Final Lecture

1. Social learning and redundancy neglect$\rightleftharpoons$
2. Some more methodological thoughts, with examples ...$\rightleftharpoons$
    1. A This-Never-Works-But-I'll-Keep-Trying Approach ...$\rightleftharpoons$

$\looparrowright$

Final Lecture

A short history of Vitamin C$\rightleftharpoons$ (For guinea pigs, fruit bats, primates)$\rightleftharpoons$

- Dawn of Humanity until Age of Oceanic Voyages (Exploration, Imperialism, Migration): People unknowingly avoided scurvy$\rightleftharpoons$
  - and got colds whenever they got colds.$\rightleftharpoons$
- Age of Oceanic Voyages until discovery of citrus fruit: Huge numbers of people died at sea of scurvy
  - and got colds whenever they got colds.$\rightleftharpoons$
  - [Some folk wisdom and health officials ignored or forgotten]$\rightleftharpoons$
  - [People paid too much attention to ship hygiene and to Argentinians]$\rightleftharpoons$
- Dawn of Age of Citrus at Sea until end of Age of Oceanic Voyages: Huge numbers of people intentionally avoided scurvy
  - and got colds whenever they got colds.$\rightleftharpoons$
- End of Oceanic Voyages until 1970: People inattentively avoided scurvy,
  - and got colds whenever they got colds.$\rightleftharpoons$
- 1970 until now: People take Vitamin C to prevent colds (and what not),
  - and get colds whenever we get colds.

Final Lecture

- A short history fo Mercury⇌

Humankind discovers Mercury. It's totally cool. It's used for medicine.⇌

- Late 1400's: syphilis arrives in Europe and Europe-settled areas.⇌
- Mercury was used on massive scale as a treatment for syphilis⇌
- Syphilis and hats kill millions and drive millions crazy⇌
  - Heads get covered, armies shut down⇌
- Different types of errors ... ⇌
  - not knowing about a poison (hats) ⇌
  - Administering a poison intentionally⇌
- Early 20th century: Mercury combined with arsenic as treatment for syphilis⇌
- February 28, 1928: Fleming discovers penicillin (430 years after syphilis)⇌
- Syphilis (and much else) virtually shut down overnight.⇌

↬

Final Lecture

- A short history of blood-letting ... $\rightleftharpoons$
- A short history of housing$\rightleftharpoons$
  - We all know the prices alway go up$\rightleftharpoons$
  - We all stopped knowing that$\rightleftharpoons$
- A short history of tulips $\rightleftharpoons$
  - (But I like my "bubbles" to last for centuries)$\rightleftharpoons$
- A short history of investing retirement savings in individual stocks$\rightleftharpoons$
- A short history of whiplash$\rightleftharpoons$
  - Fast things invented.$\rightleftharpoons$
  - Rear-ending "invented"$\rightleftharpoons$
  - Thousands stayed in bed for millions of weeks over a decade$\rightleftharpoons$
  - Oh, wait, that doesn't help

$\looparrowright$

Inferential Naivety in Observational Learning$_{\rightleftharpoons}$

- People may extract information (not fully cursed) from others.$_{\rightleftharpoons}$
- But take this information "at face value"$_{\rightleftharpoons}$
- Portable and pinned down universal definition$_{\rightleftharpoons}$
  - But now talk solely about observational learning.

$\looparrowright$

Final Lecture

Rational-Herding Literature:$\rightleftharpoons$

- People infer from actions of those with similar tastes.$\rightleftharpoons$
- Rational imitation.$\rightleftharpoons$
- Herds may start & last on wrong choice.$\rightleftharpoons$
- All realize that others also imitating$\rightleftharpoons$
- Understand *inherent* redundancy in others' behavior$\rightleftharpoons$
- Don't imitate very much.

$\looparrowright$

Final Lecture

- We are skeptical people so reluctant to imitate.⇌
- **And we should care a lot about this:**⇌
  - Examples of theories that generate extensive imitation ... predict severe badnesses in societal beliefs.⇌
- Extensive imitation $\Longrightarrow$ not rational⇌
- Extensive imitation $\Longrightarrow$ social confirmation bias & false beliefs.⇌

Now:⇌

- **Behavioral implications** of full rationality in observational learning⇌
- Very different implications of inferential naivety.

