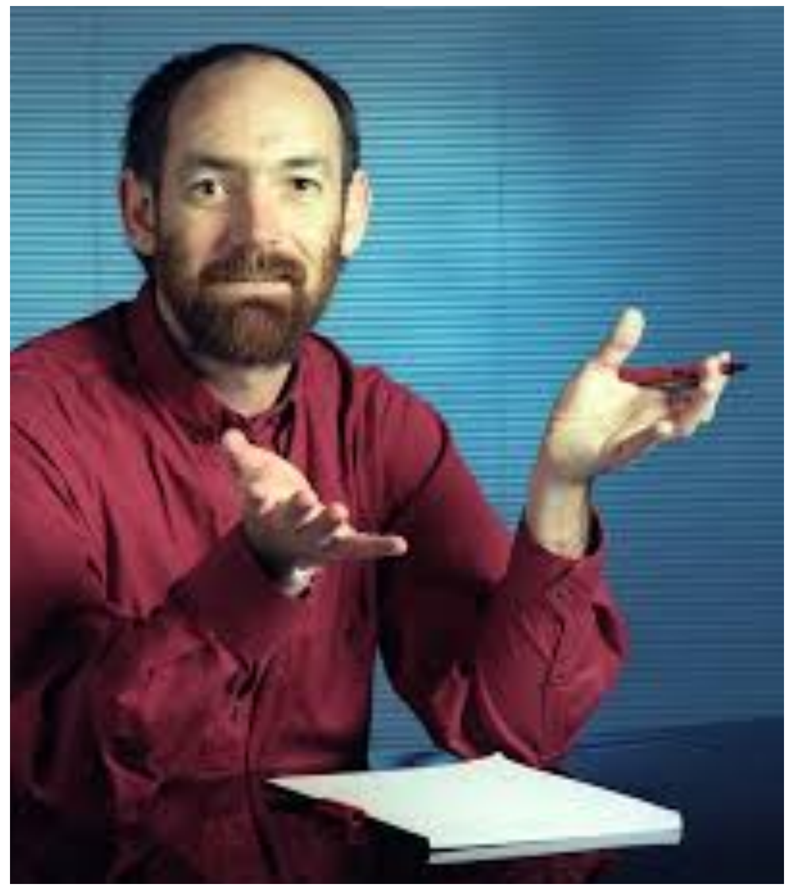
How to train your Assistant Professor

Sylvia Herbert, Assistant Professor



https://heidesmith.com/noted-australians-collection/noted-australians-part-1/

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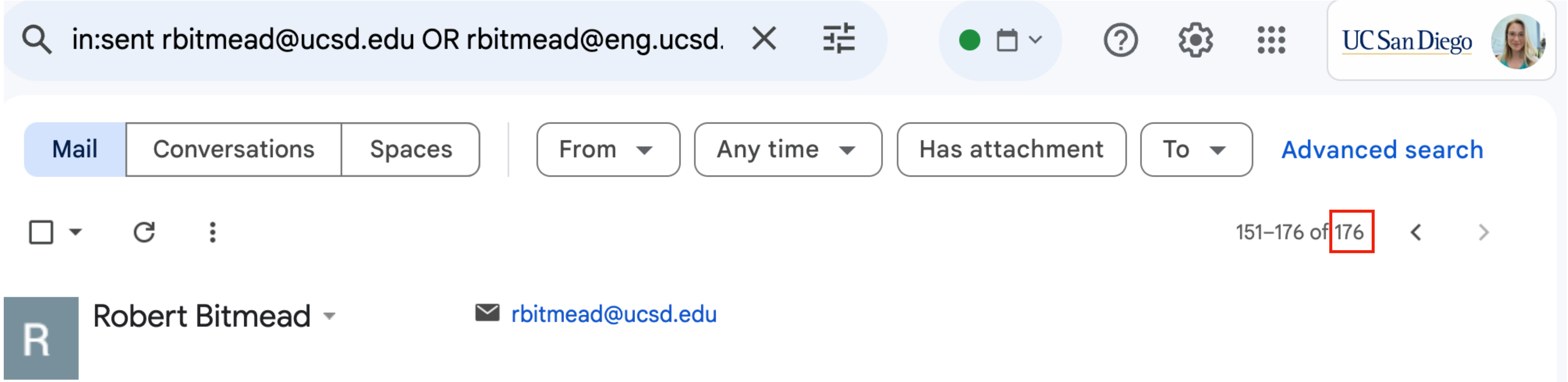

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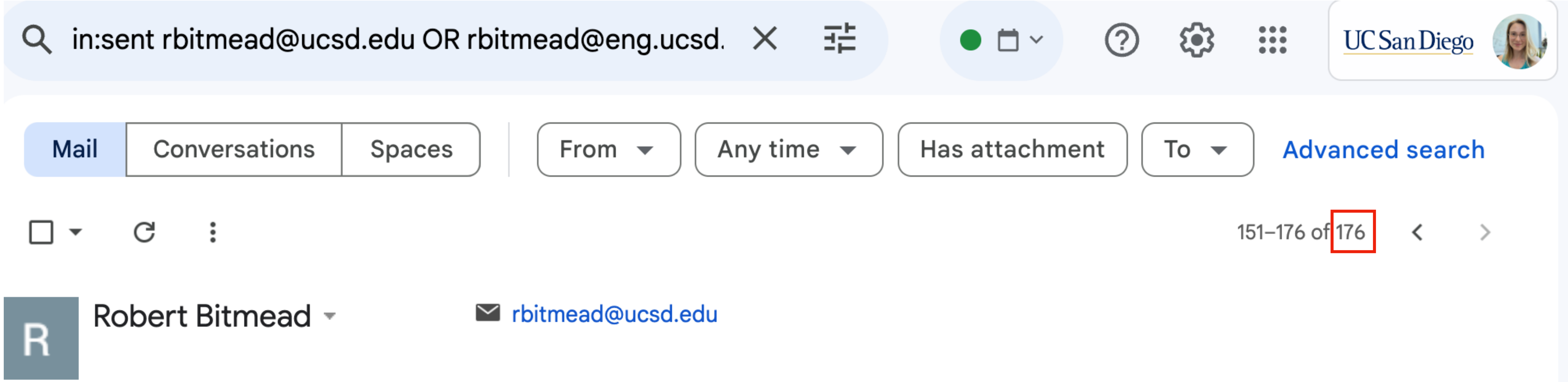

“I did not know that never responding and being useless was an option. My own mentor, whoever that was, never told me.”

Robert Bitmead <rbitmead@eng.ucsd.edu>
to Sylvia

Wed, Oct 7, 2020, 11:57 AM

Hi Sylvia,

Nice to hear from you and glad that you are about to start in earnest. Hey, you already have a UCSD email address. There is no more.

I would be happy to chat but have a plenary talk in Sapporo tomorrow night followed by an IEEE Control Systems Society Executive Committee meeting all weekend ... nominally in Mysore India. But I have time on Friday (ExCom Happy Hour is at noon!) either in the morning or afternoon. I have one meeting being scheduled with the Med School people for the afternoon. How about some time in the morning.

I shall gather all the juiciest departmental gossip in preparation.

As for attending the seminars, please email Lusia Veksler (lveksler@eng.ucsd.edu) who is our very efficient admin person looking (inter alia) after the Controls Group characters. And thank you for pointing me to the seminar page. I learnt something.

