Minding an Ecology of Steps: Toward a Practice of Attention-Flow Computing

[DRAFT - WORK IN PROGRESS]

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> "Frequency of validation of an idea within a given segment of time is not the same as proof that the idea is either true or pragmatically useful over long time. We are discovering today that several of the premises which are deeply ingrained in our way of life are simply untrue and become pathogenic when implemented with modern technology." – Gregory Bateson, "Steps to an Ecology of Mind"

> "People need new tools to work with rather than tools that "work" for them. They need technology to make the most of the energy and imagination each has, rather than more well-programmed energy slaves." – Ivan Illich, "Tools for Conviviality"

Introduction

This essay maps a path toward a practice and a technology I call attention-flow computing. Attention-flow computing is a way of extending basic ways of participating in situations with tools that meaningfully support participating in these situations. Computing today is rigid, requires a great deal of development effort to create any semblance of limited contextual fit, and most typically distracts from basic modes of interaction rather than enriching them. It lacks a robust grip on context, and can only pretend to work with content. Attention-flow computing is proposed as a way for our tools to be flexibly expressive, follow context, and augment personal and social tasks. The essay has three parts, in sum bridging the mechanical resources of computing with the ecological domain of perception and semiotics. The first part addresses the problem of context, the second part explores how information content is constructed socially given the facilities to scaffold and generalize task context, and the third explores how our tools can participate deeply and meaningfully in these processes via an attention-flow approach.

About This Essay's Approach

In the article "Centers of Attention" (TODO: link) I motivate attention-flow from empirical and theoretical research, citing the sources that I rely on to do some of the heaviest lifting. In this article I do not cite sources, and instead work backwards from high-level intuitions to fill out increasing detail. The emphasis here is on presenting the simple elegance and directness of this approach to computing, with as few potentially distracting complications as possible. Everything written here is either explained further in Centers of Attention or follows from what is written there, however the more academic style of that essay risks obscuring the simplicity of the approach, hence the need for this one.

Part I: Context

The Context Could Not Be Found

In computing, uses of the word "context" tend to fall into two categories: machine state context and human task context. In theory these two uses should more or less align, but in practice the coordination of machine and human context has turned out to be incredibly difficult.

Human task context: when defining our aspirations for the behavior of software, we consider where it fits into the meaning or purpose of real human tasks that it is involved in. Context in that sense is the most valuable kind for software to achieve. In practice, success has been very limited.

Machine state context: when constructing computing systems to perform behaviors, we use data to maintain states that software behaviors are conditioned on. For example in Clojure, we might have a function that receives a hash-map named "context", which contains a variety of keys with values that inform this function about the situation in which it finds itself. Of course I don't mean this literally, just that the behavior of the software is different when it has, for example, a valid JWT token than when it doesn't.

Machine state context (conditioning of system state on data) is the only means we have of achieving the human task-oriented kind of context (aligning system behaviors with humanly meaningful tasks). Abstractly (and with some important details we we will get into) it also seems to be the only conceivable means by which nature directs any system behavior in context. In order to do as well as nature in our synthetic systems, it stands to reason that we should inquire into what information humans, and natural agents more broadly, such as animals, plants, fungi, bacteria, etc condition their behavior upon.

Context for Natural Agents

Context is not humanly unique. In fact the core mechanics of context apply to all six kingdoms of biological life. All systems that are characterized by system-environment duality, which is to say systems that maintain constitutive boundaries of physico-chemical closure distinct from the default flow of physico-chemical causal effects, have **agency**. This is to say they are control systems bent on "holding it together", and out of the need to hold it together (to self-maintain) arises a task-oriented mode of system organization. That is the mechanism of context– from prokaryote to human.

Let's unpack this a bit. Agency, for a self-maintenant physical system, means control. Control is physical organization that corrects itself to achieve a target condition (positive feedback) or adjusts itself to maintain an existing state or condition (negative feedback). Biological agents engage in homeostatic (negative) control in order to preserve vital boundary conditions, and allostatic (positive) control in indirect service of core homeostatic processes.

Allostatic control is task-oriented. For example it can take the form of movement toward a food source, or movement away from a predator or a toxic substance. Much of control is not aimed toward altering one's position or environment, but rather altering one's position and environment in order to gain awareness of what options for action toward ends are available. This is what we call perception. When agents, through their behavior, establish awareness of what results further behaviors in the immediate situation will produce, they have picked up "ecological information" for action. Ecological information is the product of perception-action, and is the most real awareness of surroundings that any agent can have.

Perception-action, Attention, and Task

> "[Attention] refers to bringing our perception in line with our task, of efficiently picking up the information necessary to perform some task."
> – Eleanor Gibson & Nancy Rader, "The Perceiver as Performer"

We mentioned above that allostatic control (including perception-action, which produces information on options for behaviors to produce specific results) is rooted in homeostatic preservation of vital conditions. An important consequence of this fact is that agents are fundamentally engaged in an optimization of vital relavance we call attention.

