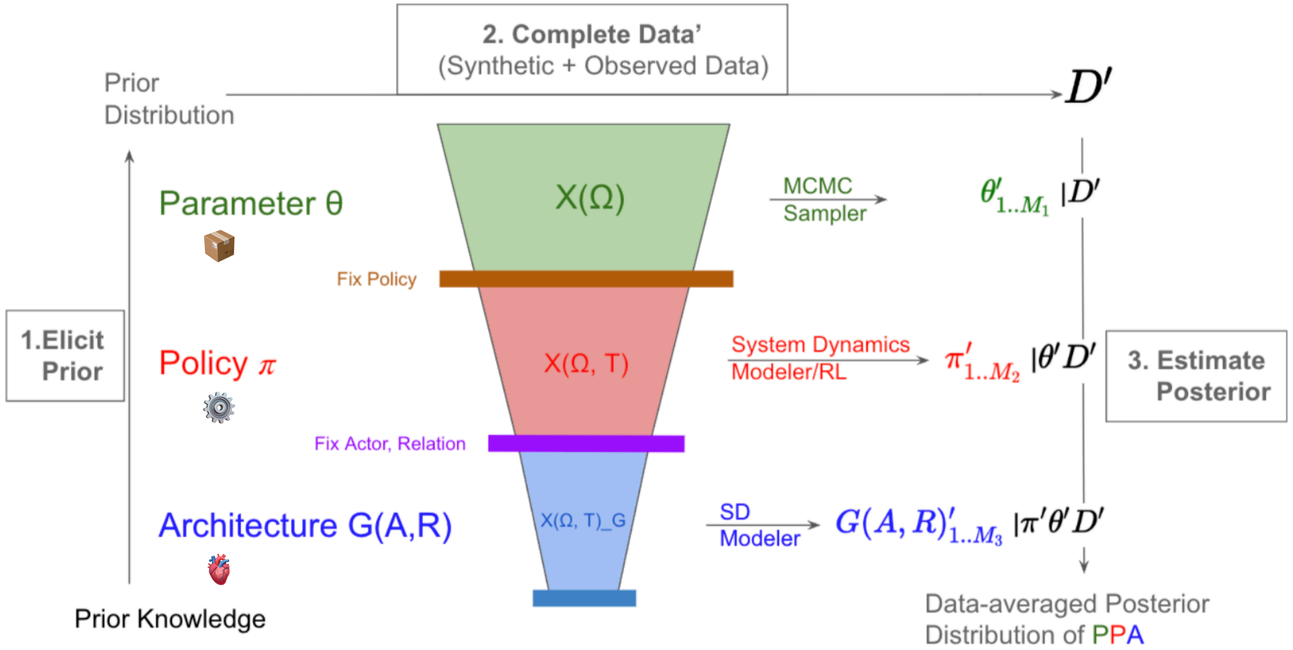
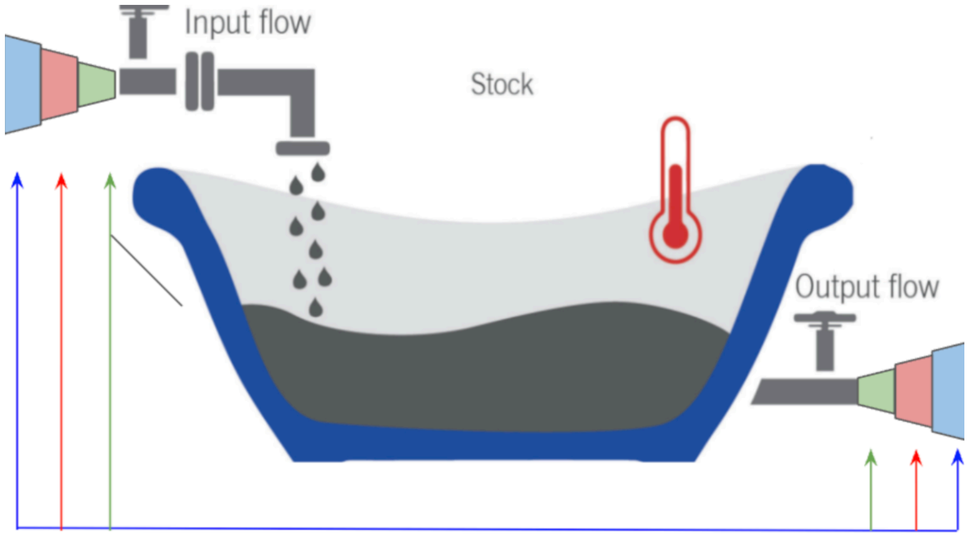
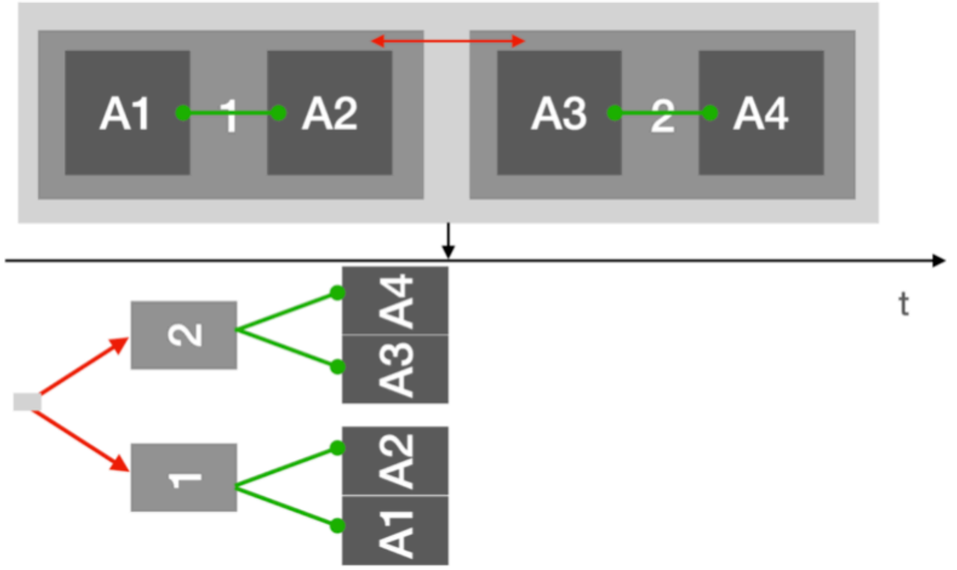
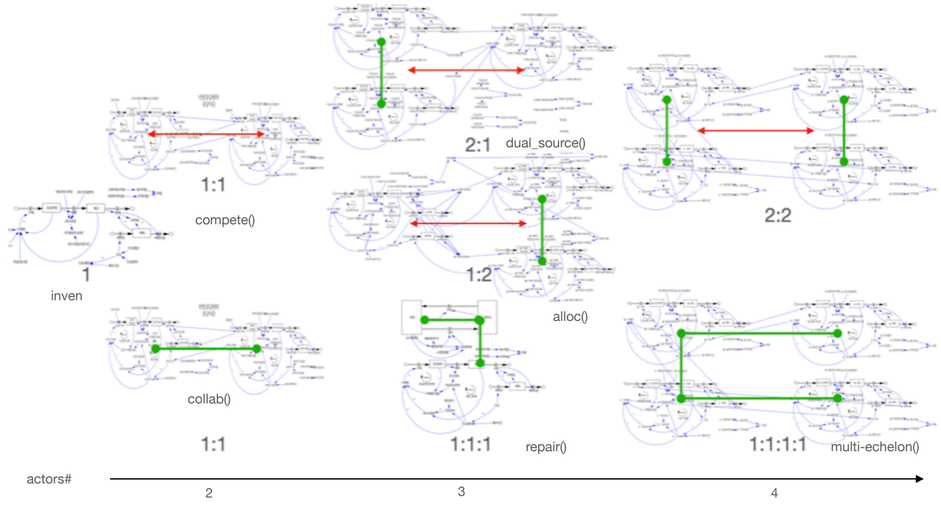




calibrate System - Policy - Params prior
with simulation-based calibration





Moon (2022)

Eric's def of **strategic decision**: degree to which a decision is 'strategic' equals the probability that it is, in equilibrium, investigated or announced as part of the optimal strategy.