↬

Review of Canonical Rational-Herding Models$\rightleftharpoons$

Banerjee (1992), Bikhchandani, Hirshleifer and Welch (1992).$\rightleftharpoons$

- Sequentially move, all privately informed, observe actions and order but not info of those before.$\rightleftharpoons$
- No direct externalities.$\rightleftharpoons$
- Canonical example:

$\looparrowright$

Final Lecture

Canonical model: Either A or B is good—but not both (?)—and binary private i.i.d. signals. A when you believe $\omega = 1$, B when $\omega = 0$. α signal of $\omega = 1$, β of $\omega = 0$;$\rightleftharpoons$

player	*signal*	*action*
1	α	A
2	β	B
3	α	A
4	α	A
5	β	$[A]$
6	α	$[A]$
7	β	$[A]$
8	α	$[A]$
9	β	$[A]$
10	β	$[A]$

$\rightsquigarrow$

Final Lecture

Efficiency facts of rational herding models:$\rightleftharpoons$

- Observing others always helps in expected terms.$\rightleftharpoons$
- High likelihood wrong herds only if those herds are unconfident.$\rightleftharpoons$
- Rational-herding literature is about failure to aggregate information, not of society (frequently) thinking it knows things it doesn't.$\rightleftharpoons$
  - (Debated in literature: is even non-aggregation really likely?)

$\looparrowright$

Final Lecture

We claim:$\rightleftharpoons$

- Canonical example, connotation of literature misleading.$\rightleftharpoons$
- Limits to imitation far bigger punchline than the imitation itself.$\rightleftharpoons$
- We think the non-imitation is unrealistic.$\rightleftharpoons$
- And (later show) it matters.$\rightleftharpoons$

Modification of the standard two-restaurant model of social learning.$\rightleftharpoons$

- Two restaurants in town, $\rightleftharpoons$
  - A and B, $p(A\ good, B\ bad) = p(B\ good, A\ bad) = .5$.$\rightleftharpoons$
  - Two states: $\omega_A \rightarrow A$ is good, $\omega_B \rightarrow B$ is good.$\rightleftharpoons$
  - Binary-state model universal.$\rightleftharpoons$ ... and weird.

$\looparrowright$

Final Lecture

- Each of ∞ diners receives private signals $\in \{\alpha, \beta, \varnothing\}$ $\rightleftharpoons$
- The signals are *i.i.d.* conditional on the state, $\rightleftharpoons$
  - α supports ω_A, $\rightleftharpoons$
  - β supports ω_B, $\rightleftharpoons$
  - $\varnothing$ uninformative. $\rightleftharpoons$
- For each Player k, $\rightleftharpoons$
  - $\Pr[s_k = \alpha|\omega_A] = \Pr[s_k = \beta|\omega_B] = .7(1-\eta)$ and $\rightleftharpoons$
  - $\Pr[\varnothing|\omega_A] = \Pr[\varnothing|\omega_B] = \eta$. $\rightleftharpoons$
  - $\eta = 0$, canonical binary-signal information structure. $\rightleftharpoons$
  - When $\eta \to 1$, information is very rare. $\rightleftharpoons$
  - (Lots results independent of η)

$\hookrightarrow$

Final Lecture

- Each Player k chooses among nine choices:$\rightleftharpoons$
  - dine in Restaurant A, dine in Restaurant B, or dine at home.$\rightleftharpoons$
  - Goes to a restaurant if she thinks there is more than 60% chance it is good, and stays at home if that is not true at either restaurant.$\rightleftharpoons$
- Depending on confidence in restaurant's quality, may go alone, or take one, two, or three of her relatives.$\rightleftharpoons$
- Superscripts for the number of people she takes: $\rightleftharpoons$

$p(\omega_A)$	[0,10),[10,20),[20,30),[30,40)	[40,60]	(60,70],(70,80],(80,90],(90,100]
Choice	$B^{+++}, B^{++}, B^{+}, B$	H	$A, A^{+}, A^{++}, A^{+++}$

$\looparrowright$

Final Lecture

Three people choose restaurants each period,⇌

- Signal conditionally i.i.d. given state⇌
- Each doing so after observing her own signal,⇌ and the full actions (three locations, and party size), in order,⇌ taken in all previous periods.

This example is clearly very contrived.⇌ But scout's honor ... ⇌

- General punchlines not based on specifics.