Sherbet is just one of the many Australian slang words for beer. It was also a boppy 1970s aussie band who are perhaps best forgotten but were at least fizzy like sherbet.

Please let me know a suitable time to talk on Friday. I can set up the Zoom.

Benvenuto e ciao,
Bob.
P.S. No, I do not speak Italian. Although I did purchase a cheese grater in Milan once using my Frenchy mock Italian and gesticulating wildly.

Robert Bitmead
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Strategic Plan

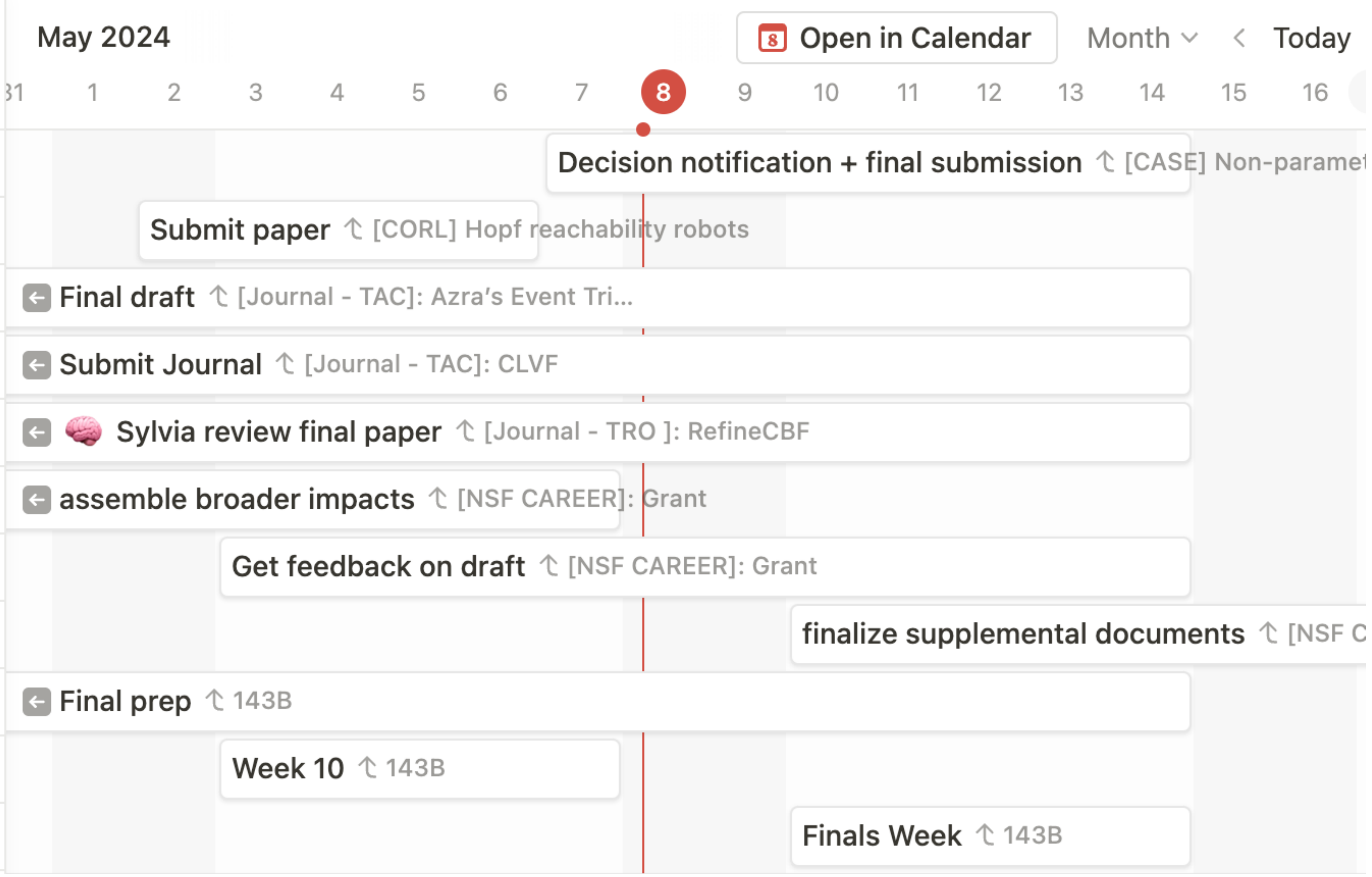
Bob's goal suggestions:

1. Build up research slowly and well (don't rush to have a ton of students and a ton of papers)
2. Understand the grant process
3. Explore San Diego
4. Build up my network of external important people who can write tenure letters for me
5. Practice saying no to most service/student requests

Default view | All | Category | Timeline | Focus Tasks | This week

🛤️ Strategic Plan - Goals/Areas

↗ Parent item	Aa Name	☑
✍️ [CASE] Non-parametric video pred	Decision notification + final submission ↑	☐
✍️ [CORL] Hopf reachability robots	Submit paper ↑ [CORL] Hopf reachability ro	☐
✍️ [Journal - TAC]: Azra's Event Trigg	Final draft ↑ [Journal - TAC]: Azra's Ever	☑
✍️ [Journal - TAC]: CLVF	Submit Journal ↑ [Journal - TAC]: CLVF	☐
✍️ [Journal - TRO]: RefineCBF	🧠 Sylvia review final paper ↑ [Journal - T	☑
💸 [NSF CAREER]: Grant	assemble broader impacts ↑ [NSF CAREEF	☑
💸 [NSF CAREER]: Grant	Get feedback on draft ↑ [NSF CAREER]	☑
💸 [NSF CAREER]: Grant	finalize supplemental documents ↑ [NSF	☑
🧑‍🏫 143B	Final prep ↑ 143B	☐
🧑‍🏫 143B	Week 10 ↑ 143B	☐
🧑‍🏫 143B	Finals Week ↑ 143B	☐



