

Designing Tools for Navigating between Our Health and Disease: Symptom Predictions and Return of Agency

(from prevention and empathy)

“Just listen to the patient, he is telling you the diagnosis”
- William Osler

Stephen Friend
Feb 8 2018





It would be nice if we could make individual assessments that could guide us

It would be nice to find other individuals whose paths in their lives health/disease could inform ours- sharing

It would be nice if we could learn how to nurture each other sharing data and insights so as to return to each of us “Agency” with empathy.

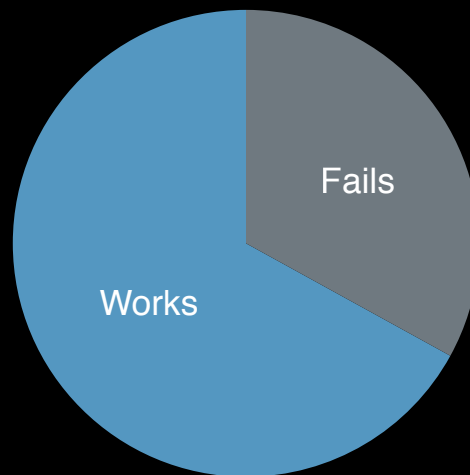
It would be helpful if we could provide ways for people to gain a sense of mastery around their health and act on their individual assessments.

health

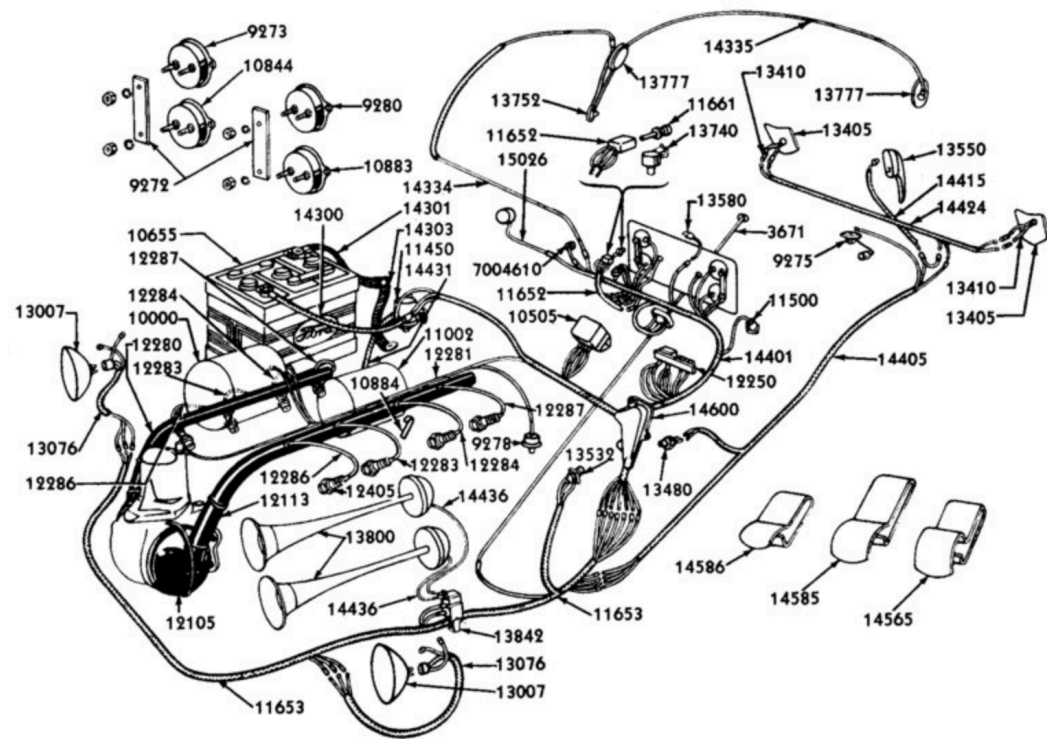
health as absence of disease?







Wiring Diagram for 1940 Ford Passenger Car



Recipe before 1983



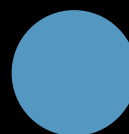
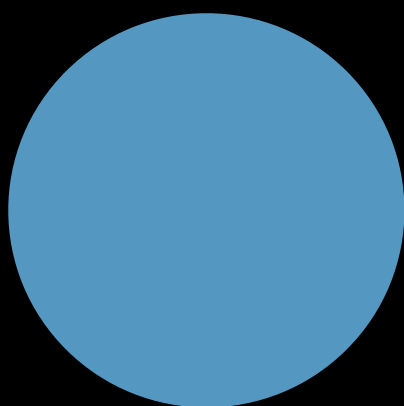
Recipe after 1983



Modern Practice

give up agency, in return for being healed





well

sick

unlinked / binary measures | mis-assessments | end-care
exclusive / poor recipes

let us consider alternate ways
to navigate between health and disease

let us find new ways to generate needed information

why not center to from and each of us



"Nothing we use or hear or touch can be expressed in words that equal what is given by the senses"