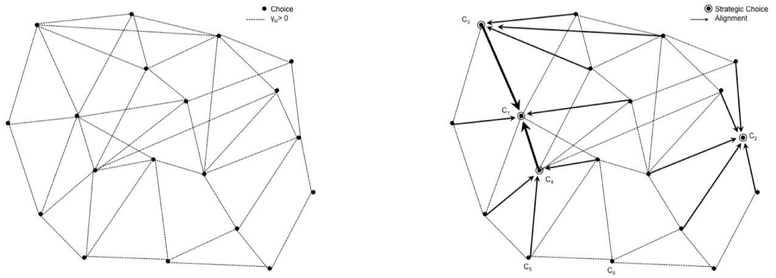
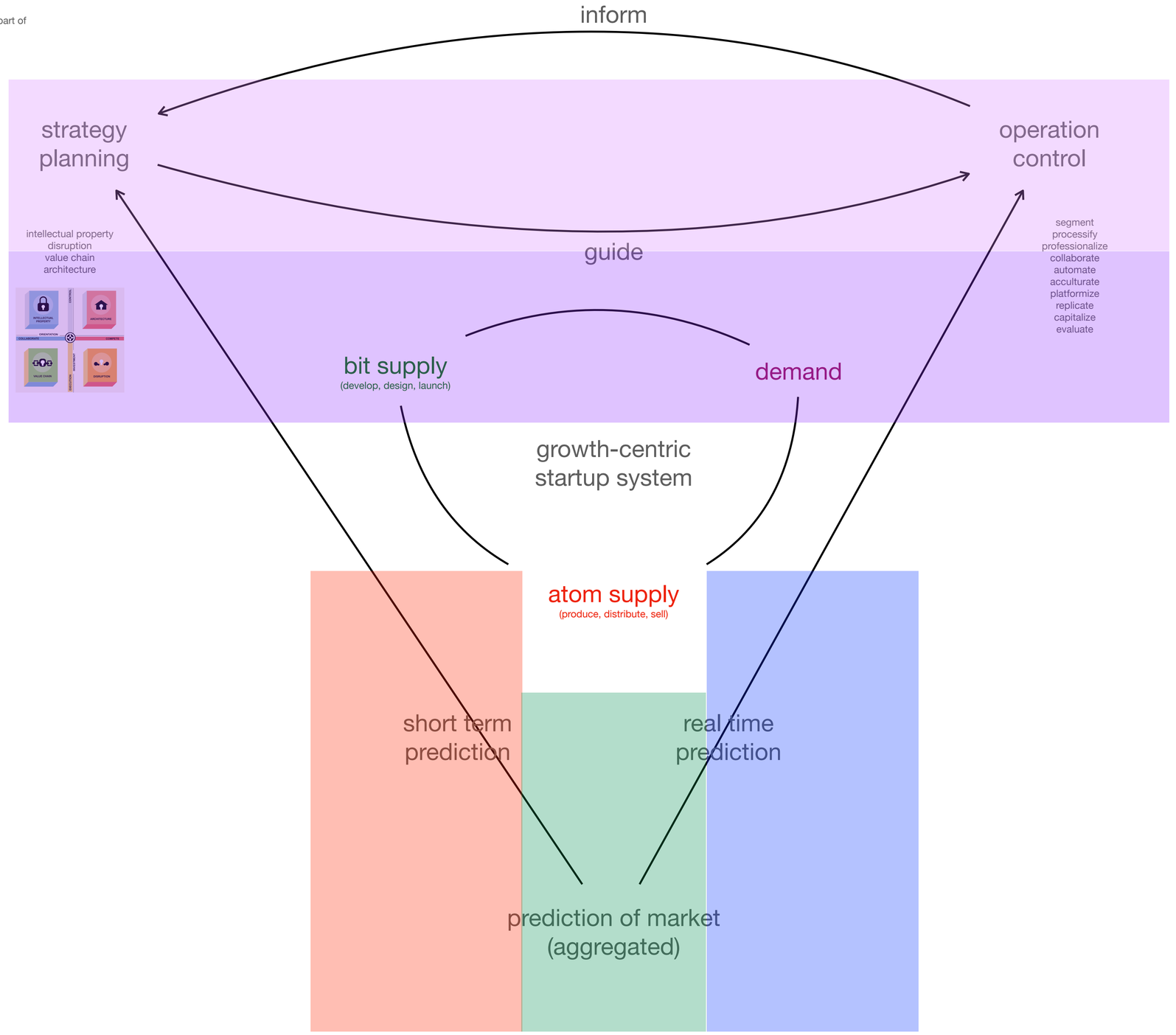
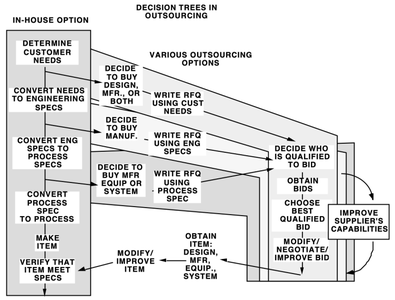


Figure 2: Strategy creates a hierarchy of decision

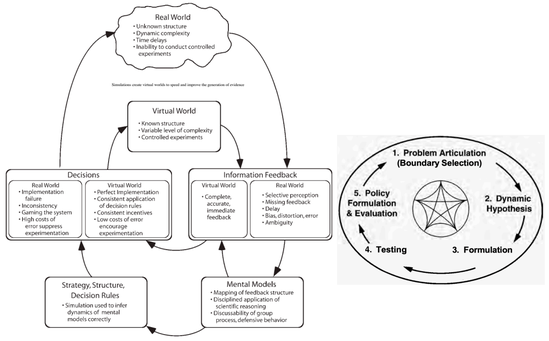
1	2
Strategy formulation	Strategy implementation
a The strategist decides which states T_k and T_{kl} to investigate.	a Each participant P_k receives the signals θ_k and θ_{kl} about (only) the choice state T_k and interaction states T_{kl} of her task.
b When she investigates a state T_k or T_{kl}, the strategist receives a signal τ_k or τ_{kl}. She can then either return to 1a or continue to 1c.	b Each participant makes his or her choice (sequentially without observing others' choices or simultaneously).
c The strategist can announce a set of choices C_k.	c Payoffs are realized.

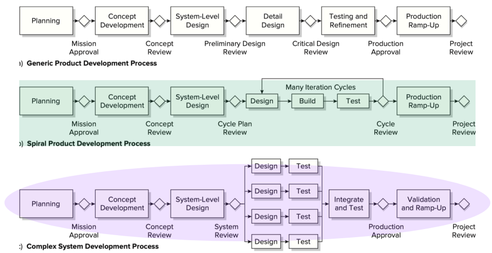


bit

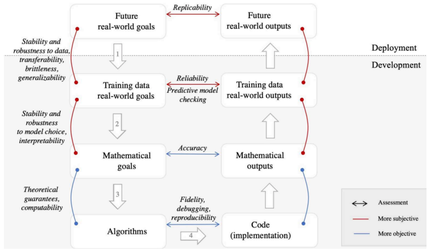


Fine, Witney (1996)





Ulrich, Eppinger, Yang (2019)



human-ai trust

operations strategy

science, statistics

system dynamics

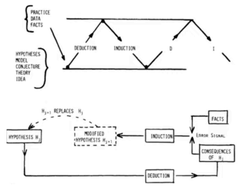
iterative diffusion of workflow

science, simulation

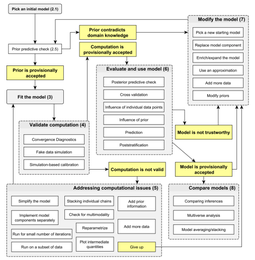
system engineering

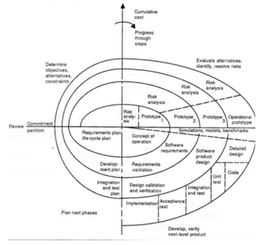
software engineering

Box and Youle (1955)