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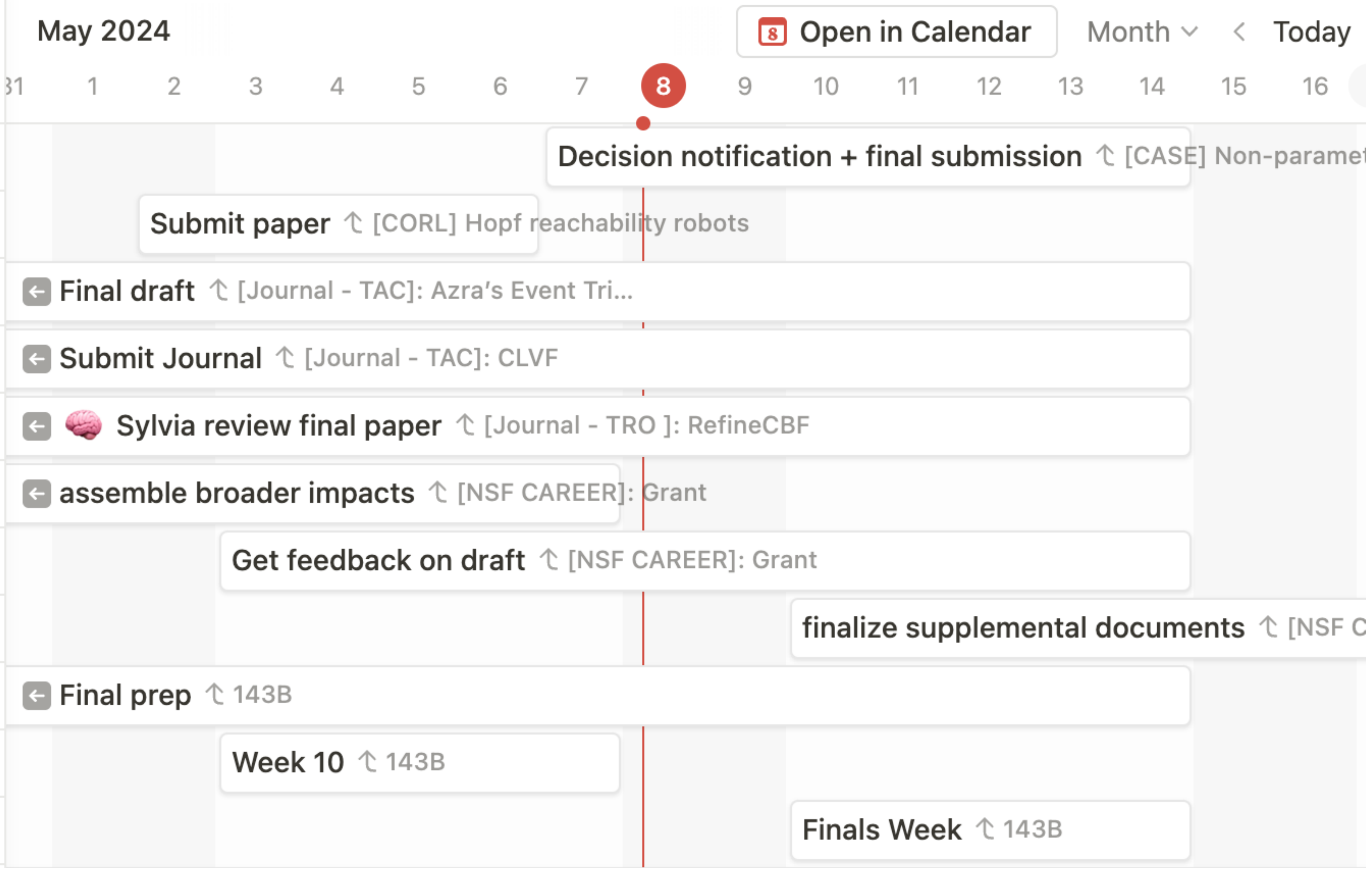

Here is my off-the-cuff discussion of your pitch.

> My suggestion, for what it is worth (since I gave up on applying to NSF years ago), is that you might want to make this less technical. The reasons for this are that (a) you need to be an expert to understand what it is about, notably scalability and verification; and (b) program managers are always looking for material they can take up the chain to their bosses to show what they are funding. So (IMHO) having the content more fit-for-educated-public consumption would help. You are using subtle technical terms like “known information” and “learned information” which makes the reader’s job hard to work out what is meant and then what the word “guarantee” might possibly mean. Is a “theoretical safety guarantee” any guarantee at all, for example?
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> Maybe if you were to write the problem up in terms of evolving safety certification for dynamic systems. Explain the safety problem in terms of ensuring the state of the system never reaches an unsafe operating point and that this needs to be done using available information. This available information starts with computer based models of the (controlled) central dynamic process and of its (uncontrolled) environment - maybe together with some idea of their accuracy limitations - but, with operation, needs to be augmented by observed data, which might or might not conflict with the original models. Be careful of the word “general” as in “general dynamic systems” and “general nonlinear systems.” It could mean different things to different people.
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> You could start by saying that there are \textit{reachability} methods which evaluate the set of all possible future states which might be accessed from a given current state. \textit{State} here connotes the position, velocity, configuration, etc of the system which constrains future evolution with time. If the reachability set avoids an unsafe region, then safety is achieved. These methods are based on Hamilton-Jacobi methods on which the PI has published recently. If safety cannot be achieved inherently, then it is possible to control the system using CBFs to prevent entering unsafe areas. Finding CBFs currently is limited to systems of certain structured but the research plan includes using the more generally applicable HJ methods to generate CBFs. [The aim should be to get the problem concept across. My version might be gobbledygook but the idea is to describe the problem importance rather than technique.]
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> [Different topic now] Systems operating in the real world present significant additional challenges for safety. Not only should the modeled system avoid unsafe states in the modeled environment, but the real system should do this in the real environment, each of which might be at variance from the models. Data taken in real time is the only way to amend the safety certification to accommodate new information. We envisage [I am making this up] two central ways that this might be done. Firstly, if the initial theoretical models are equipped with conservative bounds on their deviation from reality, then the models might be refined to tighten these bounds and thereby admit greater authority while preserving safety. Alternatively, the models themselves, rather than their bounds, might be adapted based on measured data so that the safety sets become closer to reality.
>
> There is a host of underlying research problems associated with achieving this ...

You can guess how much time I have put into cogitating about this. But my main point is to think about how to equip the program manager with material to sell to their boss, who probably thinks Hamilton Jacobi is Derek Jacobi’s younger brother and that Lyapunov was a famous dessert chef.

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2.1 System Verification

Consider a state trajectory of the continuous-time time-invariant controlled system with disturbance, ~~solving~~ Satisfying

Here

$$\dot{x}(s) = f(x(s), u(s), d(s)),\ s \in [t, t'], \text{ and } x(t) = x, \tag{1}$$

Don't begin sentences with symbols

where t and x are the initial time and state, respectively. $u \in U \subset \mathbb{R}^m$ is the control input, where U is considered bounded (in the HJ reachability case) or potentially unbounded (in the CBF case). Bounded uncertainties or disturbances can be represented by $d \in D \subset \mathbb{R}^w$, where D is a compact and convex set. The function and $f : \mathbb{R}^n \times U \times D \to \mathbb{R}^n$ is assumed to be Lipschitz continuous in the state.

D

add this to the list formally

Based on current information about the system, environment, and uncertainties in the dynamics or disturbances, safety verification seeks to keep the system outside of states that may lead to failure.

To define the notion of failure for a given environment, a reward function (also called a target function) $l : \mathbb{R}^n \to \mathbb{R}$ is constructed over the state space, with negative reward inside of obstacles (and/or other failure sets) and positive reward outside. Therefore, the zero-superlevel set of the function defines the set $\mathcal{L}$ ~~that~~ in which the system must remain ~~in~~, i.e. $\mathcal{L} = \{x : l(x) \geq 0\}$. An example of this set $\mathcal{L}$ and the corresponding reward funtion $l(x)$ can be seen in Fig. 3a and Fig. 3b. The objective of the safety control is to guarantee that the trajectory will remain in $\mathcal{L}$ for $s \in [t, 0]$ under the worst case disturbance. This involves computing the safe set, or viability kernel $\mathcal{S}(t)$, which is the set of all the initial states at time t from which there exists an admissible control signal that keeps the system safe under the worst-case disturbance. The corresponding robust safety controller is also computed to ensure this guarantee within the safe set. More formally we want to compute:

Define before discussing

- **The viability kernel** $\mathcal{S}(t)$ [1] **for** $\mathcal{L}$: Verify $\mathcal{S}(t) := \{x \in \mathcal{L} : \forall \xi_d \in \Xi_{[t,0]}, \exists u(\cdot) \in \mathcal{U}_{[t,0]}$ s.t. $\forall s \in [t, 0], x(s) \in \mathcal{L}$ where $x(s)$ solves (1) for $(x, t, u, \xi_d)\}$ for $t < 0$.
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hieroglyphics

Explain

Core ideas of safety relevant to gobbledygook

Two popular techniques for safety verification are Hamilton-Jacobi (HJ) reachability, and control barrier functions (CBFs). While there are many similarities between the two approaches, the fields have been largely disjoint. In the following sections we will biefly introduce the theory and tools for both approaches.

