Day 2 – CCN 2019 – Nando de Freitas

15/09/19

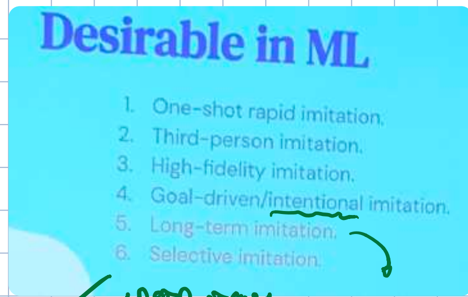
– 'Machine Learning Advances on Imitation' –

- Abstraction / Symbolic Reasoning ⇒ Efficient exploration!
  ↳ Identification of successful behaviors ⇒ Imitation → ⊕ Distillation

Foundry in RL context ← IMITATION ⇄ ABSTRACTION

Hard to define

COEVOLUTION



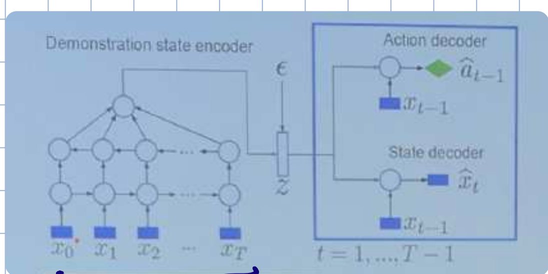
↔ ABSTRACTION / WHO ↔ WHAT

different way to achieve goal

- One-Shot Imitation → Model-Agnostic Meta-L. (MAML)

→ Domain Adaptive Meta-L. ⇒ MAML → Two nested losses
  ↳ Relationship to Hierarchical Bayes → Empirical Bayes → Infer / Fix Hyperparams
  ↳ Application: Combine Human demos w. Robot demos
  ↳ Problem MAML: Only works with short video sequences

→ Generative Models Approach



Video Frames

↳ Learn encoding vectors ⇒ behavioural (continuous) description! via Embedding
↳ Continuous ⇒ allows ∞ behaviors!
↳ Allows to generalize at test time given sequence of frames!

↳ Reed and de Freitas 16' → Neural Programmer-Interpreters (NPIs)
  ⇒ Here: Backprop through behavior → before: Only Reconstruction Loss!
↳ Towers of Hanoi → Train NPI with AlphaZero

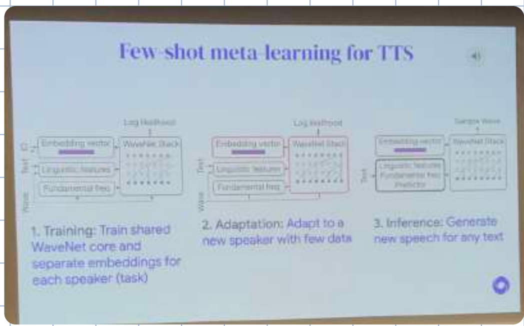
→ General approach: Fixed Core ⊕ Flexible Embedding

- Few-Shot Meta Learning → Many tasks ⊕ Few data

  ↳ Again flexible embeddings

  ↳ Modular meta-learning with shrinkage
  ⇒ Yutian Chen et al

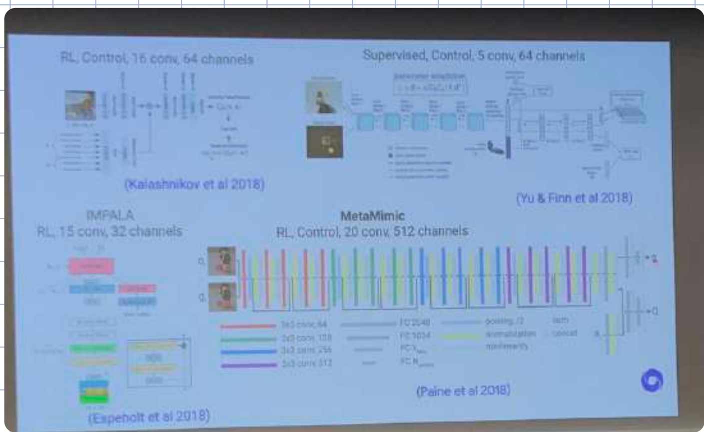
  ⇒ 4 minutes enough to imitate speech!



