reality itself.

- **Expect Unexpected Consequences:**

Micro-programming of many sub-systems by many individuals and organizations could result in problematic consequences at the macro level. As much as we try to control for a variety of outcomes, the world is much too complicated and unpredictable to be subject to complete control.

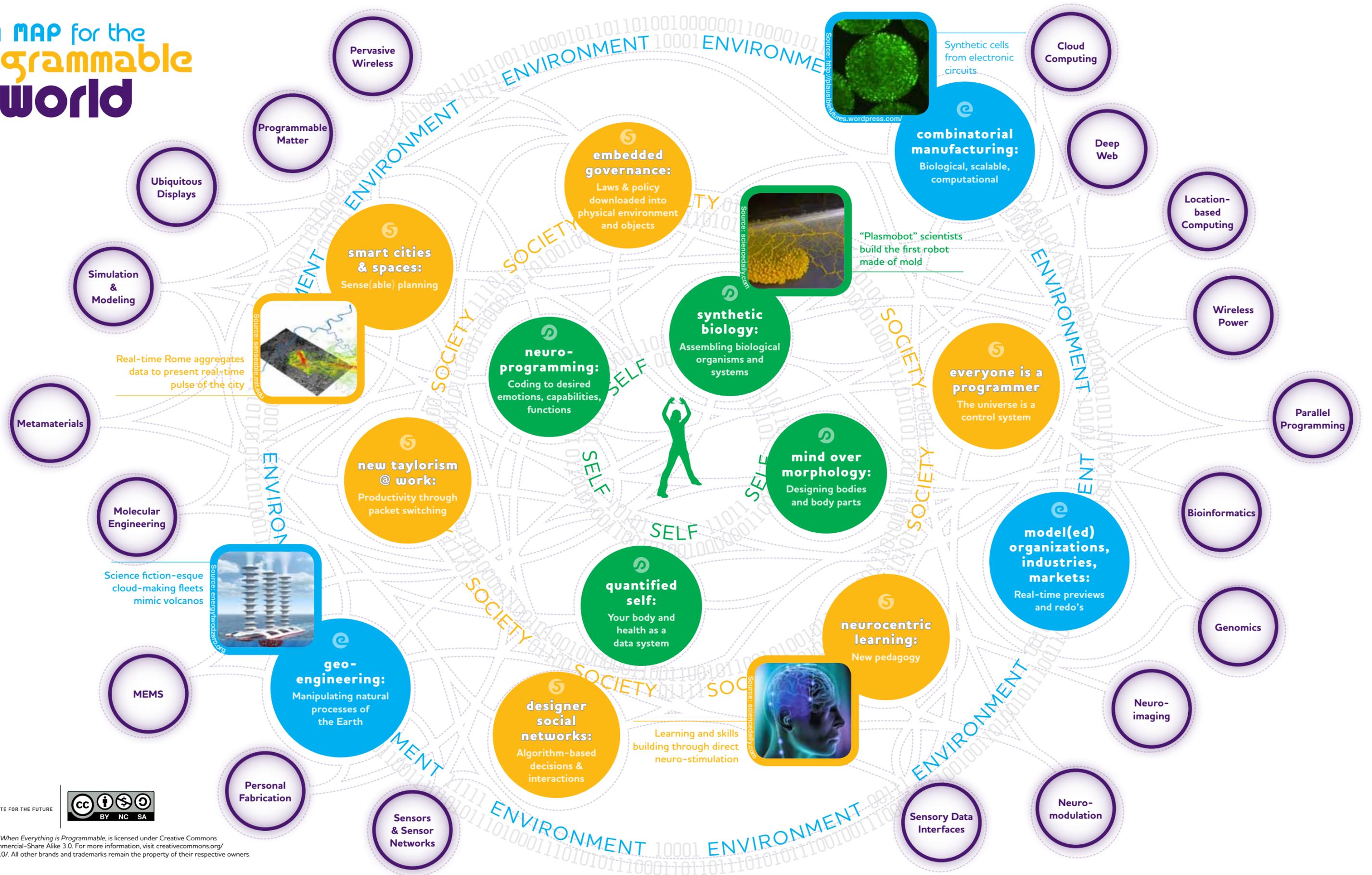
- **Be Wary of Turning “Programmers” Into the New Ruling Class:**

To achieve the democratic promise of a programmable world, we must avoid ceding control to coders. Living in a world where programmers embed their own ideas for governance in our machines can lead to a new tyranny by code.

- **Don’t Abandon Intuition:**

Will we be able to make decisions without relying on our models and simulations? Will we be unable to act in the absence of data? We must not become paralyzed when lacking an algorithm or the latest upgrade for every system to guide our lives.

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HOW TO USE THIS MAP

This map is a synthesis forecast of how advanced computational, sensing, and programming tools will re-shape our world, and where to expect the greatest disruptions in the next ten years. The map is organized around three concentric layers or rings of impact, from self to society and environment.



Layer one, at the heart of the map is the **PROGRAMMABLE SELF**. As we understand more about how our minds and bodies work, and continue to bridge the gap between our bodies and our machines, what new affordances will we create? What are the challenges we'll face?



Layer two, the next ring out, is about **SOCIAL PROGRAMMING**. While the phrase has an Orwellian tone, the concept embodies opportunity, from programming for organizational optimization to designing office spaces for maximum creativity.



Layer three, on the outside represents the **PROGRAMMABLE ENVIRONMENTS**, where tools like nanotechnology, advanced simulations, and reconfigurable robots could be used to program matter and possibly even repair our ailing planet.



FORECASTS

What are the key shifts we are about to experience as a result of everything becoming programmable? The 12 core forecasts synthesize the most important stories. These are the future forces that will reshape our reality over the coming decade.



SIGNALS

What are the early signs of the new programmable world? Sprinkled throughout the map are present-day signals—products, projects, companies, examples—that indicate important directions of change.



TECHNOLOGIES

Encircling the entire map are the key enabling technologies that will make the programmable world possible. The streams radiating from the technologies suggest intersections with the domains where they are most relevant.