↬

Final Lecture

What predictions does full rationality make?$\rightleftharpoons$

- $\emptyset$ signal, observes nothing but $H \longrightarrow$ stay home.$\rightleftharpoons$
- α or β signal, observes nothing but $H \longrightarrow$ go to restaurant.$\rightleftharpoons$
- (alone, because beliefs exactly .7 $\longrightarrow$ alone).$\rightleftharpoons$

Suppose in period 2 observe that exactly one person has gone to Restaurant A in period 1.$\rightleftharpoons$

- What do as a function of your signal?$\rightleftharpoons$
- You will realize that the three signals in period 1 were $\{\alpha, \emptyset, \emptyset\}$.$\rightleftharpoons$
  - $\beta \longrightarrow H$.$\rightleftharpoons$
  - $\emptyset \longrightarrow A$.$\rightleftharpoons$
  - $\alpha \longrightarrow A^{++}$

$\looparrowright$

Final Lecture

If observe:$\rightleftharpoons$

	actions	
Period 1:	$\{A, H, H\}$	$\rightleftharpoons$
Period 2:	$\{A, A, A\}$	

What do (as function of signal)?

$\looparrowright$

Final Lecture

	actions	response	signals
Period 1:	$\{A, H, H\}$		$\{\alpha, \emptyset, \emptyset\}$
Period 2:	$\{A, A, A\}$		$\{\emptyset, \emptyset, \emptyset\}$
Period 3:		$\beta \to H$, $\emptyset \to A$, $\alpha \to A^{++}$	

- Key logic: guys in period 2 did *not* get any additional information.$_{\rightleftharpoons}$
  - (If did, would not have gone alone.)$_{\rightleftharpoons}$
  - Period 3: rationally realize no new information in Period-2 followers.

$\looparrowright$

Final Lecture

If observe:$\rightleftharpoons$

	actions	
Period 1:	$\{A, H, H\}$	
Period 2:	$\{A, A, A\}$	$\rightleftharpoons$
Period 3:	$\{A, A, A\}$	
Period 4:	$\{A, A, A\}$	
Period 5:	$\{A, A, A\}$	

What do as (as function of signal)?

$\looparrowright$

Final Lecture

	actions	response	signals
Period 1:	$\{A, H, H\}$		$\{\alpha, \emptyset, \emptyset\}$
Period 2:	$\{A, A, A\}$		$\{\emptyset, \emptyset, \emptyset\}$
Period 3:	$\{A, A, A\}$	$\rightleftharpoons$	$\{\emptyset, \emptyset, \emptyset\}$
Period 4:	$\{A, A, A\}$		$\{\emptyset, \emptyset, \emptyset\}$
Period 5:	$\{A, A, A\}$		$\{\emptyset, \emptyset, \emptyset\}$

Period 6: $\beta \longrightarrow H$, $\emptyset \longrightarrow A$, $\alpha \longrightarrow A^{++}$

- Understanding redundancy information in actions: hard.$\rightleftharpoons$
- But it matters a lot.

$\curvearrowright$

Final Lecture

If observe:$\rightleftharpoons$

	actions	
Period 1:	$\{A, H, H\}$	$\rightleftharpoons$
Period 2:	$\{A, A, H\}$	

What do (as function of signal)?

$\looparrowright$

Final Lecture

Herding without sufficiently increased enthusiasm is a bad sign:

	actions	response	signals
Period 1:	$\{A, H, H\}$		$\{\alpha, \emptyset, \emptyset\}$
Period 2:	$\{A, A, H\}$	$\rightleftharpoons$	$\{\emptyset, \emptyset, \beta\}$

Period 3: $\beta \longrightarrow B, \emptyset \longrightarrow H, \alpha \longrightarrow A$

$\rightleftharpoons$

3 A, 3 $H \longrightarrow \omega_A, \omega_B$ equally likely!$\rightleftharpoons$

- Do we get that?

$\looparrowright$

Final Lecture

If observe:$\rightleftharpoons$

	actions	
Period 1:	$\{A, H, H\}$	$\rightleftharpoons$
Period 2:	$\{A, H, H\}$	

What do (as function of signal)?