Hannah Arendt

the power of us with our sensor enabled devices

current efforts are offering- better sensing, better data, more insights



enabling navigation of health and disease

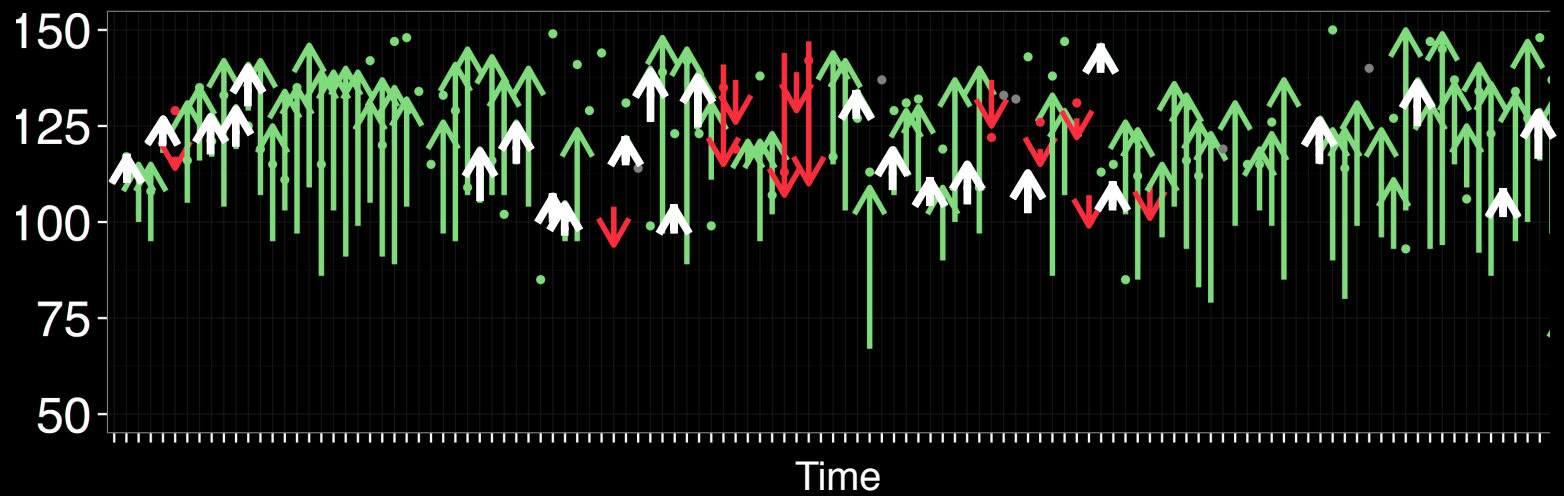
Intra-individual Diversity

among patients with Parkinson's disease

Changes

Pre Med Taps

Post Med Taps



Significant Improvement
with Medication



Marginal
Improvement



Regression

Machine Learning

depression, from digital phenotype

Instagram photos reveal predictive markers of depression

Andrew G Reece and Christopher M Danforth

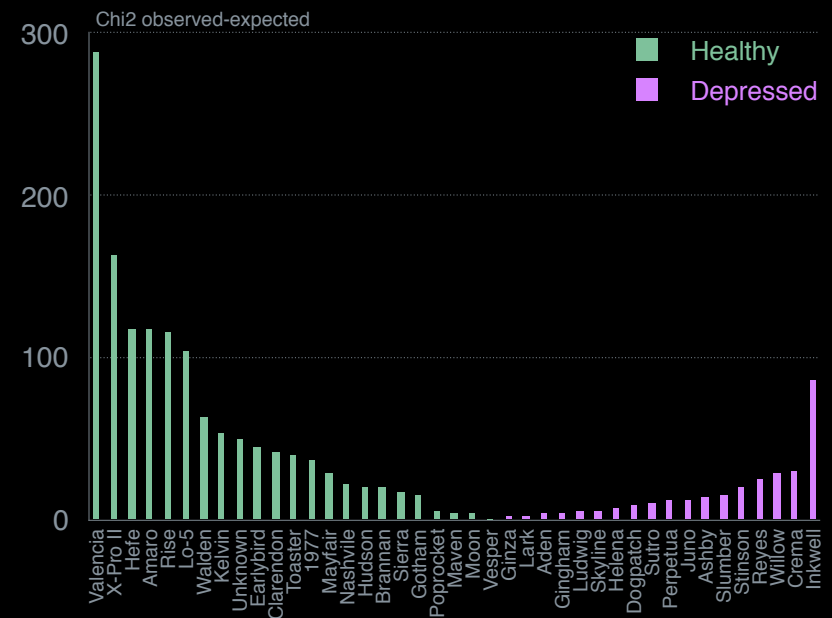
EPJ Data Science 2017 6:15 | <https://doi.org/10.1140/epjds/s13688-017-0110-z> | © The Author(s) 2017