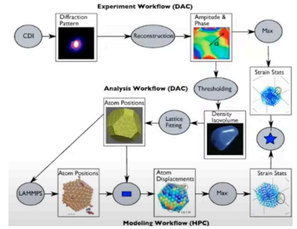


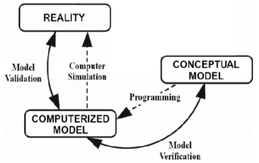
Box (1976)

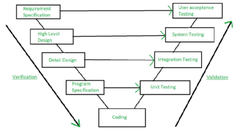




Boehm (1996, 1988)





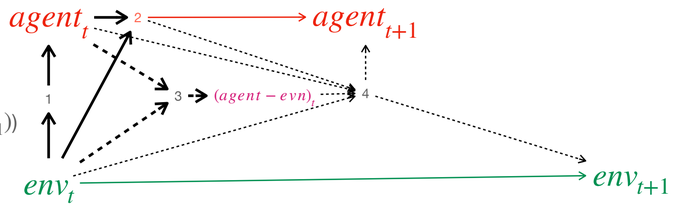


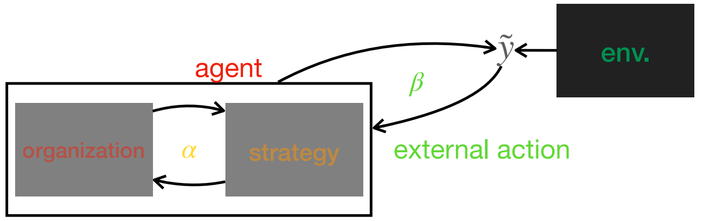
Sterman (2000)

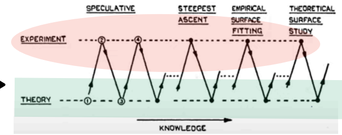
energy

atom

1.static_describe(e_t)
2.dynamic_describe(a_t, e_t)
3.static_prescribe(a_t, e_t)
= $(a-e)_t$
4.dynamic_prescribe(a_t, e_t, $(a-e)_t$, $(a_t - a_{t+1})$)
= a_{t+1}, e_{t+1}
5.describe($a_{t..t+10}$, $e_{t,t+10}$)

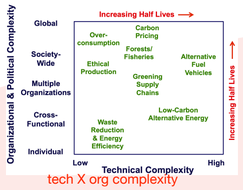






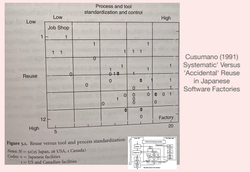
speculative | steepest ascent | empirical surface fitting | theoretical surface study

matter



tech X org complexity

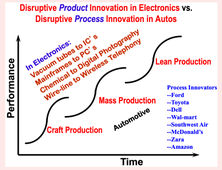
static_observe(e_t)



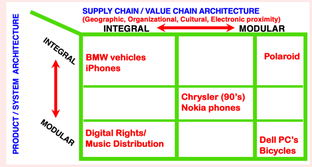
Cusumano (1991) Systematic' Versus 'Accidental' Reuse in Japanese Software Factories

supply control (~1/complexity)
= reusability (~standard, platform,, automate)

dynamic_observe(a_t, e_t)

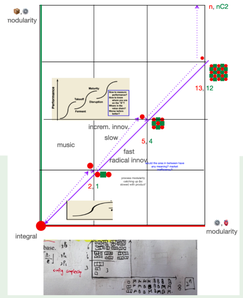


dynamic_observe(a_t, e_t)

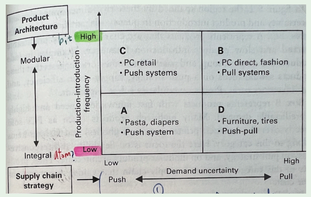


dynamic_observe($(a-e)_t$)

5.describe($a_{t..t+10}$, $e_{t,t+10}$)

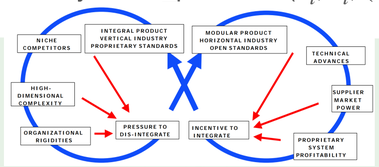


3.static_prescribe(a_t, e_t)
=$(a-e)_t$= $\beta|\alpha$

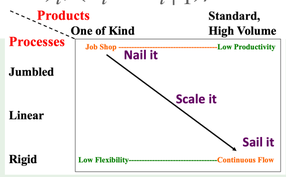


env strategy (pushpull)
given need uncertainty X agent strategy (sol. rhythm)

4.dynamic_prescribe(a_t, e_t, $(a-e)_t$, $(a_t - a_{t+1})$)



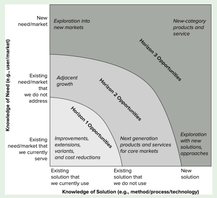
clockspeed, Fine (2000)



env: technology/innovation push, customer pull, regulation
other agent->agent: branding
agent: technical, organizational complexity

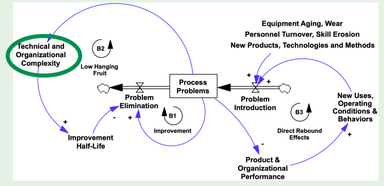
form

1.static_describe(e_t)