$\looparrowright$

Final Lecture

	actions	response	signals
Period 1:	$\{A, H, H\}$		$\{\alpha, \emptyset, \emptyset\}$
Period 2:	$\{A, H, H\}$		$\{\emptyset, \beta, \beta\}$
Period 3:		$\beta \to B^{++}, \emptyset \to B, \alpha \to H$	

$\rightleftharpoons$ $\rightleftharpoons$

You shouldn't go to A even if get α!

$\hookrightarrow$

Final Lecture

If observe:$\rightleftharpoons$

	actions	
Period 1:	$\{A, H, H\}$	$\rightleftharpoons$
Period 2:	$\{H, H, H\}$	

What do (as function of signal)?

$\hookrightarrow$

Final Lecture

	actions	response	signals
Period 1:	$\{A, H, H\}$		$\{\alpha, \emptyset, \emptyset\}$
Period 2:	$\{H, H, H\}$	$\rightleftharpoons$	$\{\beta, \beta, \beta\}$
Period 3:		$\beta \longrightarrow B^{+++}, \emptyset \longrightarrow B^{++}, \alpha \longrightarrow B$	

Go to B no matter what!

$\looparrowright$

Final Lecture

If observe:$\rightleftharpoons$

	actions	
Period 1:	$\{A, H, H\}$	$\rightleftharpoons$
Period 2:	$\{A^{++}, A, A\}$	
Period 3:	$\{A^{++}, A, A\}$	

What do (as function of signal)?

$\looparrowright$

Final Lecture

	actions	response		signals
Period 1:	$\{A, H, H\}$			$\{\alpha, \varnothing, \varnothing\}$
Period 2:	$\{A^{++}, A, A\}$		$\rightleftharpoons$	$\{\alpha, \varnothing, \varnothing\}$
Period 3:	$\{A^{++}, A, A\}$			$\{\varnothing, \beta, \beta\}$
Period 4:		$\beta \to B,\ \varnothing \to H,\ \alpha \to A$		

$\hookrightarrow$

Final Lecture

If observe:$\rightleftharpoons$

	actions	
Period 1:	$\{A, H, H\}$	
Period 2:	$\{A^{++}, A, A\}$	$\rightleftharpoons$
Period 3:	$\{A^{++}, A^{++}, A\}$	
Period 4:	$\{A^{++}, A^{++}, A\}$	
Period 5:	$\{A^{++}, A^{++}, A^{++}\}$	

What do (as function of signal)?

$\looparrowright$

Final Lecture

	actions	response		signals
Period 1:	$\{A, H, H\}$			$\{\alpha, \emptyset, \emptyset$
Period 2:	$\{A^{++}, A, A\}$			$\{\alpha, \emptyset, \emptyset$
Period 3:	$\{A^{++}, A^{++}, A\}$		$\rightleftharpoons$	$\{\emptyset, \emptyset, \beta$
Period 4:	$\{A^{++}, A^{++}, A\}$			$\{\alpha, \alpha, \emptyset$
Period 5:	$\{A^{++}, A^{++}, A^{++}\}$			$\{\beta, \beta, \beta$
Period 6:		$\beta \longrightarrow H$, $\emptyset \longrightarrow A$, $\alpha \longrightarrow A^{++}$		

Will a β signal help stop the herd?

$\looparrowright$

Final Lecture

If observe:$\rightleftharpoons$

	actions	
Period 1:	$\{A, A, A\}$	$\rightleftharpoons$
Period 2:	$\{A^{++}, A^{++}, A^{++}\}$	

What do (as function of signal)?

$\looparrowright$

Final Lecture

	actions	response	signals
Period 1:	$\{A, A, A\}$		$\{\alpha, \alpha, \alpha\}$
Period 2:	$\{A^{++}, A^{++}, A^{++}\}$		$\rightleftharpoons$ $\{\beta, \beta, \beta\}$ $\rightleftharpoons$
Period 3:		$\beta \to B, \emptyset \to H, \alpha \to A$	

- Enough.$\rightleftharpoons$
- Things far more complicated if $\rightleftharpoons$don't observe order, $\rightleftharpoons$don't observe all, or $\rightleftharpoons$ heterogenous preferences $\rightleftharpoons$
  - But nothing makes the severe limits to imitation go away$\rightleftharpoons$
- **Others' beliefs massively correlated** $\rightleftharpoons$
  - $\Longrightarrow$ **musn't imitate too much.**$\rightleftharpoons$