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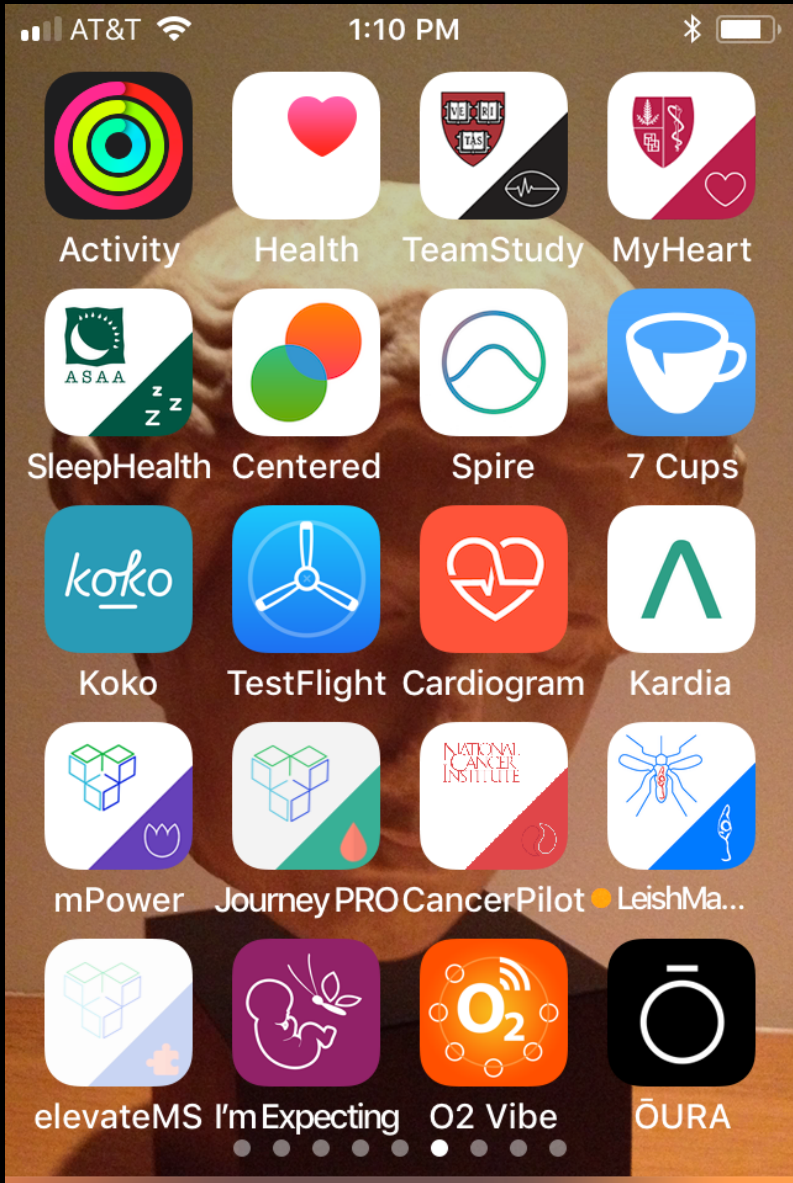
Abstract

Using Instagram data from 166 individuals, we applied machine learning tools to successfully identify markers of depression. Statistical features were computationally extracted from 43,950 participant Instagram photos, using color analysis, metadata components, and algorithmic face detection. Resulting models outperformed general practitioners' average unassisted diagnostic success rate for depression. These results held even when the analysis was restricted to posts made before depressed individuals were first diagnosed. Human ratings of photo attributes (happy, sad, etc.) were weaker predictors of depression, and were uncorrelated with computationally-generated features. These results suggest new avenues for early screening and detection of mental illness.

Filter usage difference between healthy and depressed users



let us consider risks endemic
in emerging digital health phenotyping



risks within existing health assessments

collect single or multimodal data streams

validate that device approaches match existing standards

use device approaches to guide existing therapies

assumes agent is the physician

assumes symptoms should be assessment currency

emphasis more on diagnosis than prediction

who says existing standards best anchor

aggregation to the mean smother's individual data

risks within existing suggestions

the purpose of the app is to collect data

data to be shared with physician

give “them” back data

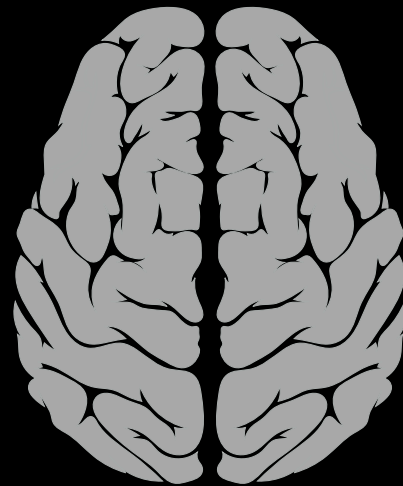
soon AI will tell you what to do (autonomous)

who is it that actually needs to be able to take actions?

who says people will take heed?



