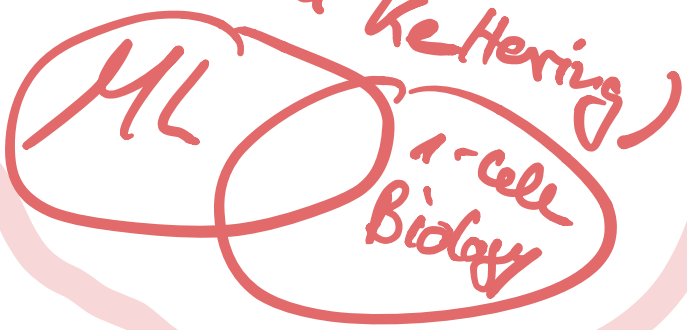
Breiman L.:
Bin Yu (UC Berkeley)
- Veridical DS -

Keynote:
Dana Peér
(Sloan Kettering)



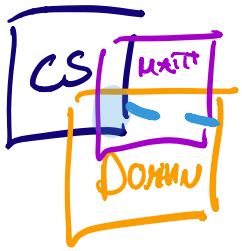
NeurIPS 2019
- Day 2,3,4 -

Joshua Bengio
SL DL → SL DL

Blaise Aguera
Social Intelligence

Kafui Dzirasa
Mapping Emotions

Bin Yu (UC Berkeley): Veridical Data Science



→ DATA SCIENCE →

VERIDICAL ↺ TRUTHFUL REALITY

⇒ Better Communication ⊕ Rigorous Evaluation Needed!

PCS FRAMEWORK

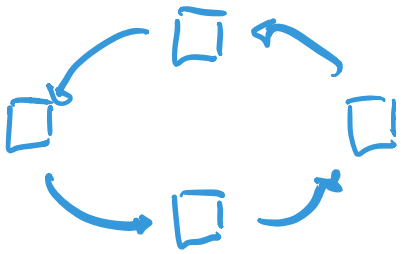
PREDICTABILITY (CS)

COMPUTABILITY (CS)

STABILITY (STATS)

STABILITY → Robustness → "Shaking" all parts of lifecycle

LIFECYCLE



⇓

PERTUBATIONS

* Data (Clean)
* Model (R2R)

PROB. INFERENCE

* Data as realisation = assumption!
  ↳ Stability: E.g. from same RV / distribution
* What does p-value mean?
* p-value as measure of model bias

⇓

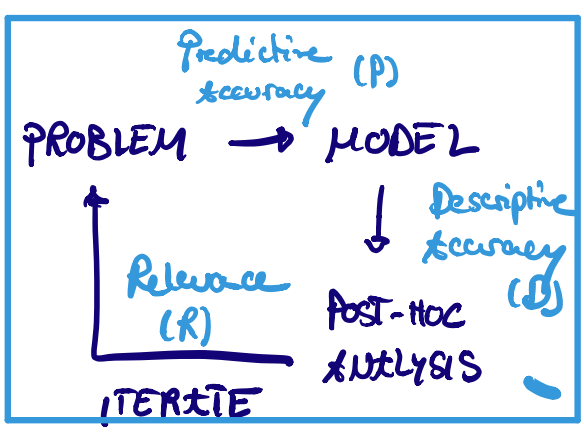
① Problem Formulation
② Prediction "Screening"
③ Target Value Perturbation Distribution
④ Summarization

ITERATIVE RANDOM FORESTS (iRF)

⊙ Drosophila → 4 interacting genes
⊙ RF ⇒ perturbating features + data
⊕ Soft-dim. reduction
⊕ Random Intersection Trees

⇒ INTERPRETATION ⇒ HYPOTHESIS GEN.

≈ EXTRACTION OF KNOWLEDGE FROM MODEL



* AGGLOMERATIVE CONTEXTUAL DECOMPOSITION (ACD)

Dana Pe'er (Sloan Kettering): ML meets Single-Cell Biology

TINY COMPUTER

- Key Challenge Single-Cell: Data analysis of RNA sequencing ⇒ GENE x CELL MATRIX
- CELL PHENOTYPES → Low-Dim. Manifold → NHOOD GRAPH TRAVERSAL
  ⇒ Shaped by regulatory nets & feedback
  - DENSE REGIONS
  - CELL STATE TRANSITIONS
    - ↳ Spectral Clustering of paths through graph
- BEAUTY OF TISSUE → Single sample contains abundance of cells at different maturity levels → *SYNCHRONOUS

- SIMPLE MODELLING → e.g. Markov Chain
  - ↳ KEY ASSUMPTION: Developmt moves forward ⇒ Not given in disorders
  - ↳ Spatio-temporal map of organization endoderm
- HCA - Human Cell Atlas