↬

Final Lecture

Same setting (same signals, players per period, etc.) but:

- Cannot observe order of play.
- **Signals rare**
- In period 3, if see
  - If see $\{H, H, H, H, H, H\}$, then believe .5
  - If see $\{A, H, H, H, H, H\}$, then believe .7
  - If see $\{A, A, H, H, H, H\}$, then believe .84
  - If see $\{A, A, A, H, H, H\}$, then believe .5
  - If see $\{A, A, A, A, H, H\}$, then believe .7
  - If see $\{A, A, A, A, A, H\}$, then believe .3

One old and one new example:

Final Lecture

	actions	response	signals
Period 1:	$\{A, H, H\}$		$\{\alpha, \varnothing, \varnothing\}$
Period 2:	$\{H, H, H\}$	$\rightleftharpoons$	$\{\beta, \beta, \beta\}$
Period 3:		$\beta \to B^{+++}, \varnothing \to B^{++}, \alpha \to B$	

	actions	response	signals
Period 1:	$\{B, H, H\}$		$\{\beta, \varnothing, \varnothing\}$
Period 2:	$\{H, H, H\}$	$\rightleftharpoons$	$\{\alpha, \alpha, \alpha\}$
Period 3:		$\beta \to A, \varnothing \to A^{++}, \alpha \to A^{+++}$	

$\rightleftharpoons$

Anti-imitation!

Final Lecture

Lesson?⇌

- Choosing a restaurant may be hard!⇌

More interesting lesson:⇌

- Most natural learning environments...⇌
  - Great deal redundancy.⇌
- Theorem 1⇌ ('False but not misleading'):⇌
  - Almost all non-single-file environments, rationality implies 'anti-imitation'.⇌
  - Intuition: if two recent guys both imitating earlier guy but not each other—imitate both, ⇌
  - **but subtract off source of correlation... earlier guy**.⇌
- Theorem 2:⇌
  - What few environments that don't demand 'anti-imitation' ⇌ (e.g., single-file),⇌ imitate all you see as if seeing only one person.

↬

Final Lecture

Harder to see:$\rightleftharpoons$

- Rational observational learning in this case:$\rightleftharpoons$
  - Eventually will herd on $\{B^{+++}\}$ or $\{A^{+++}\}$.$\rightleftharpoons$
  - More than 95% of time $\rightarrow$ right restaurant.$\rightleftharpoons$
  - Intuition: any lesser certainty, contrary signal will moderate behavior.$\rightleftharpoons$
- **When signals rare:**$\rightleftharpoons$
  - Roughly 30% of time herd starts in wrong direction, $\rightleftharpoons$
  - stays wrong $< 5\%$ time.$\rightleftharpoons$
  - $\rightarrow > 25\%$ of time: herd in wrong direction followed by reversal... $\rightleftharpoons$
  - somebody observing at least 50 people going to one restaurant and none to other decides stay home based on opposite signal.

$\looparrowright$

Final Lecture

Rationality does not just demand great care.⇌

- demands something people get wrong in systematic direction.⇌

What happens if instead people neglect redundancy?⇌

- ER (2010) particular extreme form.⇌
- "Britney" behaves as if all she is observing are independent.⇌

When signals are rare,⇌

- Tommy:⇌
  - less than 5% chance society converges to wrong restaurant,⇌
  - Everybody less than 96% sure they have right one.⇌
- Britney:⇌
  - ∼30% chance convergence to wrong restaurant⇌
  - Everybody around ∼100% sure they are right.

↬

Final Lecture

Eyster-Rabin (2014) ... $\rightleftharpoons$

- In many environments, tiny amounts of naive redundancy neglect can lead society astray.$\rightleftharpoons$
- In example:$\rightleftharpoons$ For weak signals, **any** learning rule in which$\rightleftharpoons$
  - everybody (?)$\rightleftharpoons$ who sees 50 or more go one restaurant and none go to other follows the herd no matter signal$\rightleftharpoons$
  - will lead to 30% chance of false herd.

$\rightarrow$

Final Lecture

Attention!!!