Sub-Conscious



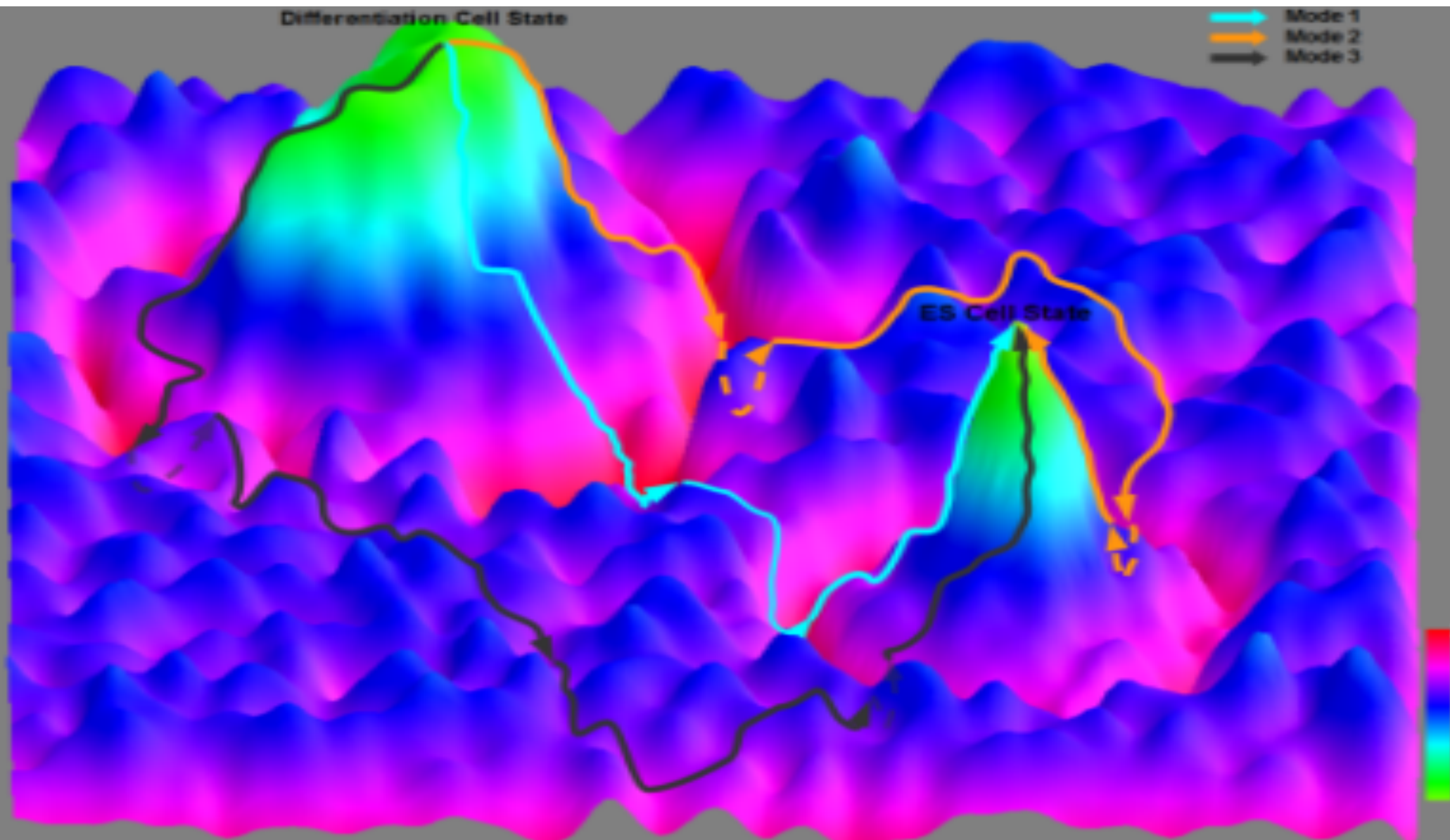
Conscious

mind work

Differentiation Cell State

Mode 1
Mode 2
Mode 3

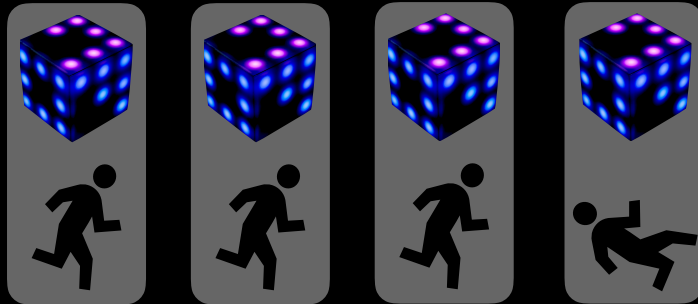
ES Cell State



Without Constraints

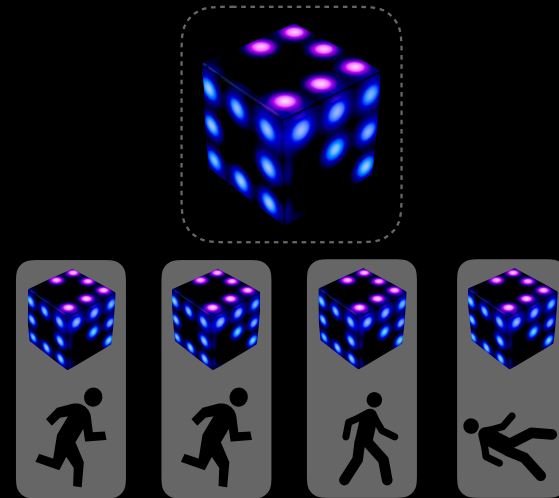
...at an individual's discretion

Parochial AI machines



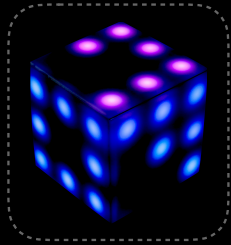
v.s.

Central AI machine

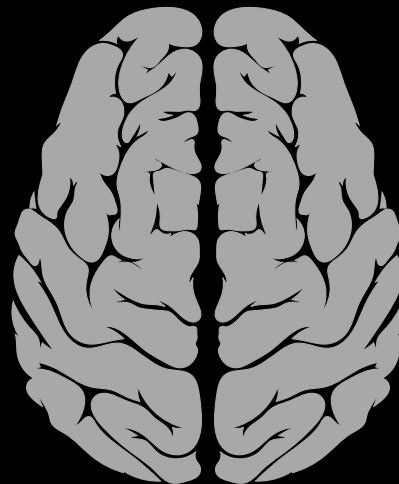


As AI can glean insights in health - who is looking out for whom, and for why?