Attention is the organization of perception-action in line with what matters. In practice that means attention is reconfiguration of resources to include those in service of the target condition and to exclude those that are not. This is what we call focus. What do we mean by "resources" here? We mean picking up information for action, as well as supporting subtasks.

Attention gives structure to a task. A task has three phases or aspects:

1. the factors involved in initiating a task, including its possibility, feasibility, and motivation.
2. the factors involved in inclusion of resources as supporting the focus of a task.
3. the factors involved in evaluating the achievement or realization of the task.

Whereas ecological information itself (a product of perception-action tasks) offers a deterministic causal path between grasped pragmatic states of initiation and realization, tasks themselves are indirect and iterative. Between the conditions for initiation and the conditions for realization, the agent configures and reconfigures focus, assembling the necessary resources.

This optimization of focus has sometimes been called "attention economy". To achieve greater economy, agents as a rule favor compression of focus into reusable task resources. This is also related to what has identified time and time again as a fundamental principle of cognition: understanding is compression.

The Task as Context

Given this explication of tasks, we are in a place to talk about context. For natural agents, all awareness and action is task-oriented, and as such the context of any task is its importance to accomplishing another task, or if not other tasks then baseline phenotypical homeostatic variables.

The context of any action is the situated task or tasks that its realized causal effect is targeted in support of. Context therefore is developed in the nesting of subtasks in the focus of a task. The task as context encompasses concerns and awareness of the situation at hand, by means of resources brought to bear, including the pickup of ecological information for action, and the convention-based semiotic use of information (more on this below.)

This characterization of context applies to all natural agents, and in theory synthetic agents can benefit from this design, which we'll have much to say about in Part III. But there is also more to say about context in part II of this essay, where the power of context is expanded by semantic information content abilities thus far in evoltion unique to human agents, as far as we can tell.

Steps in Context

The title of this essay is not merely a cute inversion of Bateson's book title and a reference to my 2018 essay where I developed the first rudimentary sketch of attention flow, though it also those things. First and foremost, the notion of an ecology of steps is (as is explored especially in Part III) the main idea of attention-flow computing. But prior to all that, what do we mean by "step".

In computing when we speak of a step, we mean an operation, given some state, executed in a sequence of other steps, resulting in successive changes of state to some final state. The process of deciding the steps is called an algorithm, or a heuristic, depending on how neatly prescribed the process is. In the agent context we mean in some sense the same thing, but with constraints that narrow the qualifying scope.

When an agent performs a task, the factors dediciing what steps to take are the causal factors defining the task: engaging the task, supporting the task (focus), and realizing the task. The task itself is also quite often actively adjusted in a process of reorganization to better realize its end. A step in this sense is a dependency within a task context. Taking a step can mean attending to a supporting task that requires further attention, or it can mean attending to a task that handily acheives its end without further attention.

The Task as Symbol

A discovery that arises from this agent-centric view of process execution is an answer to a question we posed at the beginning of Part I: what information do agents condition their behavior on? First, we depend on ecological information in order to perceive our surroundings reliably. In order to acquire such information we engage in tasks of prospective allostatic control. The conduct of such tasks develops skills of pragmatic task execution, ways of knowing and doing that leverage resources to achieve vital ends. The structure implicit in such skill is best described or mapped as a graph topology of nodes of skillful awareness, consisting in causal expectations (for engaging, supporting, and realizing tasks).

There is a "bottom-up" and a "top-down" relationship between ecological information on one hand and task know-how on the other. Agents are always skillfully probing their environments and become aware of possibilities for action– in that case the pickup of ecological information propagates bottom-up to attentionally relevant task dynamics leveraging these action options. In the top-down case, an agent is engaged in a task and probes the environment to acquire the specific resources needed for the task.

Biosemiotics, still in its infancy, has undertaken to discover the ways in which even some of the most basic agent control behaviors are scaffolded by convention, most often innately so. Something that has become clear in these developments is that the semiotic structure of control identified by Charles Sanders Peirce, which modern biosemiotics has found to be a relevant and efficacious model for biology, maps cleanly onto the structure of tasks as studied by modern ecological psychology in the school of James Jerome Gibson (the research paradigm that has most strongly guided the direction taken in this essay.) Peirce's formulation of the symbol is a mode of control in which a sign vehicle (engaging the task) leads to a targeted final object (realizing the task) but only via the indirection of an interpretant (the supporting focus of the task).

The term **center** (of attention) is a way of addressing the prospective control task as a nexus of semiotic self-control (AKA a symbol), and vice versa. The term is useful because these phenomena are one and the same, but there is no prior vocabulary with which to understand tasks as semiotic control systems, and symbols as systems of attention concerning the acquisition and use of information.

Context in Context

As we seek to align machine behavior with human-relevant context, we can look to ecological information, and topologies of attention-flow– motivated flows between centers of attention– as a clear contender for the data on which to align. The activity of biological organisms of all varieties is governed by the scarcity of attention and the need to put the most important matters front and center. Centering and focusing is a reorganization of instrumented resources in support of getting to a more preferred situation. To make context clear is to make the structure of the attention-flow followable.

Part II: Content

Part III: Computing with Context and Content