1. Building from Schwartzstein (2015), Gagnon-Bartsch, Rabin, and Schwartzstein (2008): $\rightleftharpoons$
    1. Inattention (notice the missing adjective...)$\rightleftharpoons$
    2. *Subjectively* rational inattention and **perceived benefits** of attention.
    3. You can't assume people paying attention corrects errors, except if people are very worried

$\hookrightarrow$

Final Lecture

- Complete Models vs. Incomplete/Vague Models/Frameworks$\rightleftharpoons$
  - 8% vs 8,000%$\rightleftharpoons$
  - Three-Dot Theory A vs. Corner-Eliminating Theory B (See 1st Laibson lecture).$\rightleftharpoons$
  - C-E Theory B adds situation-specific further restrictions ... that end up matching the dots exactly!$\rightleftharpoons$

Hey, I have an example to talk about! EBRD vs. back-ward looking ...
$\looparrowright$

Final Lecture

The epistemology of explanation in a non-linear world ...
"Cursedness" is a necessary, and huge, error **on top of everything else**.⇌

- Generalization: failure to use the logic of a market exchange to bound your probabilistic beliefs.⇌

General lessons in thinking about errors.⇌

- Blah blah blah ... complexity ... ⇌
- Suppose Rob (carrying a calculator) walks up to Roy and offers:⇌
  - "You give me \$100 if the 12th + 13th digit of π^2 are 93. I give you \$100 if anything else. Decide immediately without electronics." ⇌
  - Suppose Roy says "Yes" — and (bad luck, those digits are 93!) pays \$100.⇌
  - What mistake is Roy making?⇌
- With limited learning, limited attention, bounded rationality ⇌
  - Even when definitely, provably necessary role ⇌
  - It is not the epistemologically, scientifically relevant "explanation"
- **Celerier & Vallee (2015)** paper ... shocking stuff.

Final Lecture

Generalization of "cursedness" $\rightleftharpoons$

- "Inversion neglect": Even when paying attention to variables, do people have *any* consistent "structural" beliefs whatsoever to explain their reaction?$\rightleftharpoons$
- Do people form a theory of their credit-card behavior, insurance that is consistent with companies trying to make money?$\rightleftharpoons$
- Form a theory medicine and illness consistent with the world they see?$\rightleftharpoons$

$\looparrowright$

Final Lecture

- Shrouded attributes ...⇌

What are people's beliefs about what they are buying?⇌

- We are using the term (legitimately) for two importantly different things:
  - Not knowing some feature that no intrinsic reason to know about ⇌
    - And key Gabaix-Laibson insight that market incentives won't de-shroud⇌
  - But per se that insurance companies, credit-card companies, or any company intends to make money off of you **should** deshroud the shrouded attribute⇌
  - And you should know an ointment won't make you live forever or cure cancer ...⇌
  - Because you don't see immortals around you ... and you see people dying from cancer.⇌ Why?

But modeling shrouded attributes of either type: ⇌

- Whether or not people neglecting a logic they should know about ...⇌
- You must have a model about what they are thinking, not just what

Final Lecture

We need to parse by how it affects economics

- For those of us proposing alternative theories of people (experimentalists, behavioral theorists, decision theorists, etc.⇌
  - I try to make myself part of production function by supplying restrictive and widely applicable formal models.⇌
  - Experiments as input into tractable models with economic consequences and empirical implementability⇌

Two prevalent modes of economics especially worth keeping in mind.

Final Lecture

- 1. Most economics about how given assumptions play out theoretically and empirically in different economic situations.$\rightleftharpoons$
  - *Not* about iterating next improvement in assumptions.$\rightleftharpoons$
  - Research on new assumptions should mostly be seen as *input* into economics.
- 2. Most empirics in economics is about *ecological significance*, not about *existence* of a phenomenon.$\rightleftharpoons$
  - "Existence proofs" right first steps to introducing assumptions.$\rightleftharpoons$
  - But then need theory and measurable variables.$\rightleftharpoons$
  - To be used widely and well in economics, these literatures **must** make progress on answering:$\rightleftharpoons$ when and what exactly?$\rightleftharpoons$ how much?