Central AI machine



Sub-Conscious



mind work

Conscious

shaping different ways of enabling people to navigate between health and disease
persuaders dream - individual's nightmare

Considering Alternatives

A Personal Health Assistant

Allows you to understand yourself

self-navigate before and after symptoms arise

provides the freedom to act with more certainty

nurtures actions in times of strength

contributed by each for each other

Navigating Personal Health

some think humanity needs:

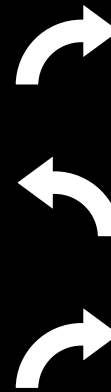
Google Earth for Health



provides a corporation's world view
really hard (to build & maintain)
not what most people need

we think humanity actually needs:

Turn-by-Turn Directions



provides suggestions relative to individuals
better aligned with personal device capabilities
provides just the right amount of information to go somewhere

Fundamental Questions about Assessments:

move beyond one dimensional maps

find actions that modify disease (in whom)

find signals emanating from us proceeding symptoms

Fundamental Questions about Suggestions:

devices in realm of protecting vs entertainment-

apps to enable sharing fueled by empathy

limits to our devices enabling individuals to act

CRITERIA FOR DEFINING BOUNDARY CONDITIONS

FREQUENT TRANSITIONS

RAPID TRANSITIONS

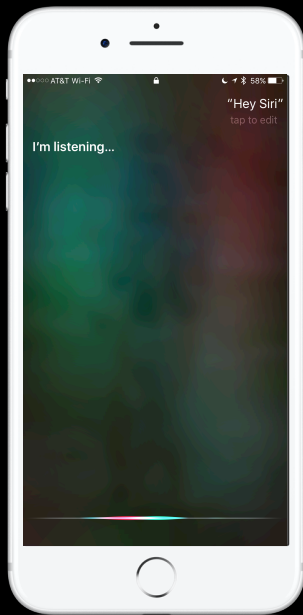
RETURN TO STARTING STATE

TIED TO EXISTING CLINICIAN VISITS

NOT ENCUMBERED BY OTHER CONDITIONS

RELATIVELY YOUNG PATIENTS (FEMALE)

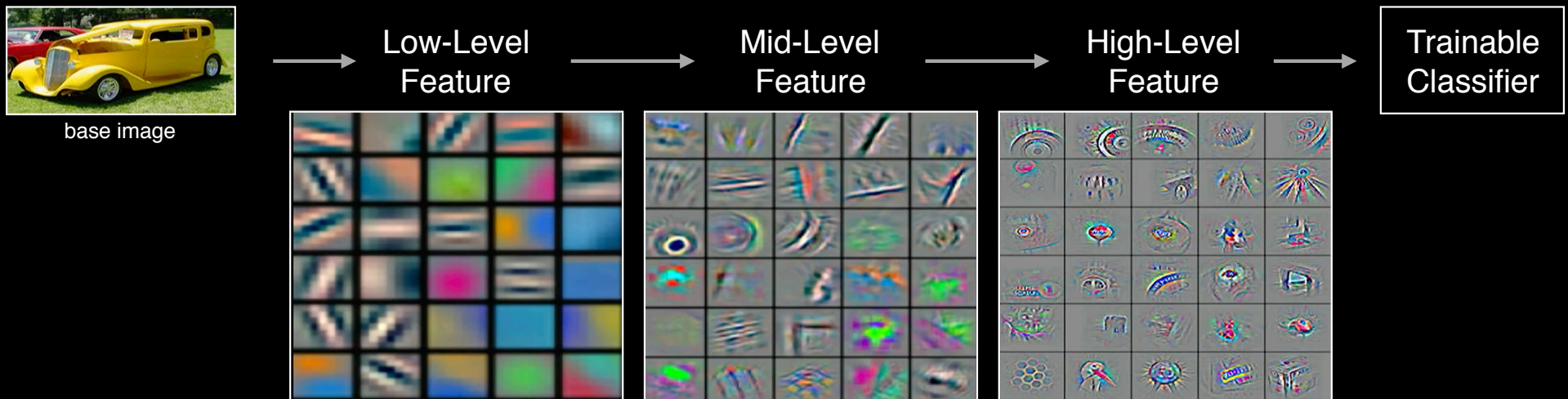
all-day sensing & recording



- heart rate
- breathing
- voice
- facial expressions
- app usage
- motion & orientation

Deep Learning

multiple stages of non-linear feature transformation



Feature visualization of convolutional net trained on ImageNet from [Zeller & Fergus 2013]

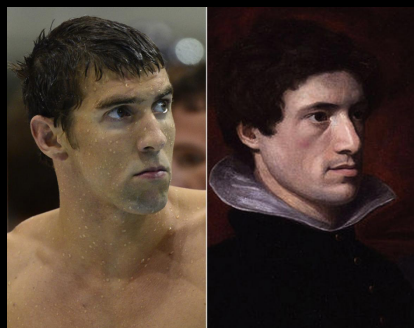
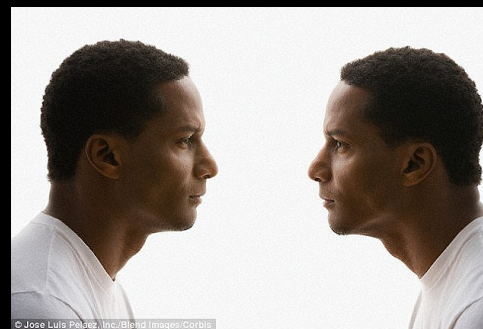
Source: LeCun, Yann , "Predictive Learning: The Next Frontier in A.I." 2017 Shannon Luminary Lecture Series

“Mimicking a user’s online behavior is far more difficult than breaking down a wall.”