- Doing better than imitation!

  ↳ D4PG → Barth-Maron et al 18'

  ⇒ large-scale distributed learning



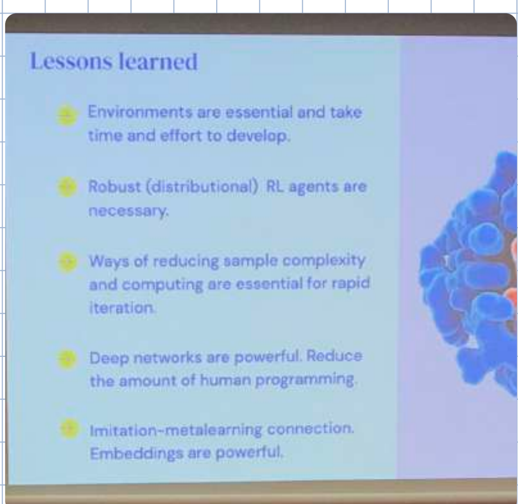
- Learn ATARI from video → Temporal distance classification (TDC)

  → Derivation wrt. input → Where do feature maps activate most?!

- Challenges → Sparse rewards → Partial observability

  → Highly variable initial conditions → Learning from sensors directly

- StarCraft ⇒ 'Pricarely' Nicolas idea of KL regularizer closeness to imitated policy



- Neuro Research Thrust: Selective Attention

- Evolution perspective Meta-Learning

  ↳ embedding ⇒ Adaptable

Bernhard Schölkopf – 'Causal Learning'

- Motivation: Cows at beach misclassified ⇒ ML ↔ Correlations!
  - → IID assumption ⇒ Violated in adversarial examples!
  - → causal relationship (asymmetry) vs. Mutual info (symmetry)

REICHENBACH'S COMMON CAUSE PRINCIPLE

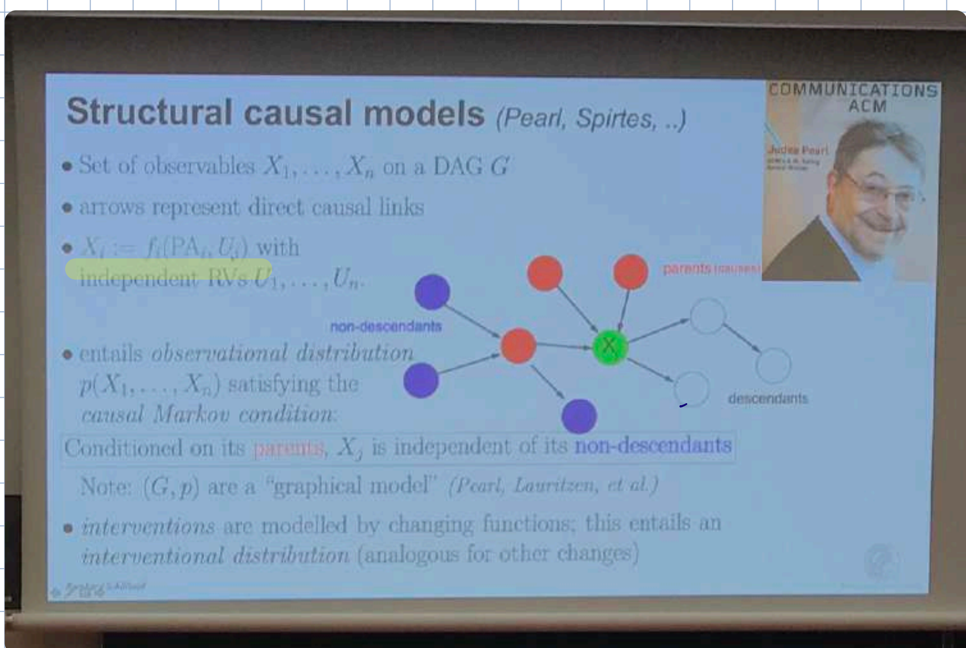
(1) $X \leftarrow Z \rightarrow Y$ → Z screens X, Y from each other