2.2 Hamilton-Jacobi Reachability Analysis

~~Re~~ Reward

~~Assume~~ Given a model of an autonomous system (e.g. a UAV, a glucose monitor, an HVAC system) and initial knowledge of what ~~would be unsafe for that system~~ (e.g. hitting obstacles, allowing glucose to drop to dangerous levels, letting a house get too warm or too cold). HJ reachability analysis computes the set of initial conditions from which your system will inevitably enter those unsafe conditions [1–3] (e.g. when a car is driving at high speeds and headed straight for an obstacle, and no matter how hard it brakes or turns it is going too fast to prevent a crash). The complement of this set is therefore the safe set.

define earlier

First, we define a cost function as

$$J(x, t, u(\cdot), d(\cdot)) := \min_{s \in [t,0]} l(x(s)), \tag{2}$$

You are using the word "safe" colloquially + as a specialist word – reads too woolly.

Why 0?

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See Fig 3

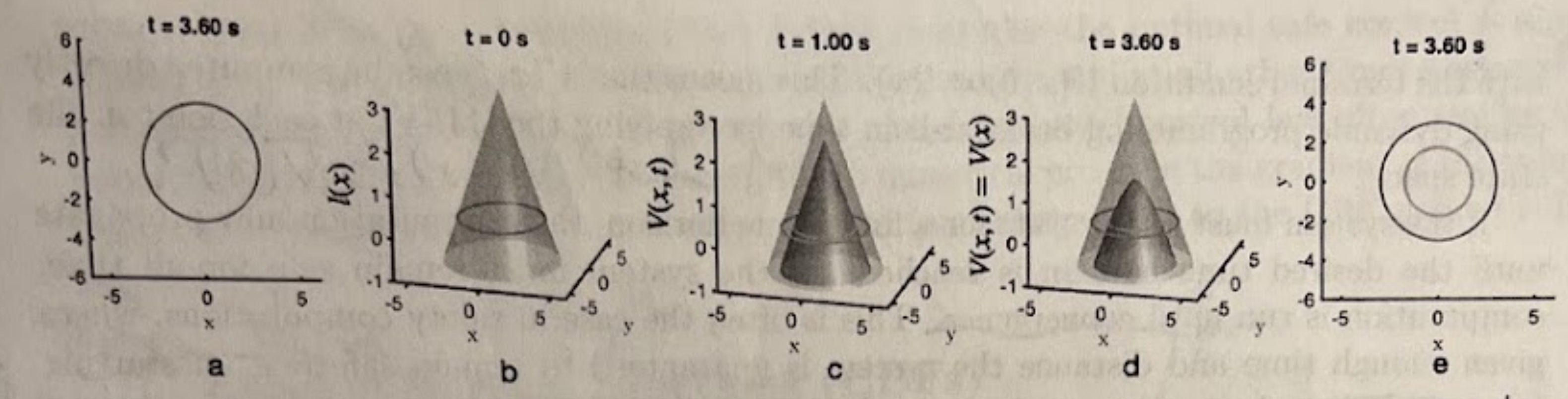

Figure 3: Process of constructing the safe set for HJ reachability. (a) Define the region $\mathcal{L}$ ~~that~~ within which the system should remain ~~within~~ (in this case, inside the black circle). (b) Define $l(x)$ with negative reward outside the desire region and positive inside. (c) Use (4) to propagate the value function backwards in time using dynamic programming. (d) If the analysis converges (which happens in this case at a time horizon of 3.6s), then the value function holds for an infinite time horizon, thus $V(x, 3.6) = V(x)$. Positive regions of $V(x)$ correspond to positive regions of $l(x)$. (e) The super-~~zero~~-level set of $V(x)$ gives the guaranteed safe set (inside the green set). This is a viability kernel that guarantees ~~the system will remain~~ inside the safe set for all time despite worst-case disturbances.

huh?

Explain

It is ignorant

Why this word?

This is going to need to come earlier to prepare my questions

which captures the minimal value of the reward $l(\cdot)$ along the trajectory $x(\cdot)$ that ~~solves~~ satisfies (1) for (x, t, u, d). Intuitively, if this cost function J is negative, it means that the trajectory violated the safety constraint at some point in the time horizon (obtaining a negative value of l), and is therefore unsafe. If J is positive, then over the entire time horizon the trajectory maintained a positive reward and therefore remained safe.

Contradiction

The objective ~~of the safety control~~ is to make J as ~~big~~ large as possible, increasing the region ~~within~~ which the system can remain safe. Under the worst case, the disturbance would act in a direction of decreasing J as much as it can. Based on this, we can define the value function $V : \mathbb{R}^n \times (-\infty, 0] \to \mathbb{R}$ as

confused J is a real number

What's this?

Ex

$$V(x, t) := \min_{\xi_d \in \Xi_{[t,0]}} \max_{u \in \mathcal{U}_{[t,0]}} J(x, t, u(\cdot), \xi_d[u](\cdot)), \tag{3}$$

An example of the value function is shown for different ~~time stamps~~ times in ~~Fig.~~ Figures 3c and ~~Fig.~~ 3d. The sign of this value function for every (x, t) captures whether the system starting from those initial conditions will be able to remain safe under optimal control and worst-case disturbances. This dissects the space into the safe regions with positive value (where there exists a controller to keep the system safe despite worst-case disturbances and uncertainties), and unsafe regions with negative value (~~where, for example, even if a car brakes and swerves, it is too close to avoid hitting an obstacle~~). More formally, the viability kernel (safe set) for $\mathcal{L}$ is $\mathcal{S}(t) = \{x \in \mathbb{R}^n : V(x, t) \geq 0\}$. In ~~Fig.~~ Figure 3e, $\mathcal{L}$ is the region inside the black circle, and the computed safe set $\mathcal{S}$ is shown in green.

Keep it formal

To solve for this value function $V(x, t)$, it has been shown that the function is the viscosity solution to the following Hamilton-Jacobi-Isaacs Variational Inequality (HJI-VI) [3]:

Why do you need this?