TechCrunch, August 2015

“Next-Gen Cybersecurity Is All About Behavior Recognition”





scalable organizational construct

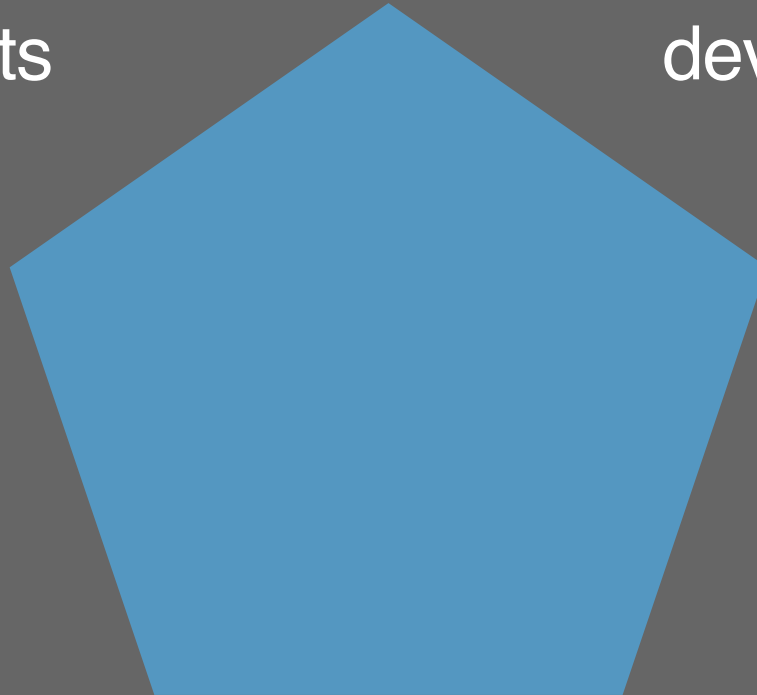
cohorts

device & apps

assessments

suggestions

data flow



CLUSTER OF SYMPTOMS

(in common among pregnancy and those receiving chemotherapy)

FATIGUE

EMESIS

GAIT

EDEMA

MOOD

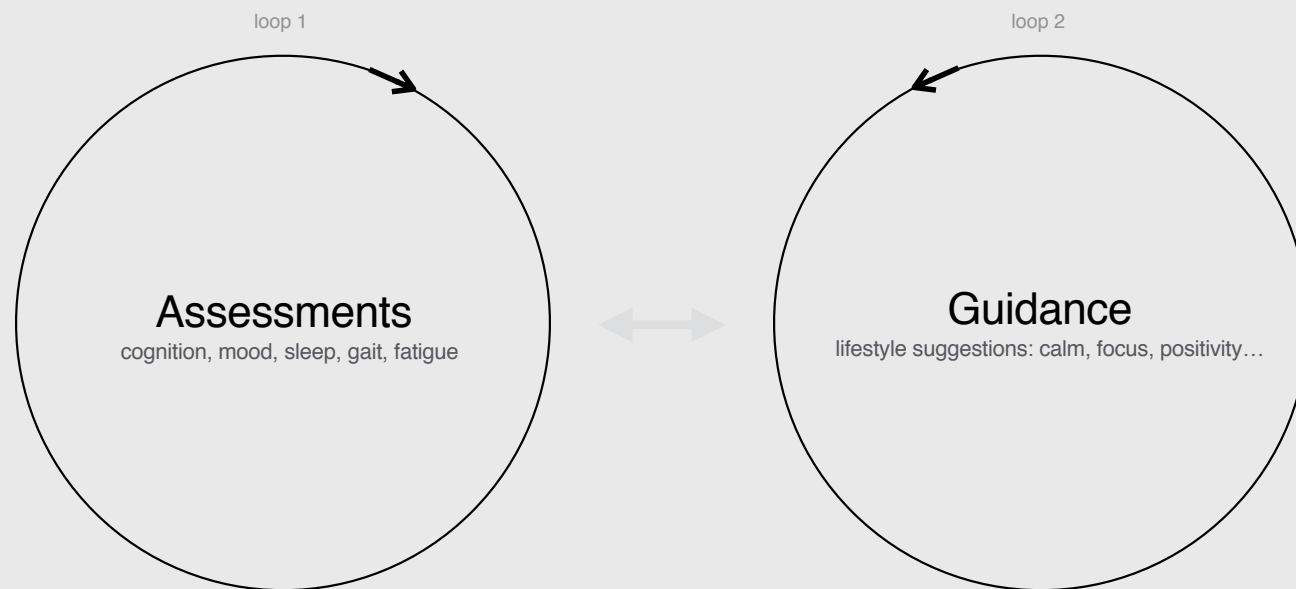
COGNITION

GLYCEMIA

Health Assessments | Signals to Symptoms (examples)