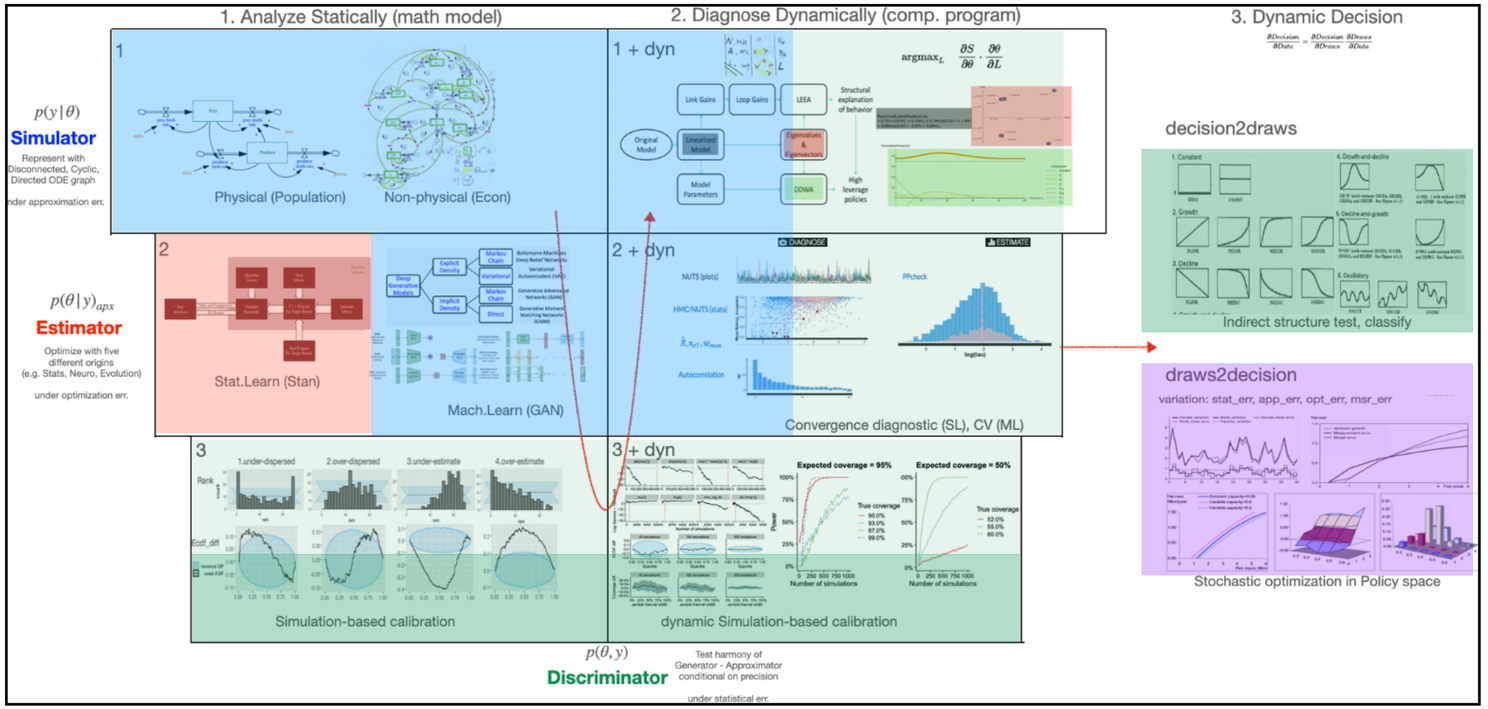


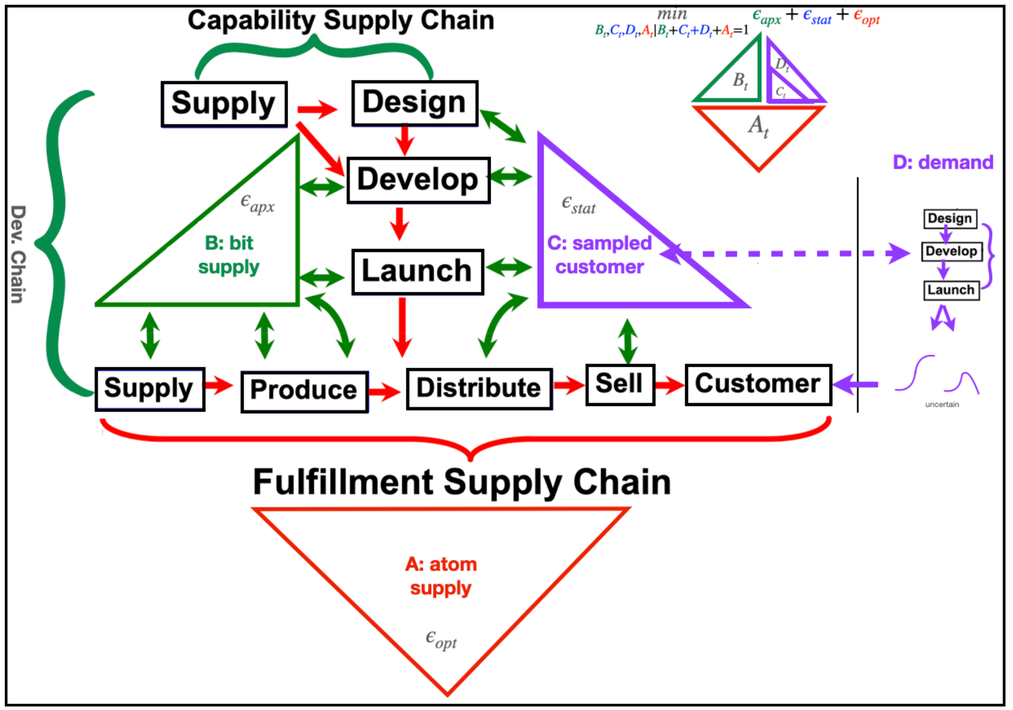
need solution risk: 1<2<3

2.dynamic_describe(a_t, e_t)



data for decision → diagnostics ← operations for entrepreneurs





1.1. supply

Introduce each individual's capability. Angie and Charlie shares experience of pivoting from an non-successful startup organization. In terms of domain, Angie and Charlie has experienced different types of business (B2B, B2C, B2G (government)). For educational organization, Charlie was initial dean of Asian school of business and Angie is manager of Bayesian computation community (StanKorea, 1.02k subscribers). We have not only expertise, but also good network with MIT TIES group (Fiona Murray, Scott Stern, Bill Aulfet, Eric von Hippel), Singapore SMART innovation center (Howard Califano), Korea SNU's innovation center (Jangpil Kim, Ensuk Seo).

1.2. design

NSS_GPS for entrepreneurs, which combines Charlie's NSS, TIES group's entrepreneurial compass, and Angie's actionable workflow.

1.2.1. NSS [1] is a sequential three time stages of startup in its lifecycle. The nail stage involves rapidly iterating to establish a viable value proposition and business model. The scale stage involves growing the company by building capabilities and processes to serve an expanding market. Finally, the sail stage is when growth slows and the focus turns to incremental improvement and sustaining the now-mature business.

1.2.2. entrepreneurial compass [2] is four strategical directions to develop ideas of each startup. Intellectual property strategy focuses on gaining control of innovations through patents and trademarks, and collaborating to reduce costs. The value chain strategy aims to be the preferred partner in a slice of an industry's value chain through strong execution and collaboration. The disruption strategy targets underserved segments and uses iteration and learning to expand. Finally, the architectural strategy creates an entirely new value chain by controlling a key resource or interface that coordinates multiple stakeholders to provide new consumer value.

1.2.3. Actionable workflow [3] is an entrepreneurial decision making architecture. Iterative testing of how 1. needs of stakeholders, 2. structural knowledge of experts, 3. machine learning methods come together is the key. It hinges upon Simulation based calibration, widely adapted testing framework in Bayesian community, which can check whether the implementation of statistical and computational model align with our expectation (prior knowledge). Based on its graphical unalignment signal, one can converge to a consistent model, more quickly and reliably.

1.3. develop (todo)

theory

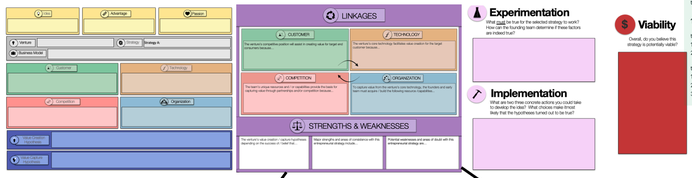
- NSS needs simplification or dynamic introduction to prevent cognitive overload
- entrepreneurial compass needs to dynamic learning component embedded
- Actionable workflow needs architectural update for automating the iteration so that its product, explainable policy, can be broadly distributed
- the three can be combined under Bayesian decision making [4] framework

tool: system architecture to combine the three is needed to establish database

1.4. launch

theory (memo)
1st launch (Jan.2023): 15.785 digital product management projects
2nd launch (Spring.2024): 15.785 digital product management course

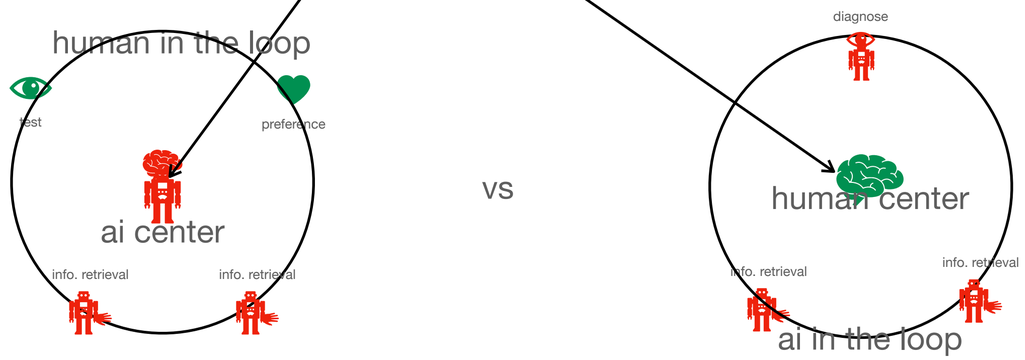
tool (manus)
1st launch (Sep.2023): AI product management demo day (with Charlie Fine)
2nd launch (Oct.2023): System dynamic research seminar (with Tom Fiddaman)
3rd launch (March.2024): Bayesian Entrepreneurship conference (with Scott Stern, Charlie Fine)

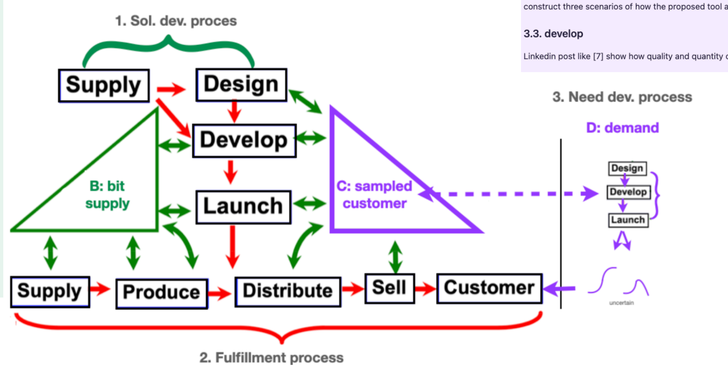


Experimentation
What can be true for the selected strategy to work? How can the founding team determine if these factors are indeed true?