$$0 = \min\left\{l(x) - V(x, t),\ D_t V(x, t) + \max_{u \in U} \min_{d \in D} D_x V(x, t) \cdot f(x, u, d)\right\}$$

use $\frac{\partial}{\partial t}$ $\frac{\partial}{\partial x}$

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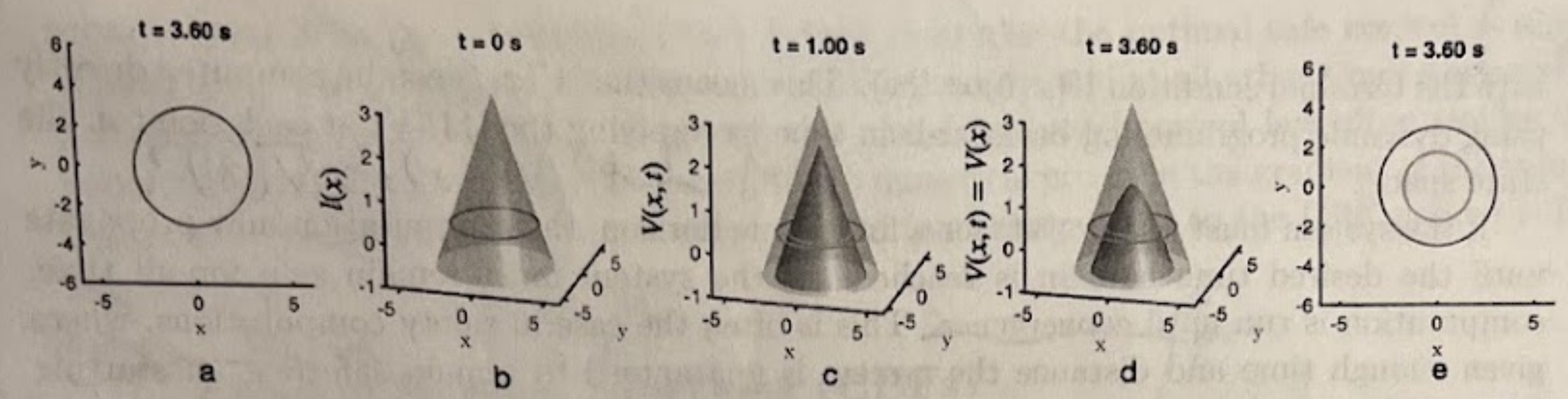

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huh?

Explain

It is important

Why this word?

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Contradicts

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Why do you need this?

$$0 = \min\left\{ l(x) - V(x, t),\ D_t V(x, t) + \max_{u \in U} \min_{d \in D} D_x V(x, t) \cdot f(x, u, d) \right\}$$

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Don't begin sentences with symbols

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D

add this to the list formally

Based on current information about the system, environment, and uncertainties in the dynamics or disturbances, safety verification seeks to keep the system outside of states that may lead to failure.

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hieroglyphics

Explain core ideas of safety verification to gobbledygook

Two popular techniques for safety verification are Hamilton-Jacobi (HJ) reachability, and control barrier functions (CBFs). While there are many similarities between the two approaches, the fields have been largely disjoint. In the following sections we will biefly introduce the theory and tools for both approaches.

2.2 Hamilton-Jacobi Reachability Analysis

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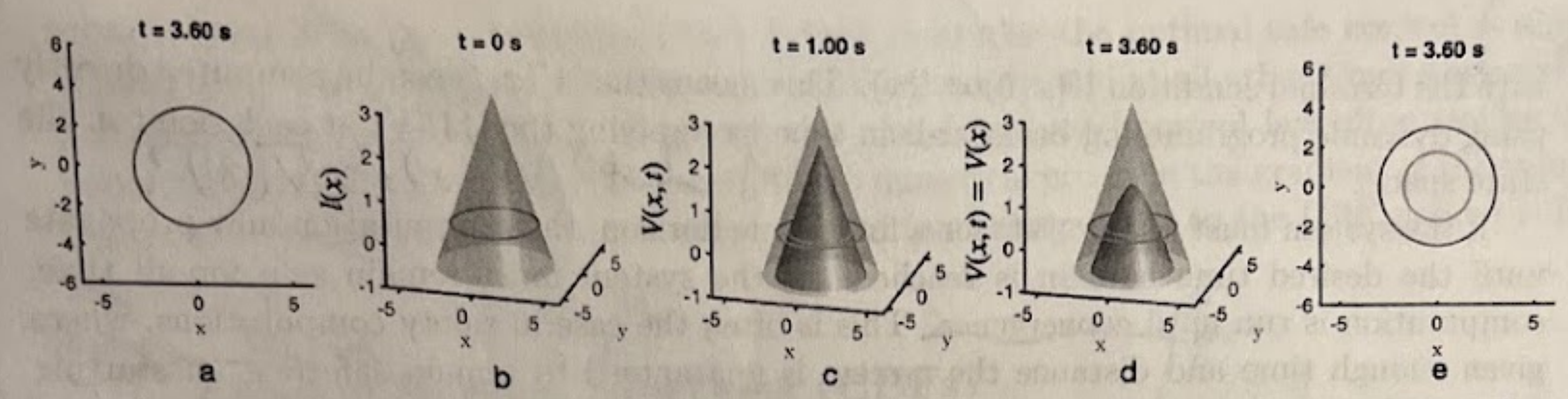

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hieroglyphics
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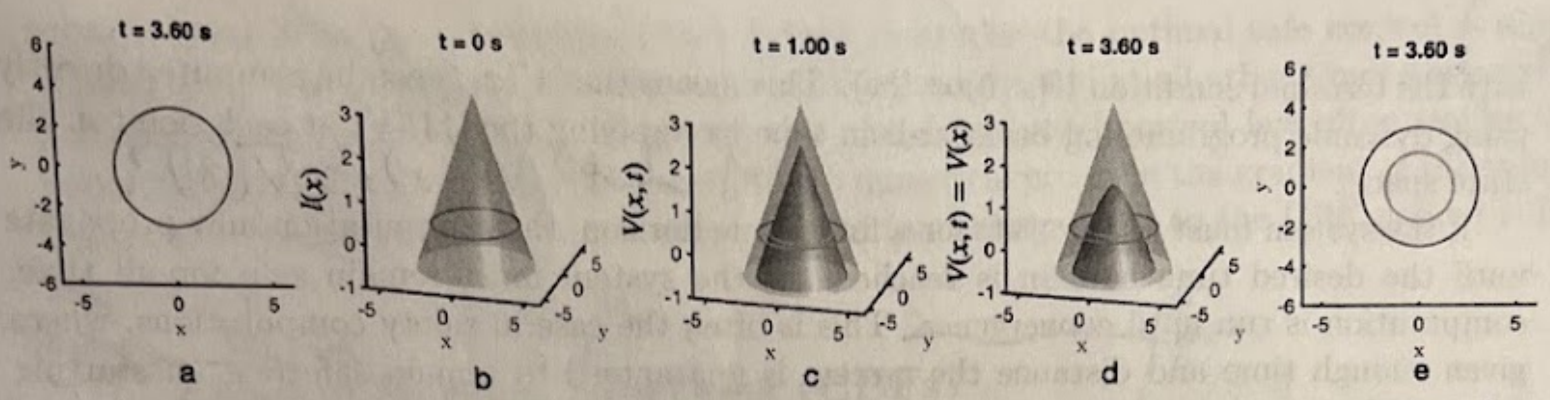

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huh?

Explain [illegible]

Why this word?