		Smart Phone	Smart Watch	Other	Accelerometer	Gyroscope	Steps	Pedestrian	Distance	GPS Vectors	Background HR	Device lock history	App in focus	Messages	Calls	On-wrist	Stride	Exercise calibration	Voice & breathe minutes	Voice samples	Voice pitch	Typing speed	Typing corrections	Language content	Sleep time	Nighttime HR
		●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Cognition	Decreased ability to navigate	●	●					●			●															
	Driving slowly	●	●					●																		
	Decreased vocabulary																		●					●		
	Change in grammar																		●					●		
	Disruptive speech cadence																		●					●		
Mood	Typing speed																			●	●					
	Decreased vocabulary																		●					●		
	Disruption of normal cadence																		●					●		
	Reduced social engagement							●			●	●	●	●										●		
	Apathy							●		●	●	●	●	●			●		●							
Sleep	Sleep disruptions	●																						●		
	Sleep fragmentation	●																						●		
	Lower amount of REM	●																						●		
	Heart rate variability	●																							●	
Gait	Gait speed	●	●		●	●	●	●									●									
	Variability of gait	●	●		●	●	●	●									●									
	Arm swing	●	●		●	●	●	●																		
Fatigue	Heart rate	●	●		●	●	●	●								●	●	●								●
	Total activity	●	●		●	●	●	●								●	●	●								
	Reduced mobility	●	●		●	●	●	●								●	●	●								

1 → 3 Years | Linking Feedback Loops





© picture alliance/AP Photo

“

In an ever-changing, incomprehensible world, the masses had reached the point where they would, at the same time, believe everything and nothing, think that everything was possible and nothing was true.

Hannah Arendt, 1906 - 1975



Source: The Origins of Totalitarianism

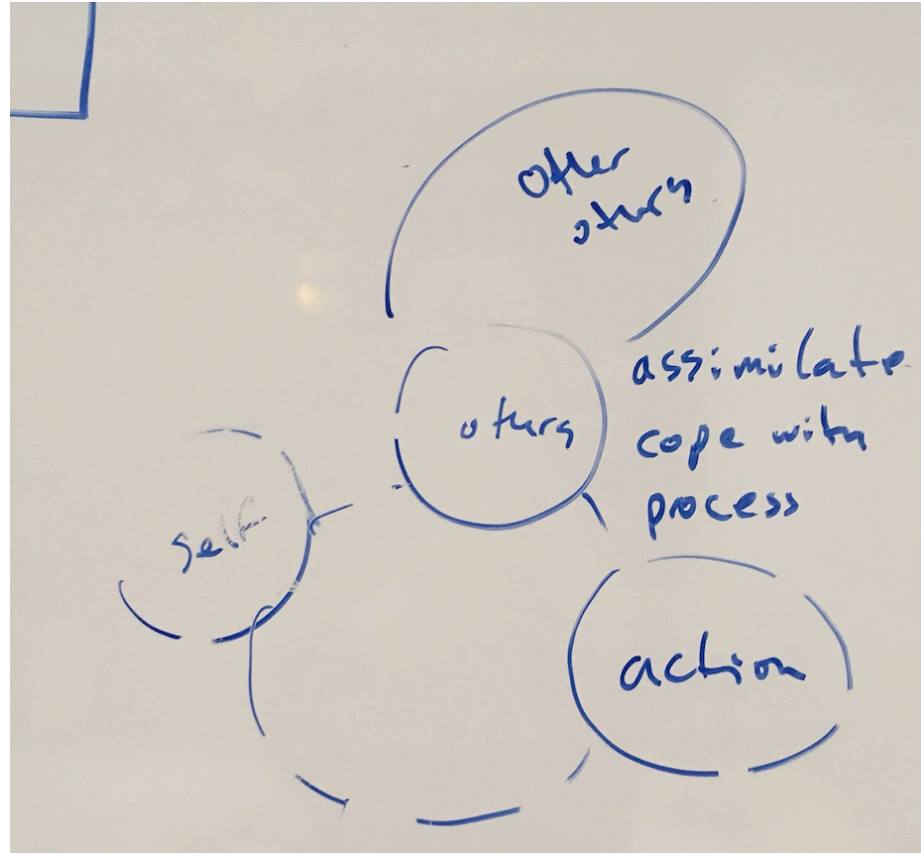


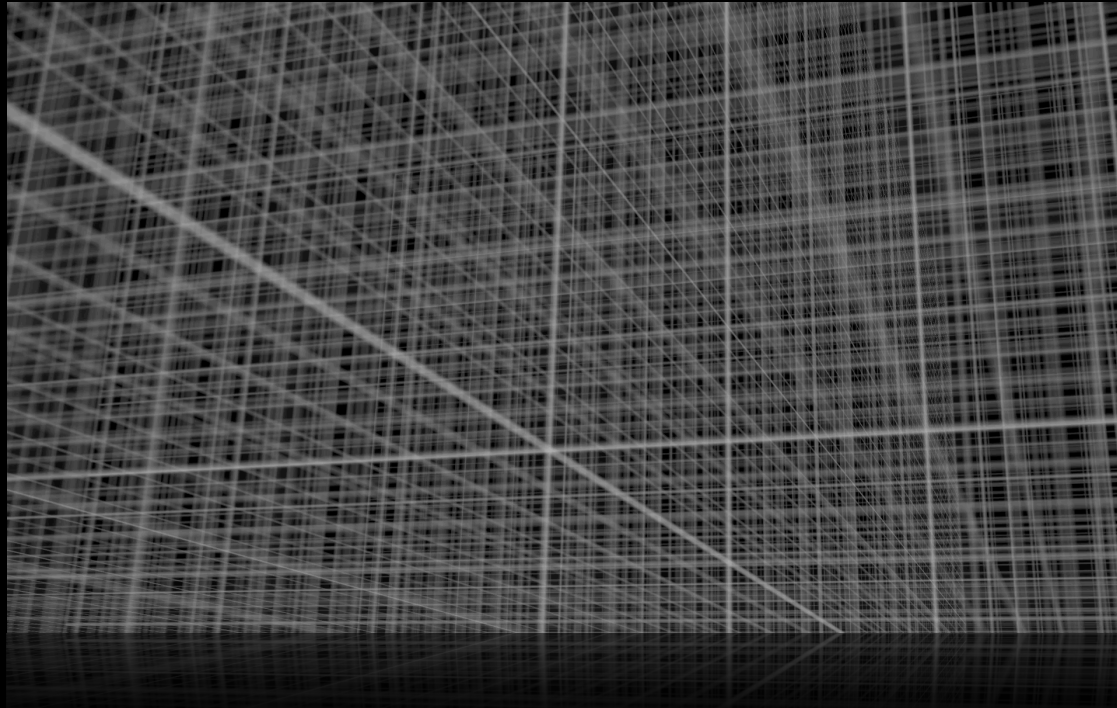
For the things we have to learn before we do them,
we learn by doing them