Final Lecture

In fact, let's work it out.$\rightleftharpoons$

- A la Laibson GE, dutch books$\rightleftharpoons$
- But also: What errors have the biggest effect$\rightleftharpoons$
- Compare: lots and lots of errors in herding context, but theory tells us redundancy neglect is the big-ticket item. $\rightleftharpoons$

Basically, in the long-run social outcome,$\rightleftharpoons$

- it is basically steady-state trembles that matter$\rightleftharpoons$
  - in proportion to the trembles$\rightleftharpoons$
- And redundancy neglect that matters on a much more massive scale, much magnified of the mistakes individuals making

Final Lecture

- Some theories may be Brussels sprouts...$\rightleftharpoons$
  - You: Brussels sprouts a great.$\rightleftharpoons$
  - Me: Brussels sprouts suck.$\rightleftharpoons$
  - You: Oh no, you just haven't tried them the right way ...$\rightleftharpoons$
  - Me [to self]: Here it comes ...$\rightleftharpoons$
  - You: You need to fry them with garlic ... $\rightleftharpoons$add butter sauce ...$\rightleftharpoons$ add chile ...$\rightleftharpoons$ mix in broccoli ...$\rightleftharpoons$ bake them into chocolate cake ...$\rightleftharpoons$ eat them on a mountain-top ...$\rightleftharpoons$ eat them with a beautiful naked person ...$\rightleftharpoons$ run out and buy them when you learn about a raise ... $\rightleftharpoons$
  - It's always the sauce $\rightleftharpoons$
- Broccoli, spinach, virtually unadorned ...

$\looparrowright$

Final Lecture

Or papayas?$\rightleftharpoons$ (the BR(ϵ) part of QRE, sometimes)

- Me: Papayas suck. Why do people eat Papaya?
- You: You just have the flavorless ones. Here's a fresh one with flavor ...
- Me: Can you please pass the flavorless one.$\rightleftharpoons$ ... and all the mangos you have.

$\looparrowright$

Final Lecture

Two Themes from my perspective: $\rightleftharpoons$

1. All models are false, so let's stop the paradigm of testing whether or not a model is true $\rightleftharpoons$
2. Subjective judgment guided by intuitions from theory and economic implications **must** be a component in defining transparency and (especially) judging the reliability of results.

Final Lecture

All theories are false.

- They make simplifying assumptions [p.s. — often stated in the papers], they leave things out.⇌
- A model that says everything is ... a cloned world, not a model.⇌

I've proposed before ... would love all experiments to begin with the 1.5 sentences "All theories are false. In light of this fact, [rest of the paper]⇌

- If you want to follow it by breathless declarations that you've shown some model is false, live with the awkwardness.⇌
- [Accepting a model is often the most bizarre.⇌
  - You've just decided by some standard that the theory is close enough.⇌
  - Or, my favorite, the model fits "surprisingly well"]⇌
- But rejecting theories is a tired conceit that ought to start embarassing authors

Final Lecture

Explaining to your grandmother$\rightleftharpoons$

- It *is* good ("ceteris paribus") to be able to explain your ideas to your grandmother.$\rightleftharpoons$
  - But not all ideas are simple.$\rightleftharpoons$
  - If your grandmother is one of those over-confident types who think that anything they don't understand is b.s., and doesn't go in for 'book learning' then ignore your grandmother.$\rightleftharpoons$
  - (If you learned nothing else in these two weeks than that, it is to ignore your grandmother)

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- But if your grandmother is open-minded, smart, and no-nonsense, and she understands what you are saying but doesn't buy it, then worry.$\rightleftharpoons$
  - You: "I show people engaging in road rage are trying to build a reputation in their city as somebody who won't let anybody cut in front of them." $\rightleftharpoons$
  - Grandma: "No, that is not what they are thinking. They are angry and in the grip of emotion."$\rightleftharpoons$
  - You: "You don't understand Grandma, I've proven that in the limit as people are patient in fact there exists a SPNE that supports this as perfectly rational. I don't *need* to assume people are angry!" $\rightleftharpoons$
  - Grandma: "I admittedly don't understand what a subgame-perfect equilibrium is, but I *do* understand what you claim that people are thinking and feeling, you disrespectful, condescending prick. You're full of it. $\rightleftharpoons$Get a life. $\rightleftharpoons$It's cold in here, turn up the thermostat."$\rightleftharpoons$
  - You: "I'm arguing that it is 'as if' people are not angry." $\rightleftharpoons$
  - Grandma: "Okay, fine, so I'm arguing it is 'as if' you're full of it, you snotty kid. $\rightleftharpoons$Now turn up the thermostat!" $\rightleftharpoons$
  - You: "But I've shown my result in continuous time!"