

optimization and learning for control

- this course will focus on the following stochastic optimal control problem:

$$(SOCP) \quad \min_u \text{cost}(x, u)$$

$$\text{subject to } x_{t+1} \sim \text{dynamics}(t, x_t, u_t)$$

$x_t \in X$ is the state — we'll consider $X = \mathbb{R}^d$ and $|X| < \infty$
 $u_t \in \mathcal{U}$ is the control input / decision variable (finite set)

$$\begin{aligned} x: [0, T) &\rightarrow X \\ u: [0, T) &\rightarrow \mathcal{U} \end{aligned} \quad \left. \begin{array}{l} \text{"x" or "u" without subscript} \\ t \in [0, T) \text{ denote entire time history} \end{array} \right\}$$

$\hookrightarrow x|_{[0, t]}$ is the "restriction" to times $\{0, 1, \dots, t\}$

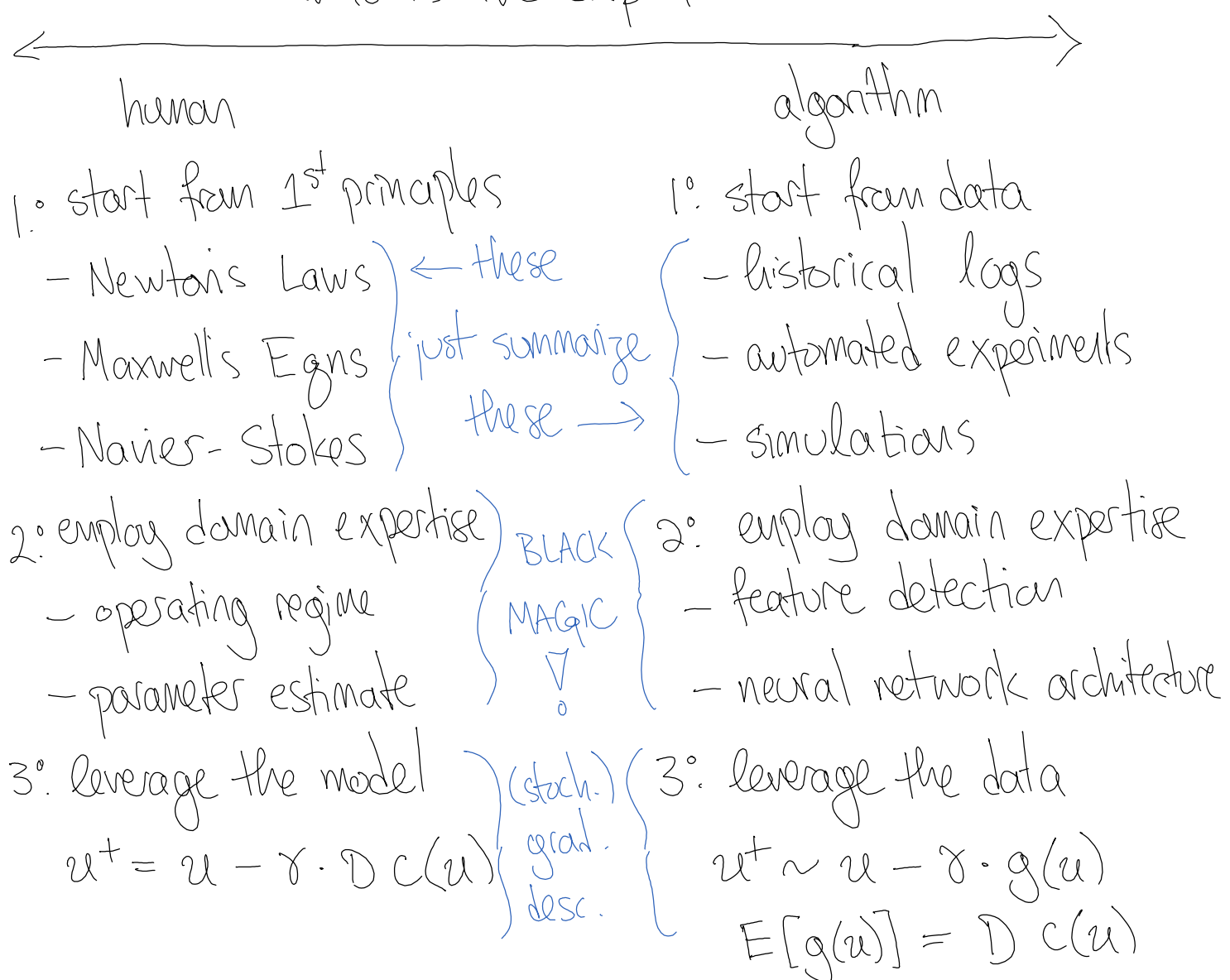
$a \sim b$ means "a is a random variable drawn from distribution b"

ex: $\min_u \sum_t c(x_t, u_t)$ — sum of running cost
s.t. $x_{t+1} = F(x_t, u_t)$ — difference equation
(DE)

* clearly an optimization problem; where's the learning?

→ in the real world, cost c and dynamics F aren't known exactly — must be "learned" through "experience", either by expert humans or expert algorithms

who is the expert?



* takeaway: these two "extremes" are closely related

→ neither approach is "right"; best approach bridges both