Hannah Arendt

Suggestions: High-level architecture

Build out playful spaces
where people can explore
and in doing so find the support
they need to regain the agency
they need to make actions

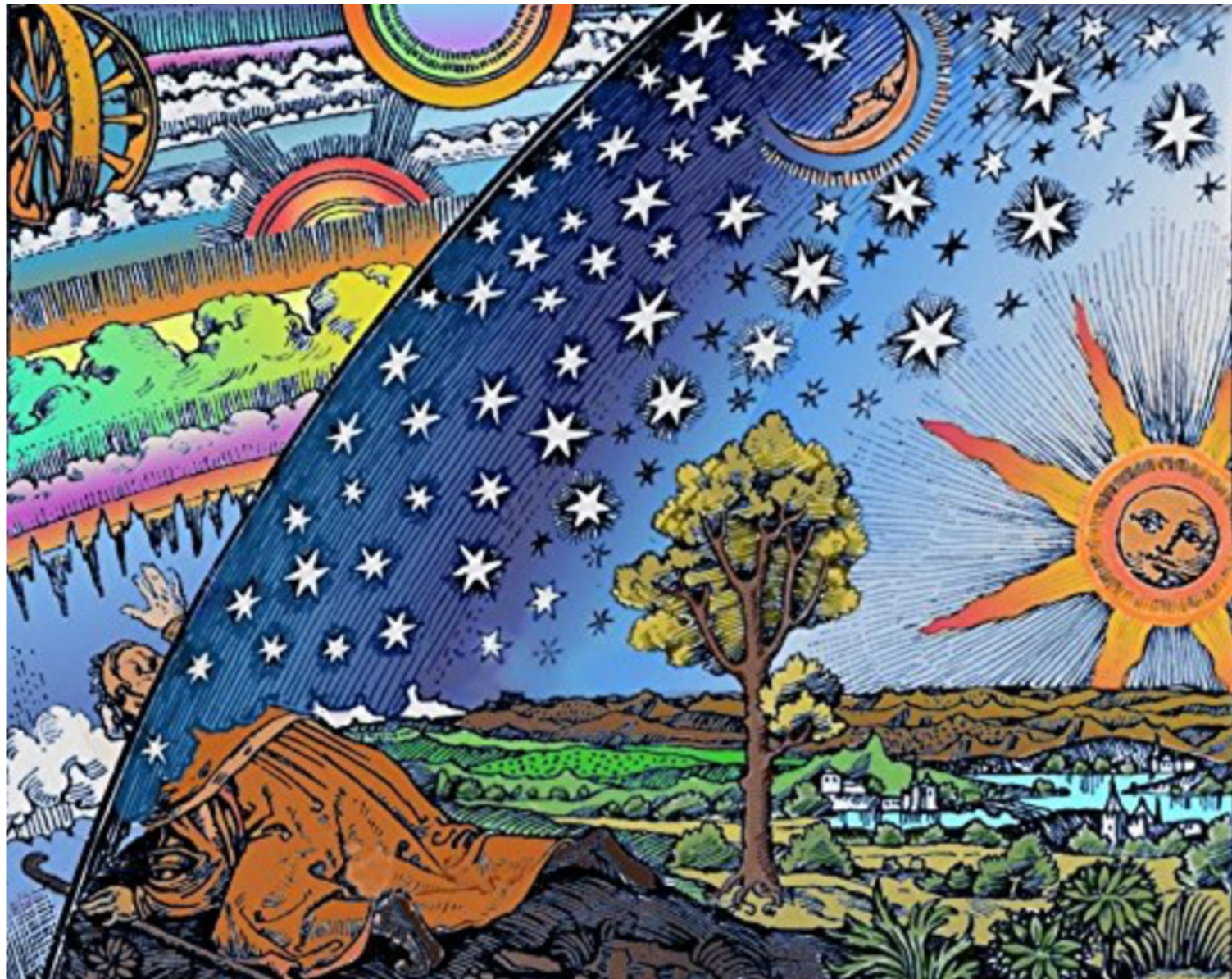




tapping into the desire to give to each other - can we use an open health “exploratorium”

“all yearn to give back to those around them” - Sean

4 You and Me





The new always happens against the overwhelming odds of statistical laws and their probability, which for all practical everyday purposes amounts to certainty, the new therefore always appears in the guise of a miracle.

Hannah Arendt