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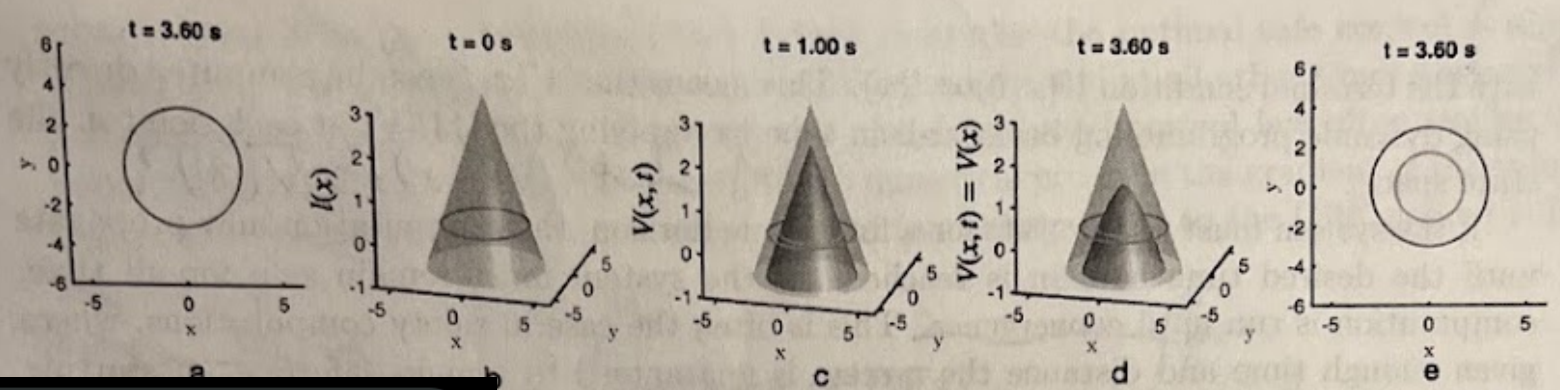

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why do you need this?

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Advice throughout the years

Research & Funding

- Whether to collaborate with other faculty in research
- Feedback on grant proposals, white papers
- How to talk to program managers
- Starting and joining technical program committees
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- Introduction to relevant professional society members

Teaching

- How to pick out a good TA
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Service, Politics, Etc.

- Advice on whether to accept/reject a particular service request (and whether it involved free food)
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Advice throughout the years

Research & Funding

- Whether to collaborate with other faculty in research
- Feedback on grant proposals, white papers
- How to talk to program managers
- Starting and joining technical program committees
- Which editorial jobs have the best cost/benefit ratio
- Introduction to relevant professional society members

Teaching

- How to pick out a good TA
- Creating a special topics course
- Teaching during COVID
- Handling disgruntled students
- Teaching material
- Running a class while sick
- How to update undergrad controls courses

Service, Politics, Etc.

- Advice on whether to accept/reject a particular service request (and whether it involved free food)
- Where to find good food and beer
- Navigating space/facility issues
- Handling confidential government emails
- When and how to tell the department I'm pregnant
- Whether to delay promotion due to childbirth or submit my file, feedback on my file
- What gifts to give departmental staff
- How to throw coffee at dangerous drivers
- How to review PhD and faculty applications

Service requests

This looks “mostly harmless,” which is how the Earth is described in The Hitchhiker’s Guide to the Galaxy. This could give you some service without impacting much on your available time. The good part about any service is not so what you can do for the university but the contacts that you make from serving on committees. That can prove valuable and, at the very least, a good learning experience. The risk of it being a time sink appears to be negligible.

[1] Dobbin, Frank, and Alexandra Kalev. "Why diversity programs fail." Harvard Business Review 94.7 (2016): 14.
[2] Dobbin, Frank, and Alexandra Kalev. "Why doesn't diversity training work? The challenge for industry and academia." *Anthropology Now* 10.2 (2018): 48-55.
[3] Hightower J.L., “10 Things Colleges & Universities Can Do to Increase Racial & Ethnic Diversity of Faculty” Medium, 2016.
[4] Kaiser C.R., Major B., Jurcevic I., Dover T., Brady L.M., and Shapiro J.R., “Presumed Fair: Ironic Effects of Organizational Diversity Structures,” Journal of Personality and Social Psychology 2012.

Evidence-based Methods to Promote Recruitment and Retention of Under-Represented Minorities in STEM

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- Active recruitment programs

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- Active recruitment programs
- Increasing role models

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- Promoting effective mentorship

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Evidence-based Methods to Promote Recruitment and Retention of Under-Represented Minorities in STEM

- Active recruitment programs
- Increasing role models
- Promoting effective mentorship
- The mentorship aspect was especially effective: "…on average [mentorship programs] boost the representation of black, Hispanic, and Asian-American women, and Hispanic and Asian-American men, by 9% to 24%" [1].

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Advice for young faculty

Be sure to have fun.

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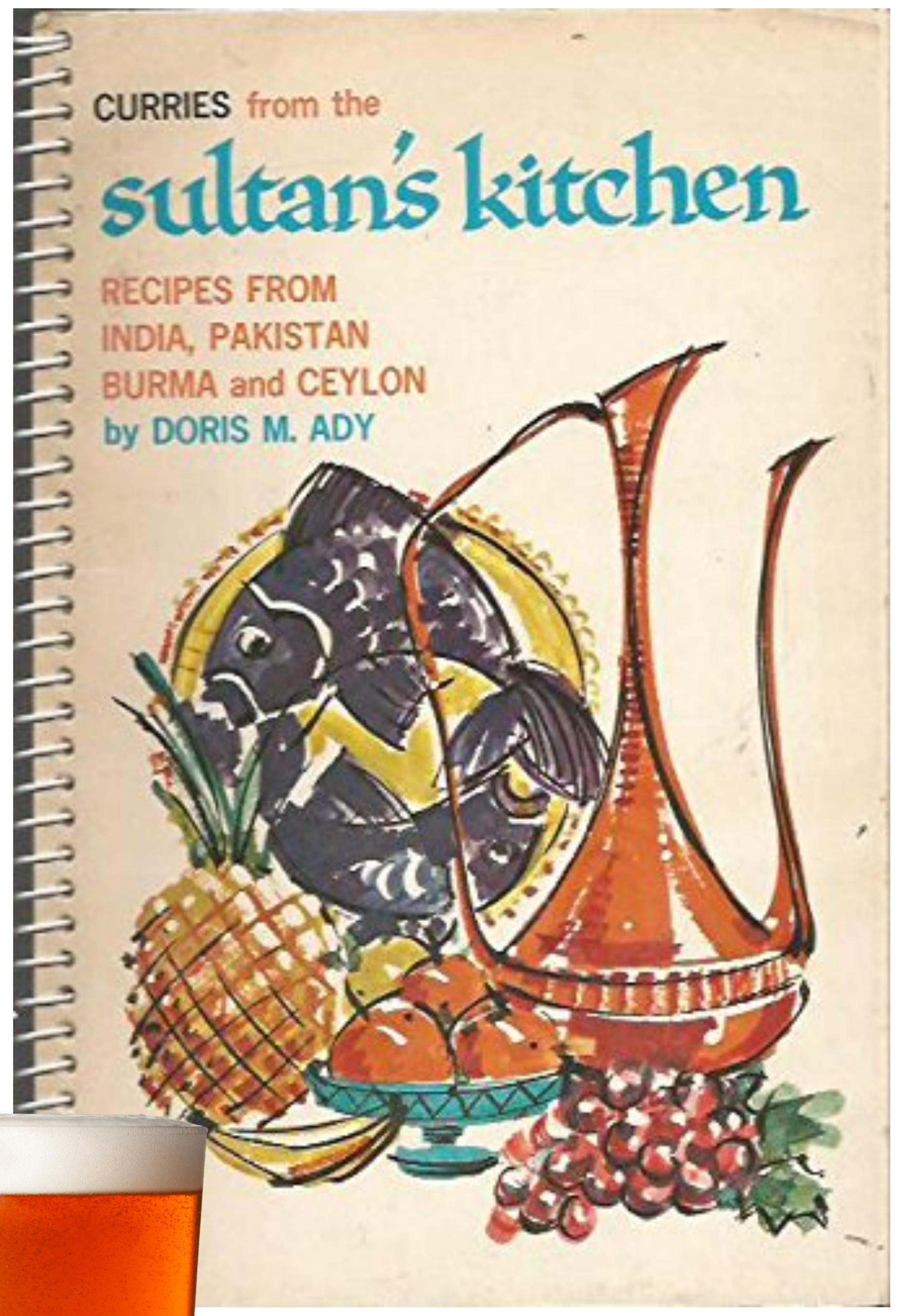