Implementation
What are key three concrete actions you could take to develop the idea? What choices make those likely that the hypotheses turned out to be true?

Viability
Overall, do you believe this strategy is potentially viable?





Before the theory and tools become concretely proposed, we should develop its need by introducing the usefulness of NSS, entrepreneurial compass, actionable workflow to the public.

3.1. supply

theoretical and practical discoveries as we go through solution development process and fulfillment process.

3.2. design (todo)

construct three scenarios of how the proposed tool and/or theory can sovle the problem of potential customer

3.3. develop

Linkedin post like [7] show how quality and quantity of potential customers are updated.

2.1. supply

theory: scaling up experimental social, behavioral, and economic science (Abdullah Almaatouq [5], Thomas Mallone)

tool: combine LLM on probabilistic programming language (PPL) framework (Vikash Mansinghka [6])

2.2. produce

theory: 1st (Aug.2023): this proposal
tool: 1st (Sep.2023): AI product management demo day (with Charlie Fine) - pivot after feedback from 1st production

2.3. distribute

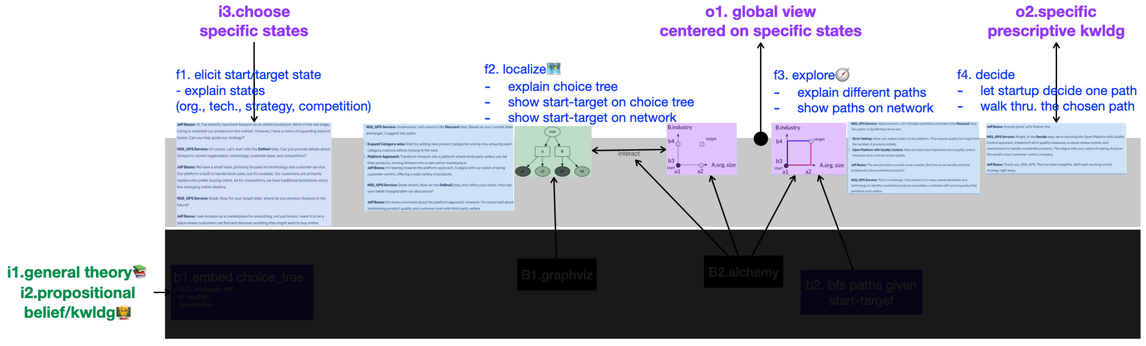
theory: 1st (Fall.2023) project for Jinhua and Scott's class, combining AI and entrepreneurship, upload on arxiv
tool:1st (Sep.2023) make first version of strategy chat service available online

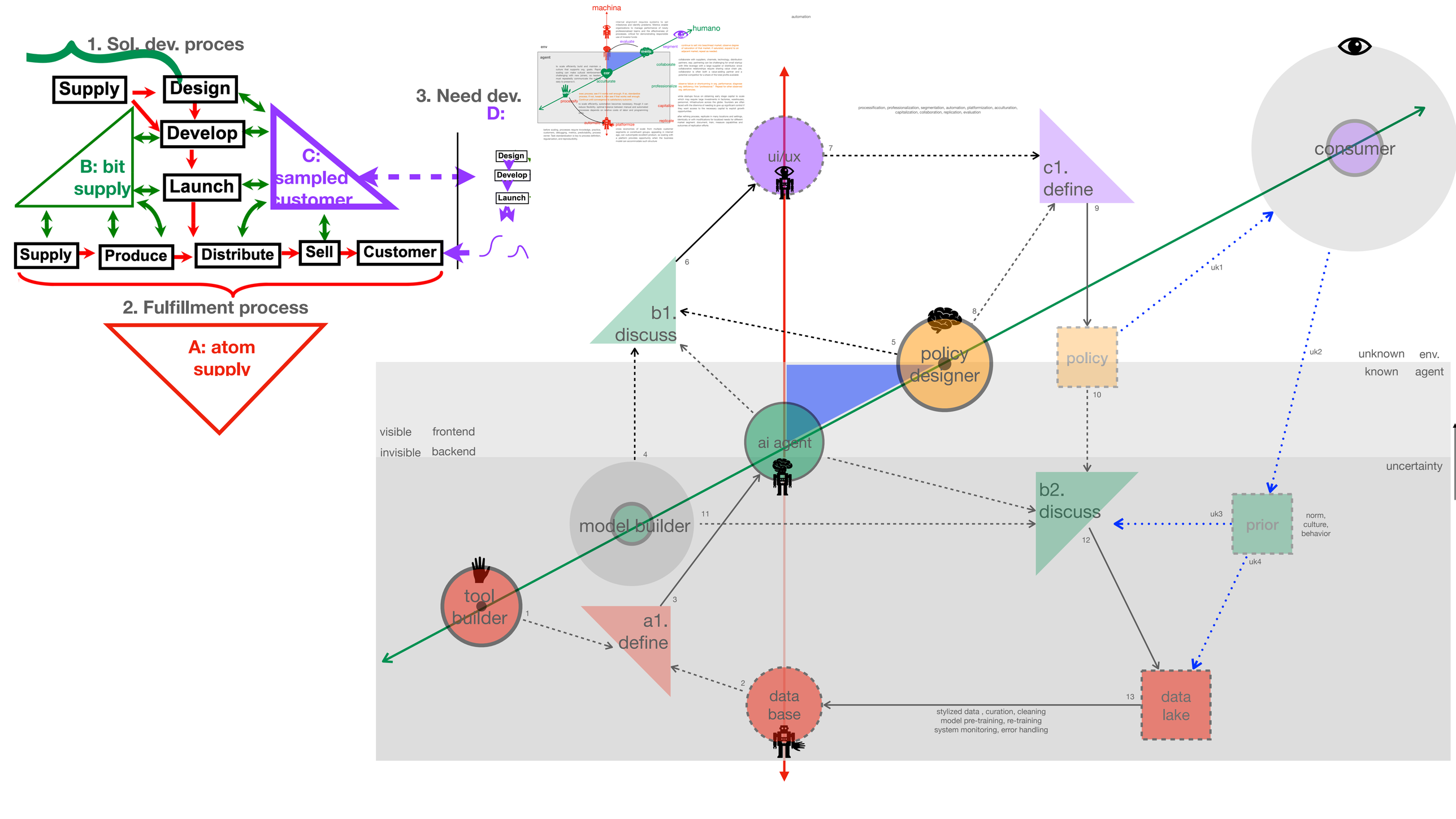
2.4. sell

theory: get positive response on theoretical contribution from TIES group and M3S project members
tool: get positive response on practical contribution startsups, mentors, VCs

2.5 customer

alpha: delta v's eleven cohorts (~200); 15.785 digital product management students (~100), 15S.10 students (~30)
beta: startups using online NSS_GPS service