BIOLOGY GOAL: NOT PREDICT BUT UNDERSTAND

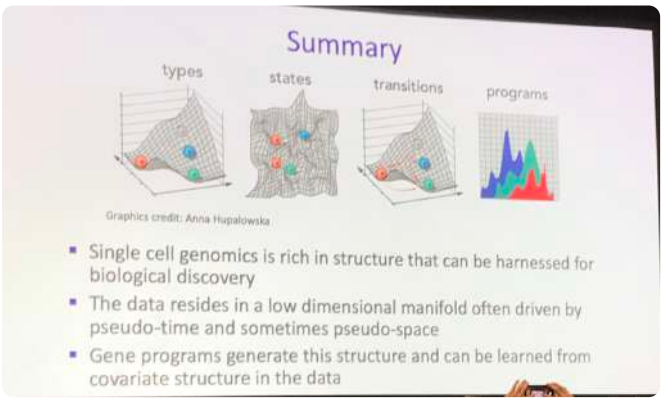
↳ Importance of Outliers!

CELL TYPES ↔ CLUSTERS ↔ STATES

- Use raw image directly instead of intermediate segmentation output

COVARIATION-DRIVEN MANIFOLD LEARNING

↳ Covariation Between Components



Yoshua Bengio: System 1 DL → System 2 DL

Daniel Kahneman

S1
- FAST & UNCONSCIOUS
- HABITUAL
- CURRENT DL

S2
- SLOW
- CONSCIOUS
- PLANNING
- FUTURE DL

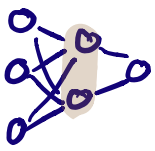
① CHANGES IN DISTRIBUTION

→ Violation iid assumption
↳ 'Shuffle' solution wrong!
→ Want good generalization
↳ Need new assumptions

AGENCY ⇒ NON-STATION.

↓

SOLUTION: **COMPOSITIONALITY**

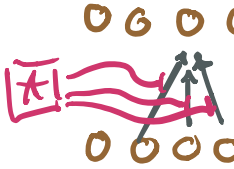


* Distr. Repr.
* Layers
* Language

↳ Systematic Generalization
⇒ Recombination of Concepts

② ATTENTION & CONSCIOUSNESS

→ Focus of Computation
⇒ DYNAMIC CONNECTION



→ Differentiable Soft-Attention
→ Bahdanau et al. 15'

→ KEY + VALUE ⇒ INDIRECTION
⇒ operation on sets

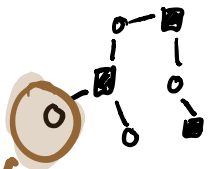
GLOBAL WORKSPACE THEORY

Out-of-Distr. Generalization
High-level Cognition
→ **GOALS**
Connections between parts
Agent-Perspective ⇒ Causality

⇒ Need Priors to Empower S2!

S1 ↔ LANGUAGE ↔ S2

③ C-PRIOR: SPARSE FACTOR GRAPH



Sparsity = Property of h-level variables manipulated w. Langg
≠ Marginal independence

④ META-L. ⇒ LOCALIZED Δ HYPOTH.

→ Explicit optimisation for generalization
↳ Causes for Δ in distr. ⇒ Independt Mechanisms
→ Good representation ⇒ Local Treatment!
→ Bengio et al. 19' ⇒ How to prefer pairs?

⑤ COMPOSITIONAL DL → RIMs

→ Goyal et al. 19':
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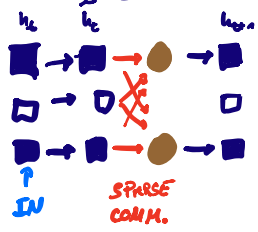


HYPOTHESIS - CONSCIOUS PROCESSING

→ Right representation ⇒ Sparse Graph
→ Semantic Variables = Causal Variables

⇒ TIME FOR ML TO EXPLORE CONSCIOUSNESS

Blaise Aguera y Arcas : Social Intelligence
(Google AI)

FEDERATED LEARNING
- Decentralized Training -

COMPUTE ↔ NEURAL NETS ↔ DATA

LOCALITY, PRIVACY, ENERGY, COMMUNICATION

Google CEREBRA
↳ Mobile Processing !
* Mobile Nets
* Edge → TPU

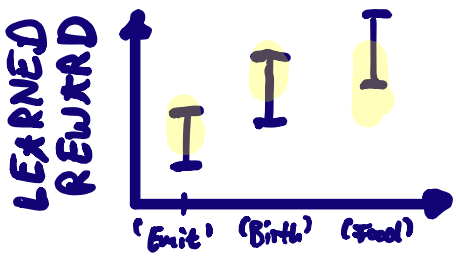
SCALE
A. Data = Rare + Abundant
B. Compute = Massive + Limited
C. Quick Convergence Important

ECOLI ⇒ Q-TABLE 'GENOME"

EVOLUTION LEARNS VIABLE BEHAVIOUR
⇓
What was optimized? (IRL)
→ Genome = Reward Map
↳ Inverse : Meta-Learn

CURRENT CHALLENGE

⊙ Loss + Prediction + DNN
→ covers very little of real problems !
↳ P. Churchland 16'



LARGE ERROR BARS
→ No individual bacteria optimisation !