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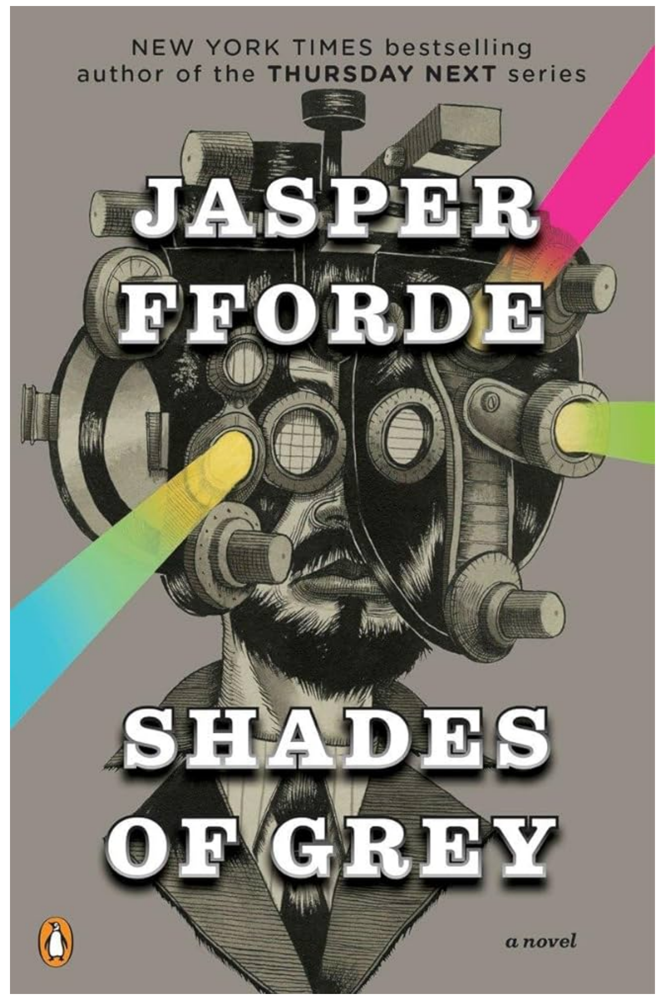
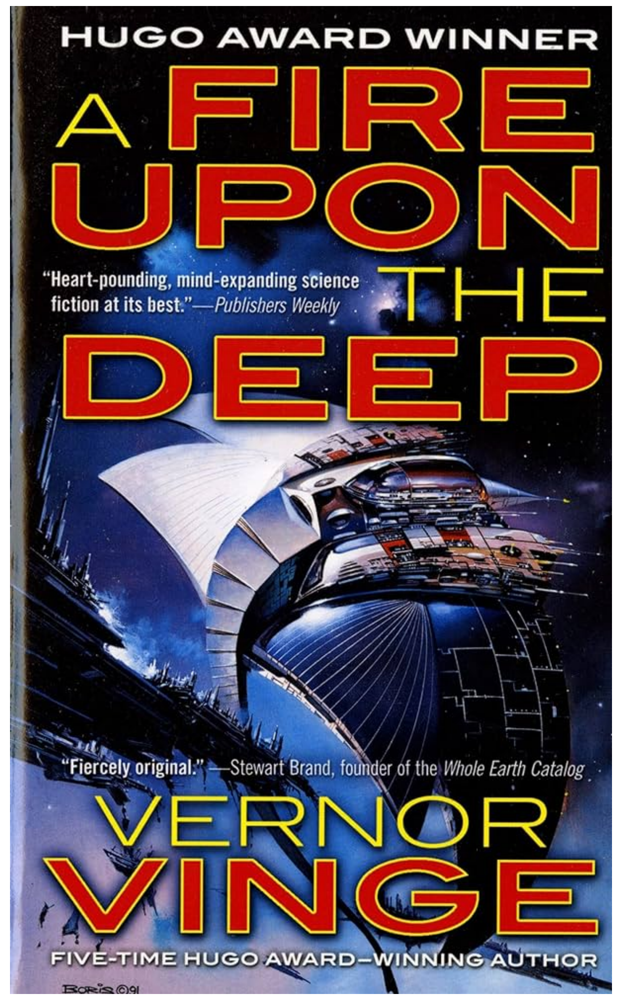
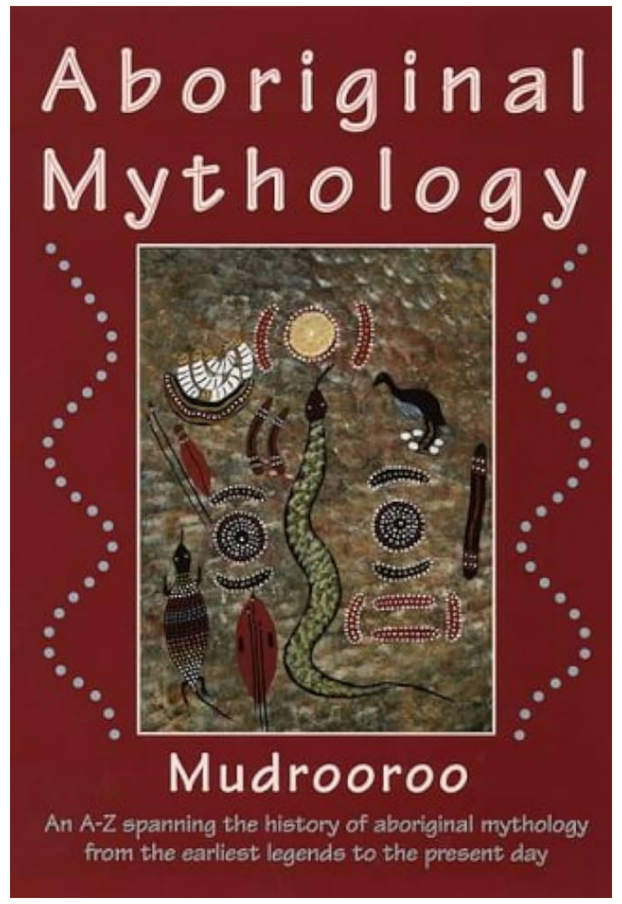