1. Sol. dev. proces
Supply
Design
Develop
Launch
B: bit supply
C: sampled customer
Supply
Produce
Distribute
Sell
Customer
2. Fulfillment process
A: atom supply
3. Need dev.
D:
Design
Develop
Launch
machina
humano
env
agent
evaluate
segment
collaborate
professionalize
capitalize
replicate
automate
platformize
acculturate
proactivity
merit
eor
automation
processification, professionalization, segmentation, automation, platformization, acculturation, capitalization, collaboration, replication, evaluation
ui/ux
c1. define
consumer
b1. discuss
policy designer
policy
ai agent
model builder
b2. discuss
prior
tool builder
a1. define
data base
data lake
visible
invisible
frontend
backend
unknown
known
env.
agent
uncertainty
norm, culture, behavior
stylized data , curation, cleaning
model pre-training, re-training
system monitoring, error handling
uk1
uk2
uk3
uk4
1
2
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5
6
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11
12
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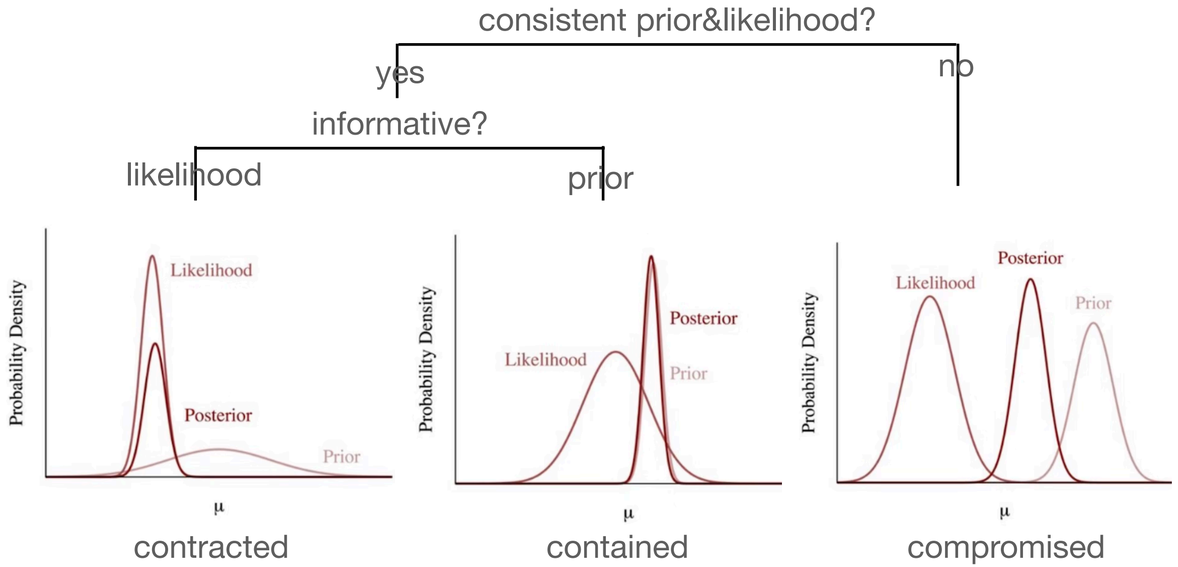
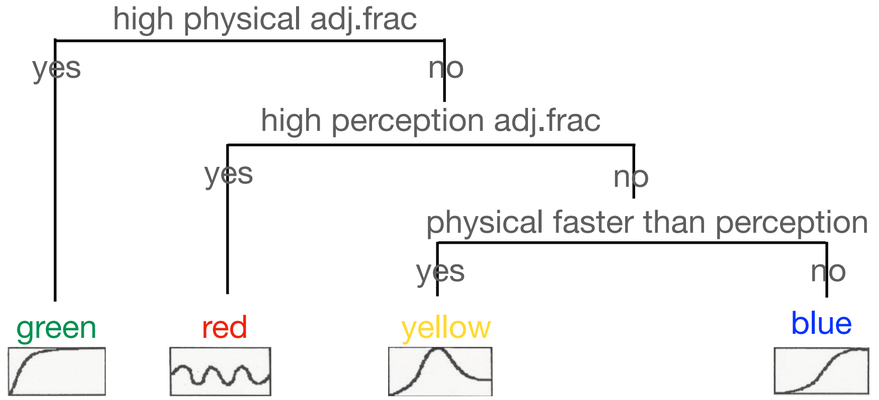
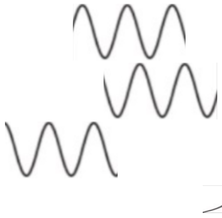
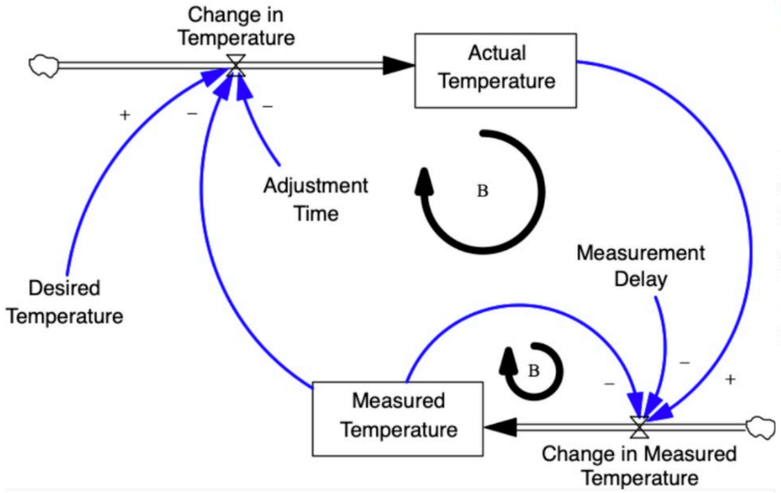
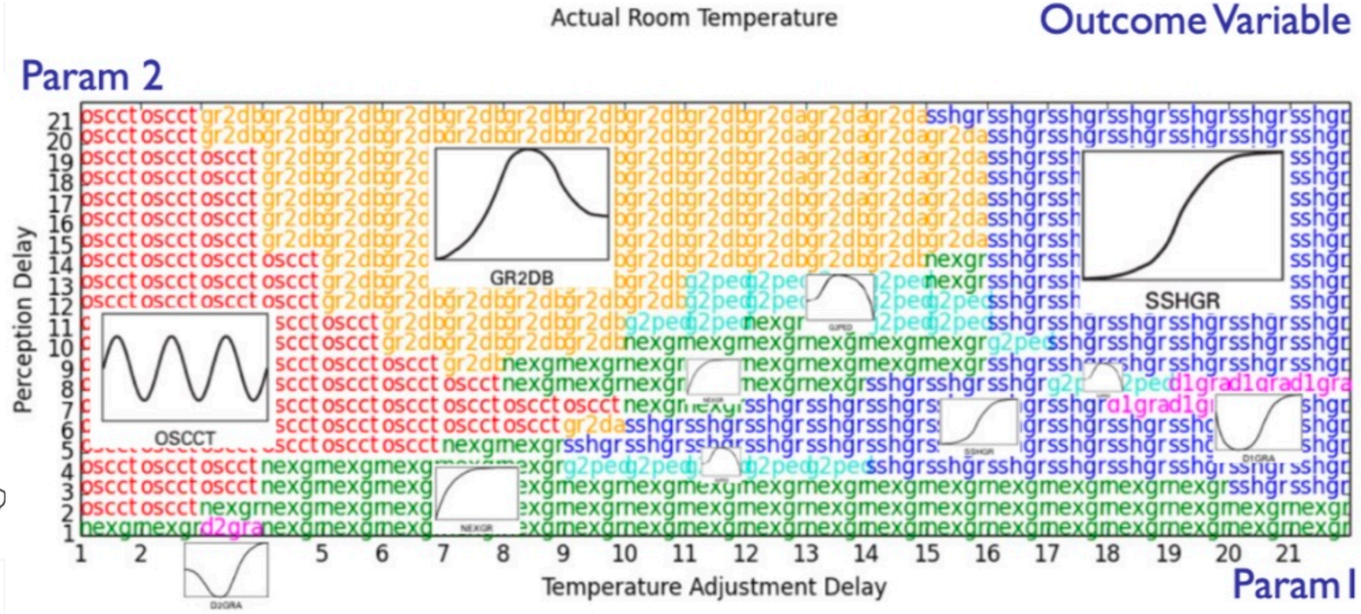

consistent prior&likelihood?
yes
no
informative?
likelihood
prior
Probability Density
Likelihood
Posterior
Prior
μ
contracted
contained
compromised


high physical adj.frac
yes
no
high perception adj.frac
yes
no
physical faster than perception
yes
no
green
red
yellow
blue




Change in Temperature
Actual Temperature
Adjustment Time
B
Desired Temperature
Measurement Delay
Measured Temperature
Change in Measured Temperature


Actual Room Temperature
Outcome Variable
Param 2
Perception Delay
GR2DB
SSHGR
OSCCT
Temperature Adjustment Delay
Param I

biological parameter: ref high risk share, all cause sensitivity, seasonal amplitude, initial infection rate, time to onset, time to infectious, time to onset, time to advance, fraction requiring hospitalization, mild duration, treated fatality rate, untreated fatality multiplier, behavioral parameter : initial population, contact density decline, contact stratification, potential frac population quarantined, available hospital beds per capita

policy lever: group isolation, relative isolation effectiveness pre-symptoms, state policy switch, behavioral risk reduction, relative behavior change for low risk, fatigue threshold?, log behavior change threshold, behavior change threshold, behavior sensitivity, behavior response time

