Introduction to Complexity and Applied Complexity, Spring 2021

Module 0 — Introduction

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Readings

- None

Intuition Through Unlearning

What is the pedagogical approach that we will take with this course?

For starters, this is not a technical course. We will use some math and computational stuff, but we will try to introduce what we use as gently as possible. Really, this is a course that'll help build ***intuition***, by way of what we'll call unlearning. That unlearning primarily will take place in the assumptions we hold. The assumptions we make about a system are generally where the errors sneak in, and then all of the reasoning that follows, of course, is affected. So, there'll be a big focus on unlearning commonly held but hidden assumptions — surfacing them, questioning them, and gaining some sensitivity to applying them in the right places. We're not trying to just learn new facts. We also want to make better decisions. We want to better understand the mapping from assumptions to the real world, figure out where they work and don't work, and develop a frame of mind that helps us operate in the complex world we find ourselves in.

None of the models we'll use are meant to capture the world in full. We won't use models to try to predict what's going to happen — a model is not a crystal ball. Of

course, whenever you mention this to people, they will acknowledge that fact, but when it comes to their behavior, they'll tend to use them as a crystal ball anyway. It's really important to try and pull that sort of bad practice out of the world as best we can.

Another similar comment: complexity is itself a very complex topic. There is no consensus view on these things. How terms are used varies from person to person, and that makes it more challenging. All the readings we will go through present the perspective of the author. No single reading is meant as an authoritative source on something in a complete sense. The readings are really just meant to get the conversation going and get the ideas in place.

The different concepts that make up this space are linked together in various ways. It's not something you can go through in a linear sequence and get the full picture. You have to traverse through the network of concepts many times before you start to get a feel for where you are in that concept space. To that end, we'll try to revisit the main, foundational themes again and again as we move along, to highlight how the fundamental stuff is reappearing in different contexts and in different guises. The idea is to get a holistic perspective, not just to "download information" into your brain. Rather, we're trying to soak in the space, the ideas and the framing of the world. It might turn out that this holistic, big picture view is blurry. Yet it's actually better to have a blurry big picture than it is to focus on a very precise, narrow, detailed account of some piece of this space.

The Arc of the Course

Let's give a broad outline of the arc of the course. There are four phases that we'll go through. We won't strictly stick to this outline, some things will appear out of order as there are interesting connections and whatnot, but the general arc is as follows:

- **Fundamental concepts:** We will use computational models to demonstrate how few assumptions are needed for certain kinds of phenomena to occur, which is rather enlightening.
- **Living systems:** Biological systems, organisms, ecosystems, evolutionary development. This class of systems represents another order of complexity beyond what the fundamental concepts cover. As it turns out, the behavior of these kinds of systems become very informative and enlightening when we look at other kinds of systems, including highly technical systems, software systems, things like that.
- **Decision making in complex environments:** Decision making under uncertainty, where there is risk involved and things of that nature.
- **Functional complexity:** By this, we mean things that work — engineering, design, software systems, architecture, agriculture, political systems and so on. How do we not just *make* decisions within a complex environment, but how do we *generate systems* that demand there be complexity for them to do what they do?

So that's the big overview. Let's go through each point in slightly more detail, just to tease a little more out.

Fundamental Concepts

We'll start by clearly showing the insufficiency of commonly held, unstated assumptions. People do all sorts of analyses or carry out all sorts of engineering processes, all of which typically have unstated assumptions that don't match the real world. In addition, we want to establish the relationship between specific kinds of assumptions — and those assumptions being met in a particular system — and common classes of behavior we observe. Think of this as a kind of allegorical approach

to looking at these models. We have these models that we can treat as narratives, in a sense, that tell us how things would behave if assumptions ABC are met. And then we can look at the world and say, are these assumptions met? Should these assumptions be met? Should we seek for our systems to meet these assumptions?

Living Systems

In phase two, when we're looking at living systems, the following are important:

- Self production and survival — what makes certain systems persistent, and what kinds of properties do systems need to have to survive in the world?
- Developmental processes — how do we understand, and how do we think about the complexity of, say, an individual organism? And of course, we have this amazing set of interactions and functional complexity that makes us alive. How we come to be is very, very telling about how things need to be constructed if they are to be complex and functional.
- Evolution and ecosystems — where do things come from, what does order emerge out of?
- Finally, we'll take a look at behavior, cognition, perception and action. A lot of assumptions about how these work in individual organisms turn out to be incorrect in demonstrable ways. If you can reframe how people actually operate or how agents operate in a complex world, it'll change how you develop systems, make decisions, etc.

Decision Making in Complex Environments

Phase three, decision making in complex environments is about operating under uncertainty. Complexity begets uncertainty in a necessary way. We'll explore situations where there's some irreducible amount of uncertainty. Where do we draw that line? How do we make decisions knowing that things will be uncertain — a kind of certainty about uncertainty. And of course, a big part of that is looking at systemic risk and, and behavior of large scale systems.

Functional Complexity

Finally, phase four is about generating *functional complexity*, as we're calling it. We'll look at approaches to design, how we think about design processes with a respect for complexity, and the challenges it brings. This approach looks different from design processes that don't have that kind of sensitivity to complexity. We will also think about applications to engineering and human organizations. How are human organizations structured? What are the implications of those structures? And of course, we'll get to politics and society — something very crucial in this day to think about. How should we structure our political systems such that we're not constantly in turmoil, constantly in tension, constantly on the brink?