DON'T PANIC



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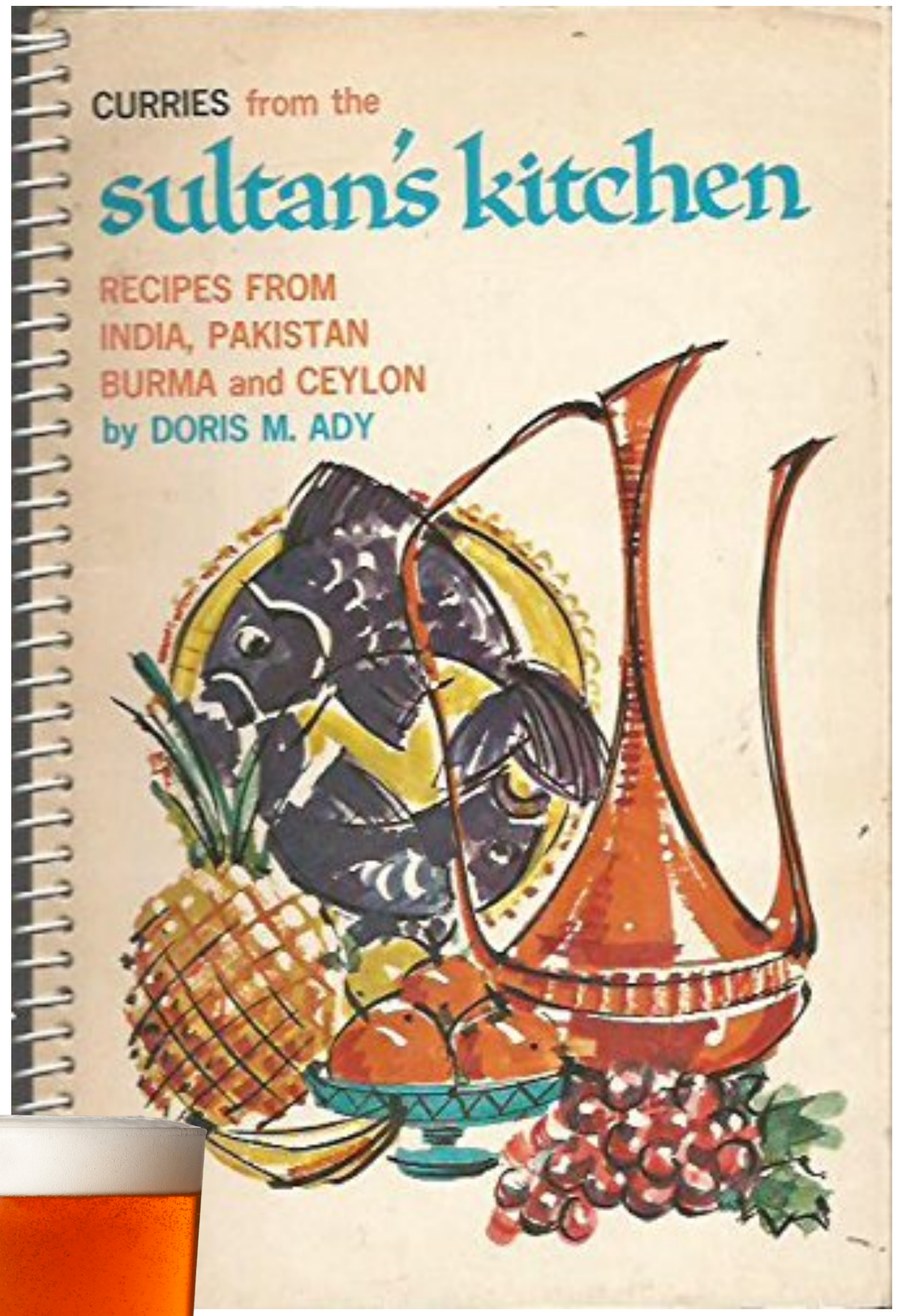
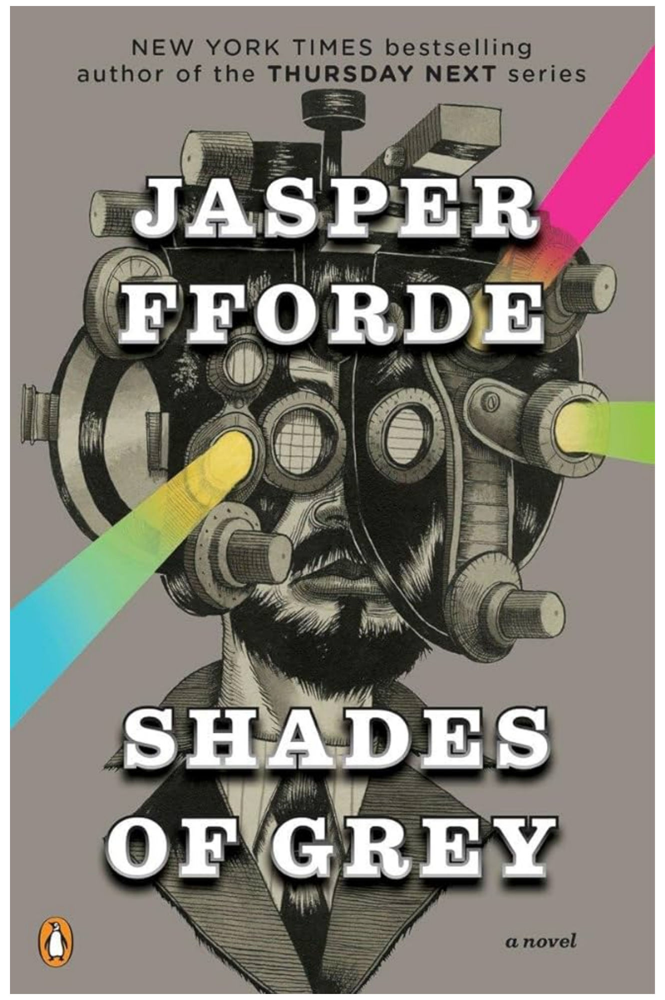
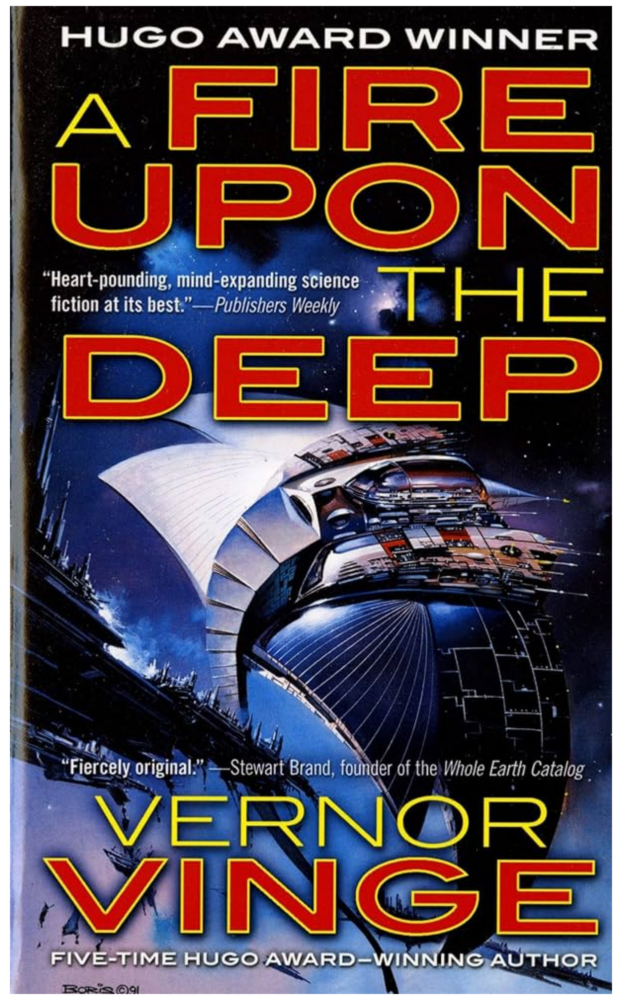


Thank you for making this job fun.





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