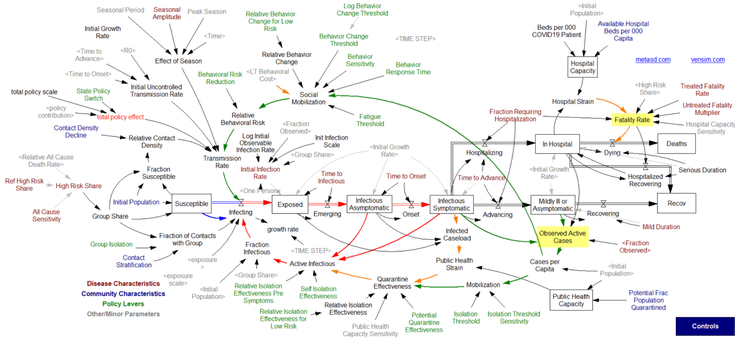


fig.1: vensim ui

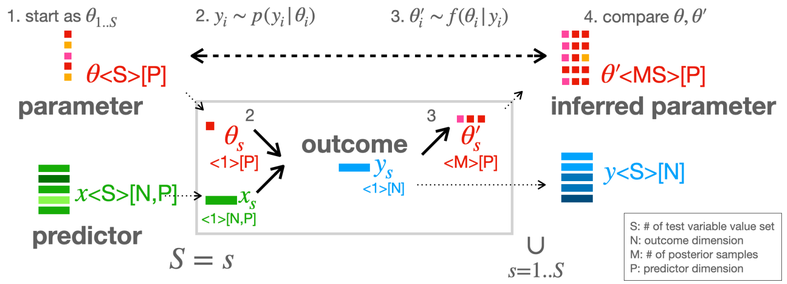


fig.3 SBC experiment lab

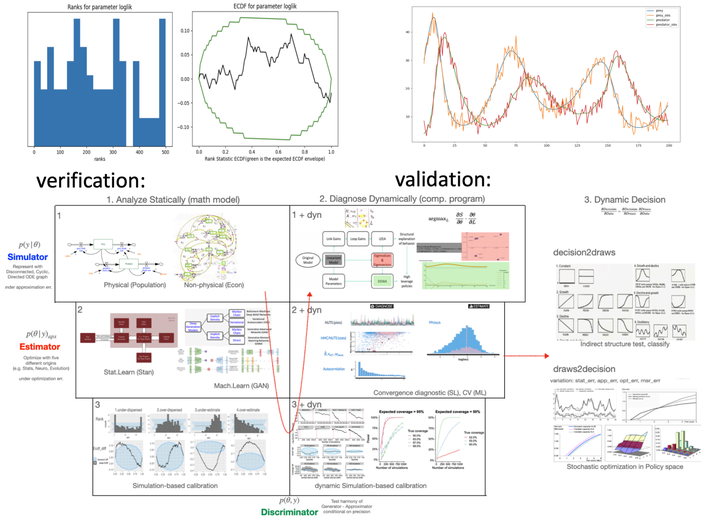


fig.5 how faster posterior triggers update of slower prior

```
dv = {"dims": {"x1", "x2", "f1x", "f2x", "f3x", "param", "costcomp_tv", "noncost_tv", "space", "time", "h1", "h2"},  # action
  "coords": {  # pcstvh
      'x1': {"dims": ("x1"), "data": x1},  # COST ($) TODO: if I use ["cost"], should i change x1_pcsth1 as "x1" or "cost"?
      'x2': {"dims": ("x2"), "data": x2},  # POPULATION (person)
      # f1(x1), f1(x2), f2(x1x2), f3(x1x2)
      'f1x': {"dims": ("f1x"), "data": f1x},  # MARGINAL AVERAGE VACCINE VALUE, MARGINAL AVERAGE VACCINE TAKING POP
      'f2x': {"dims": ("f2x"), "data": f2x},  # MARGINAL AVERAGE VACCINE VALUE PER PERSON ($/person)
      'f3x': {"dims": ("f3x"), "data": f3x},  # MARGINAL AVERAGE VACCINE VALUE PER PERSON w.r.t. PARAMETER ($/person/punit)
      'f4x': {"dims": ("f4x"), "data": f4x},  # MARGINAL AVERAGE VACCINE VALUE PER PERSON w.r.t. PARAMETER ($/person/punit)

      'param': {"dims": ("param"), "data": xr_param_lst},


      'costcomp_tv': {"dims": ("costcomp_tv"), "data": costcomp_tv}, 'noncost_tv': {"dims": ("noncost_tv"), "data": noncost_

      'space': {"dims": ("space"), "data": states}, 'time': {"dims": ("time"), "data": time}, "h1": {"dims": ("h1"), "data":
  "data_vars": {  # 5+3 three vdot_ coordinate is only needed for data variable
    "x1_pcsth1": {"dims": ("x1", "param", "costcomp_tv", "space", "time", "h1")
    "x2_pnsth1": {"dims": ("x2", "param", "noncost_tv", "space", "time", "h1"),
    "x2_pcth1": {"dims": ("x2", "param", "costcomp_tv", "time", "h1"), "data":


    "x1_csth2": {"dims": ("x1", "costcomp_tv", "space", "time", "h2"), "data":
    "x1_cth2": {"dims": ("x1", "costcomp_tv", "time", "h2"), "data": np.zeros(s
    "f1x_pcst": {"dims": ("f1x", "param", "costcomp_tv", "space", "time"), "dat
    "f1x_pnst": {"dims": ("f1x", "param", "noncost_tv", "space", "time"), "data
    "f1x1_pct": {"dims": ("f1x", "param", "costcomp_tv", "time"), "data": np.ze
    "f1x2_pct": {"dims": ("f1x", "param", "costcomp_tv", "time"), "data": np.ze

    "f1x1_p": {"dims": ("f1x", "param"), "data": np.zeros(shape=(len(f1x), len(
    "f2x_pcst": {"dims": ("f2x", "param", "costcomp_tv", "space", "time"), "dat
    "f2x_p": {"dims": ("f2x", "param"), "data": np.zeros(shape=(len(f2x), len(x
      # sens
    "f3x_pcst": {"dims": ("f3x", "param", "costcomp_tv", "space", "time",), "da
    "f3x_p": {"dims": ("f3x", "param",), "data": np.zeros(shape=(len(f3x), len(
    "f4x_cst": {"dims": ("f4x", "costcomp_tv", "space", "time",), "data": np.ze
```