(2) $X \rightarrow Y$ (3) $X \leftarrow Y$

→ all lead to same observation $P(X,Y)$!

→ Berkson's paradox ⇒ Introducing variable Z leads to correlation

- Structural Causal Models → Pearl ⇒ Do-Calculus
  - ↳ Mechanistic PoV
  - ↳ Traditionally GM perspective does not focus on intervention?



→ Global ⇒ Local Markov Condition

↳ Both implied by existence of graph!

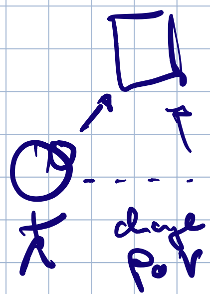
↳ Factorization of joint distributions $\prod_i p(X_i | PA_i)$

- How to learn about graphs without interventions?

→ Message passing ⇒ learn about graph structure

• INVARIANCE ↔ Causality → invariance allows for clever causal experiments!

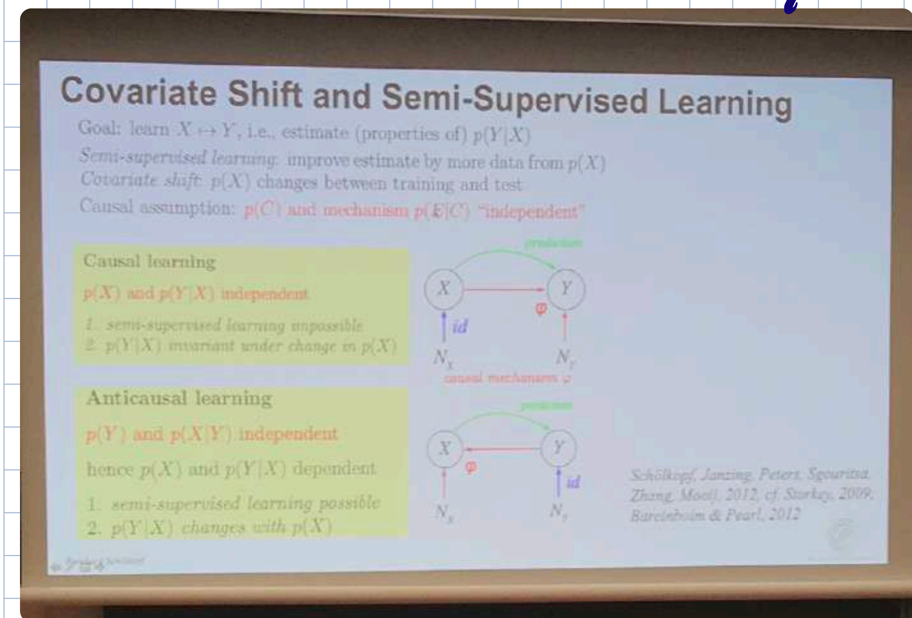
↳ Get sense of 3d structure since object does not change / is invariant!