GANs = 'MINIMAL SOCIETY'

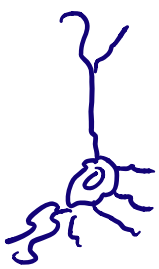
⊙ Combined system no longer GD
↳ Special vs. General Relativity
⊙ One vs. Many is ill-defined !

TOWARDS * NON-SOTA MODEL

Synapse ⟷ Neuron
≈ LSTM cell ≈ LSTM cell

w_t^{ij} a_t^i

↳ Weights = Connectome ⇒ INNER
LSTM Params = Genome ⇒ OUTER



BRAINS DON'T JUST EVALUATE A FCT.)

⊙ Feedback + Dynamics !
↳ No separate phases
↳ Multiple timescales

⊙ Learn & Learn w. Building Blocks
↳ Ravi & Larochelle 17 !

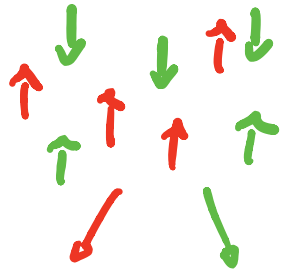
⊙ Mordvintsev, Randazzo
↳ Self-organizing Neural Cellular Autom.

ENSEMBLE OF CELLS → SOCIAL

↳ Fully evolve e. rules + architectures
↳ Artificial Societies

Kafui Dzirasa (Duke) - Mapping Emotions: Discovering Structure in Mesoscale Electrical Brain Recordings

DEPRESSION (Severe Stress)



↑↑↑ Suscept. ↓↓↓ Resilience

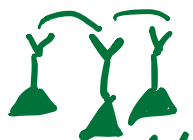
GOAL: DISENTANGLE

Brain Activity Manipulation → CAUSALITY?! ← Model + Observation

→ Induce Emotions → LATENT NETWORKS ← fMRI Scan next day

KEY ASSUMPTIONS:

1. Emotions are encoded at timescale of secs
2. Emotions = Emergent feature of cell network
3. LFPs signal activity of populations



⇒ Analysis Method: GP Model (Ulrich et al.)

1. STRESSOR
2. LATENT
3. RECORDING

ELECTOME NETWORS (PFC)

- 3 Different Ones
- to Vulnerability Signatures!
- to Susceptible animals have anatomical diff. signatures

VALIDATION via

1. MOLECULAR M. Manipulation
   - Molecule 'sidekick 1'
   - ↳ increases future vulnerability
2. PHYSIOLOGICAL M
   - IFNK → hits net 1
3. BEHAVIOURAL
   - ↳ Childhood Trauma
4. GENETIC RISK FACTORS

MOUSE IN 'SHARK TANK' + PFC RECORD

⇒ Some mice are left completely unstressed others suffer from severe trauma ⇒ PTSD

WHAT TO DO WITH VULNERABILITY

⇒ Do antidepressants target identified signatures

↳ Ketamine ineffective, DBS no modulation ⇒ BUT: Disease network → Still vulnerable in future!

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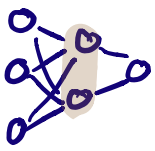

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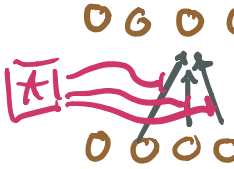

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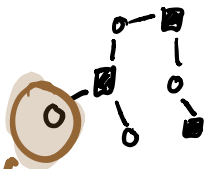

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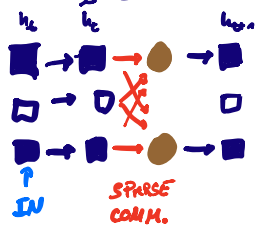

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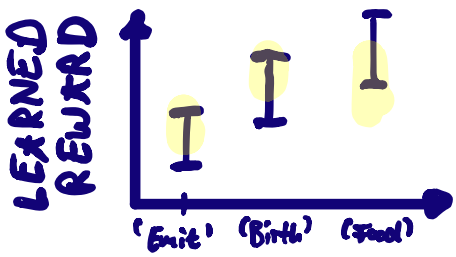

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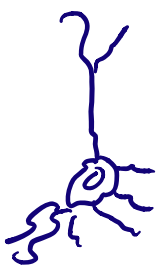

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