fig.2 unified data structure

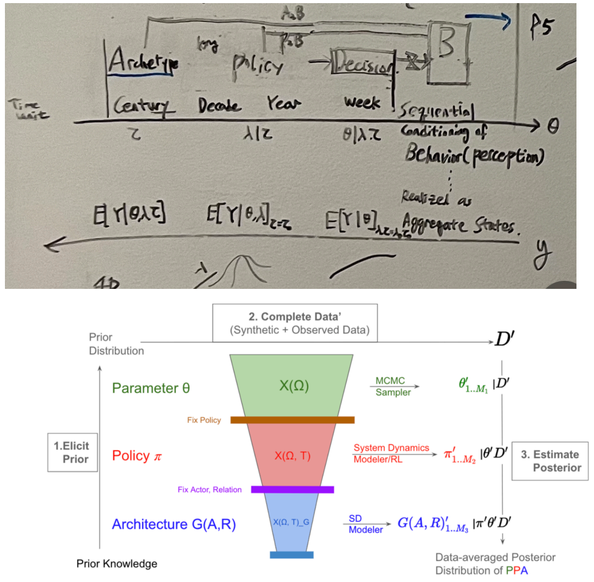


fig.4 parameter hierarchy from slow to fast, from generator to estimator

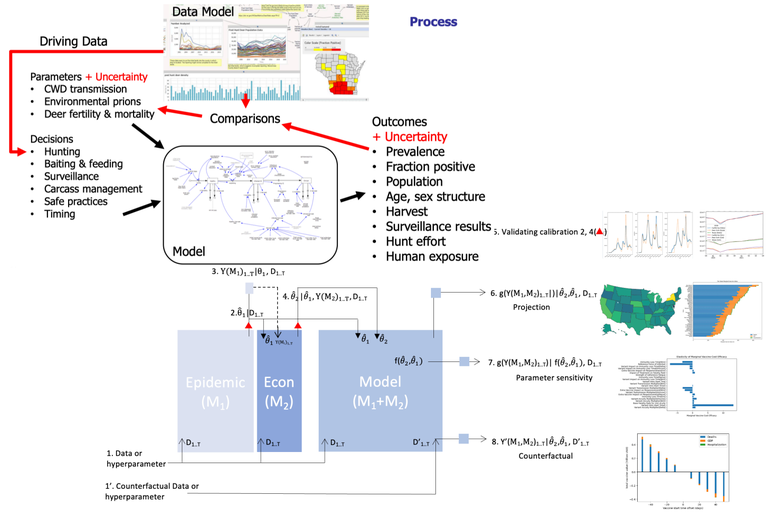


fig.6 workflow for covid model

generator
estimator
testor

different test for digital vs physical

	DIGITAL	PHYSICAL
Development	software, apps, and/or online services	Develop and set up products and processes, including sourcing raw materials, developing supply chains, and production lines.
Production	Upfront cost of development, servers, and other digital infrastructure	Continuous management of manufacturing & supply chains
Cost Structure/ Scalability	~Zero marginal costs for more copies; May require increased marketing reach	Unit production costs can be significant and increasing scale may require added capital investment
Distribution	online via app stores, websites, and/or cloud-based services	transportation to retailers or directly to consumers; requires logistics, inventory management, returns, etc.
Updates and Improvements:	Can be continuous, remote, and as visible or invisible as desired without the user even noticing. Allows for rapid iteration based on user feedback and data analytics.	improvements or modifications require creating a new version of the product and potentially recalling/repairing the old one.
Data Collection and Analytics	Data collection and analytics can be engineering into the products and infrastructure to a significant degree	Unless the product has a digital/connected component, data collection may be challenging, especially when the product was not sold directly be the manufacturer.
End of Life	discontinue support or updates, shut down servers or online services. Data migration and user communication are key considerations. Some labor redeployment.	discontinue production and factories, and dispose of unsold inventory. Environmental considerations, such as recycling or disposal of the product, are also important. Significant layoffs possible.
Entry Barriers	Competitors may be able to enter more easily. Including pirates.	Manufacturing and supply chain capabilities may create higher barriers to entry

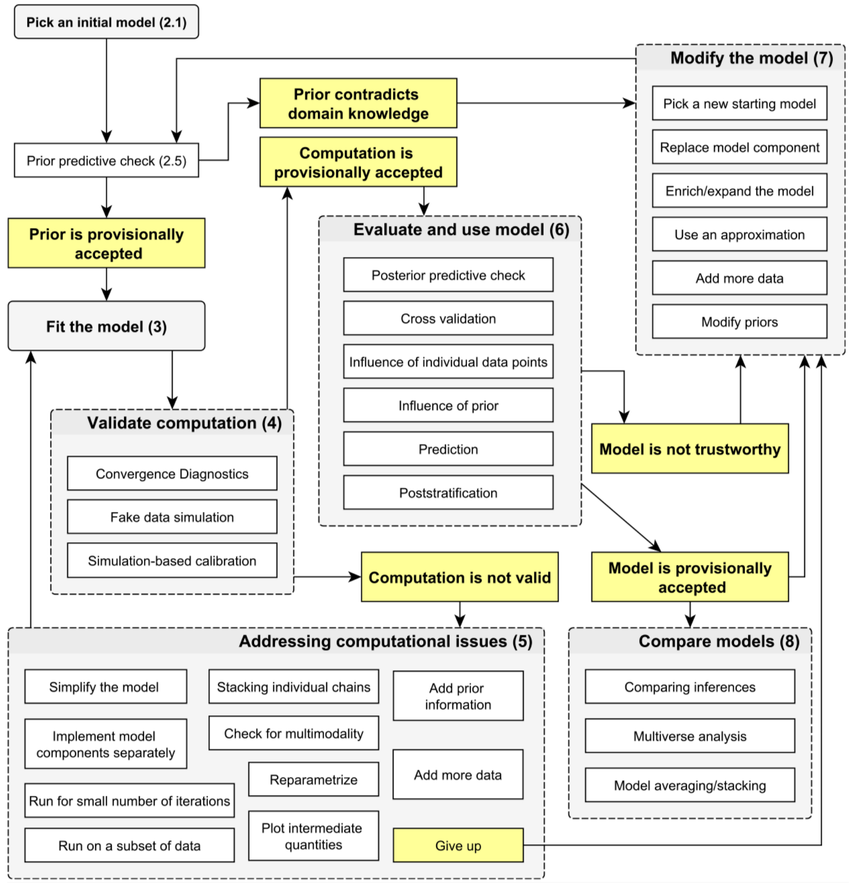
Common Software Problems

Question	Try This First
Is this code even being executed ?	In that code, try turning on the onboard LED (digitalWrite)
Is this IF statement being executed ?	In that code, try turning on the onboard LED (digitalWrite)
What is the value of this Variable ?	Serial.print
What data did I just receive ?	Serial.print (if you have Serial; if not, use the onboard LED)
Is my Arduino sending/receiving data on a pin ?	Check the pin using Oscilloscope
Are the serial wires working ?	Check the pinout diagram, and check the pin using Oscilloscope

Common Hardware Problems

Question	Try This First
Is this wire connected ?	Multimeter connection check
Is the solder bleeding ?	Multimeter dis-connection check
Is this device connected properly ?	Check device pinout
Is this device getting power ?	Multimeter voltage check
Is this device sending anything back to me? / Am I sending anything to it ?	Oscilloscope
How are these pins supposed to communicate ?	Find a working example and measure signals using Oscilloscope
Is this device getting enough power ?	Check its output pins using Oscilloscope

concept → need help! → example



Andrew's Bayesian workflow

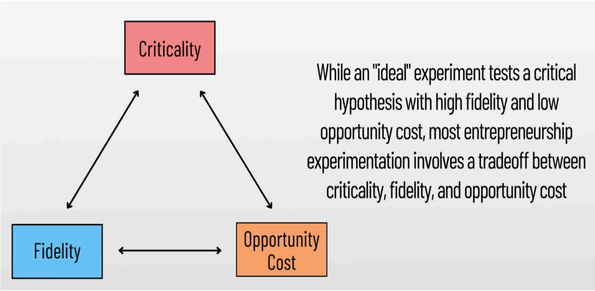
Taxie Team's Analysis

Assumption	2 Cars	3+ Cars
A 200-mile range would provide an electric vehicle enough range for a typical rideshare shift	The two vehicles had already proved their vehicles needed at least 260 miles of range	No additional information
Full-time rideshare drivers who adopt Taxie would make more money through lower operating costs and improved payments	Early data already suggests drivers were making more money; current customers were referring friends because of the benefit they saw	No additional information
Rideshare drivers would be willing to pay $400/week for a bundled car service	The first two vehicle and current marketing campaign were already informing that customers are willing to pay	No additional information
The current charging infrastructure in Boston was sufficient for rideshare drivers	Current infrastructure had been sufficient up to now; however as the size of the fleet scales to >50 cars, this may not be the case	Three cars would still not give much insight; would need a larger fleet
The current systems can be used to operate a larger fleet (>50 vehicles)	Taxie's current systems could manage their two vehicle fleet; needed to test their system at scale	A third vehicle would add some insight; a much larger fleet would be more informative
Taxie's business model is profitable at scale	The team had significant data about operating costs however they knew these costs would decrease at scale, needed a way of figuring out what these costs would look like	Three cars would still not give much insight; would need a larger fleet

The Power of Iterative Customer Experiments

	Experiment	Outcome
	130 dresses, 140 invites Large range of dresses Styling advice	34% conversion rate
	Narrower selection (building off Harvard trial) Can see but not try dresses	75% conversion rate 85% perfect return rate (100% with one-day grace)
	1000 inbound marketing email Email PDF and telephone ordering No styling advice	**5% conversion rate**

Dimensions of Entrepreneurial Experimental Design



Scott's Testing E-Strategy