→ Sparse interventions! ⇒ LINK CAUSAL & STATISTICAL STRUCTURE

• Interesting ideas to infer direction of time from video frames

• Kolmogorov vs. Shannon entropy → Fund. arrow of time



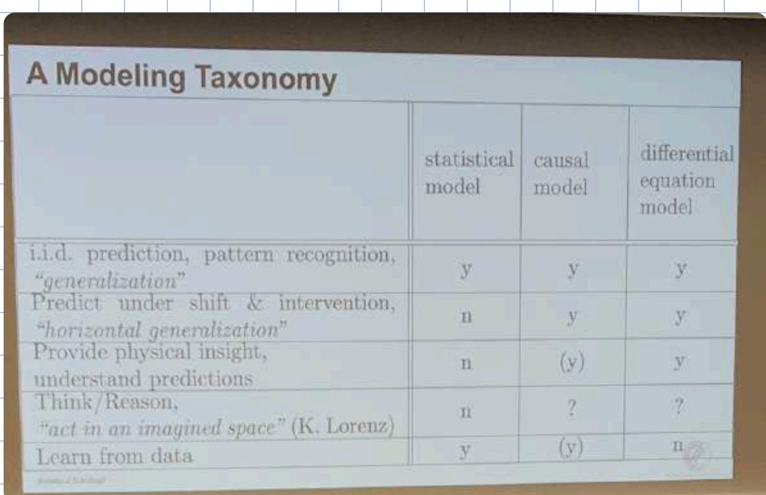
• ICML paper 18'

↳ specialization of experts for transfunctions!

↳ Robustness

• Recurrent Independent Mechanisms

↳ Bengio + Schölkopf!



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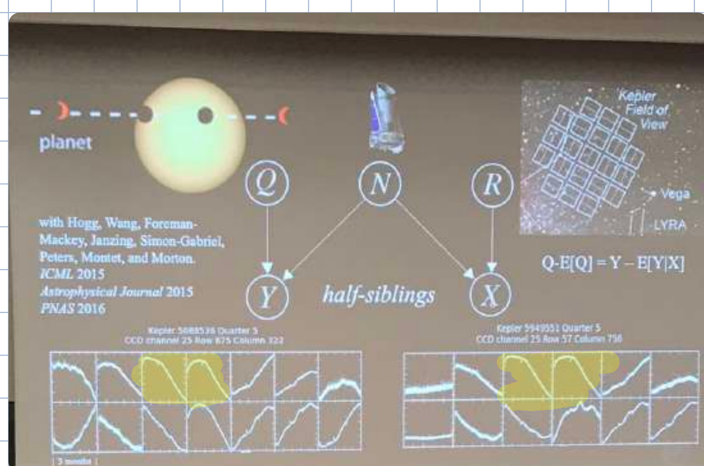
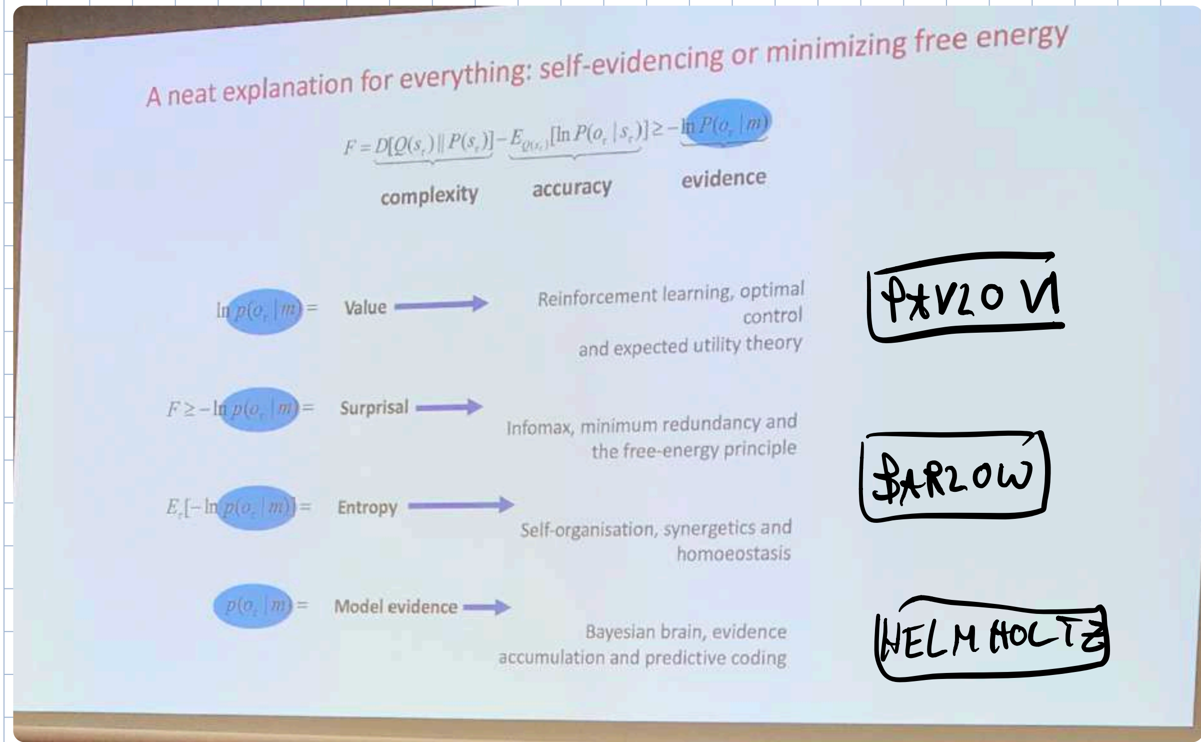


↳ predict y from variability of X!

Debate: The Free Energy Principle — Karl Friston // Jeff Beck



- Active inference
  ↳ exploration
- Bayesian Surprise
- Mutual Info
- KL / Risk-sensitive control
- Exp. Utility Theory

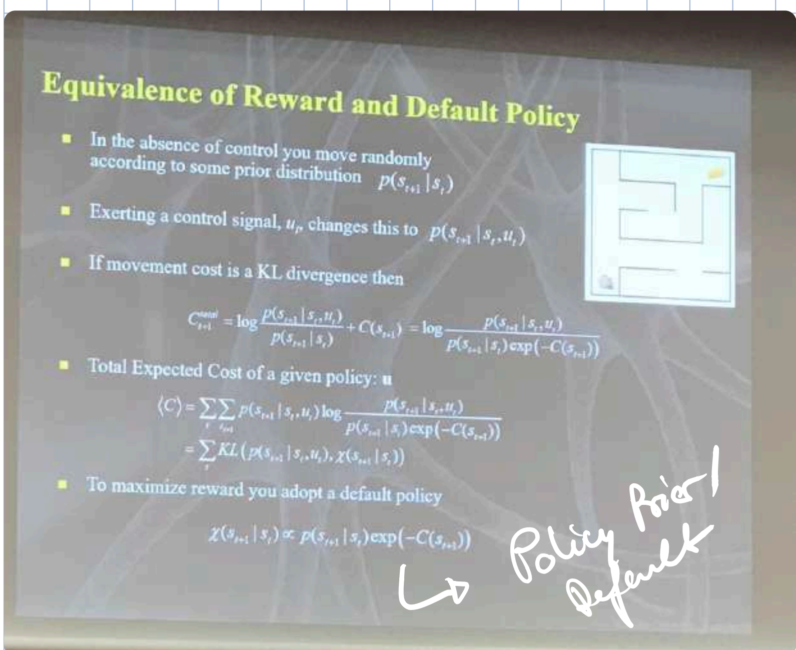
⇓

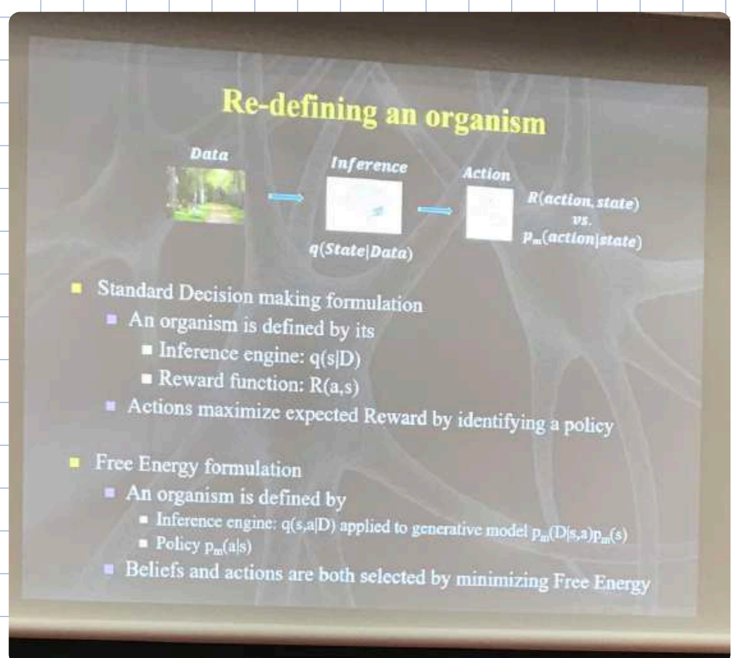
IMPERATIVE: Min. Free Energy

→ Jarzynski equality & Landauer's principle

- FEP as concept vs. theory of cognitive capabilities
- Surprise → sensory
  → metabolic

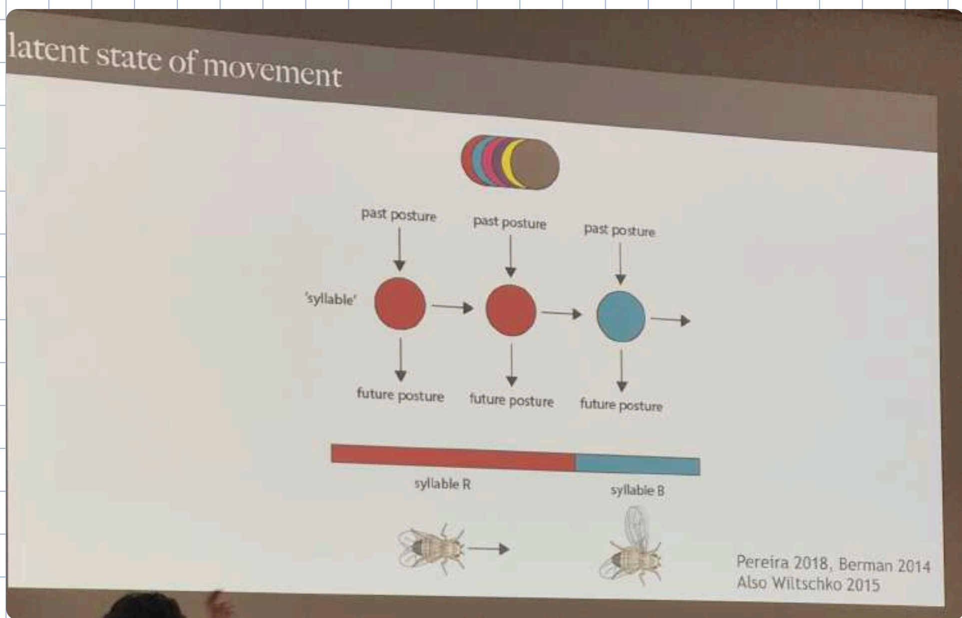
∃ Difference RL vs Active Inference FEP





Interacting Minds ⇒ Cross-Collaboration → Random labs

- Couzin (2009) → Models Review!
- Tinbergen → Founder ethology discipline
- No trial averaging! ⇒ One continuous process of behavior!
  ↳ Hard to define episodes
- Fruit flies mating behavior → Song male to signal interest!



Adam Calhoun – Speaker –

* Pay attention to single-trial dynamics

* Unsupervised analysis of actions // of relationships → ways of interaction!

Social Psych! Mark Thornton – Speaker –

- Perception of other minds → Risk-aversion → FP
  → Humans want to be fooled ⇒ Turing test too easy
- How to represent actions ⇒ Thornton & Tamir, 19'