LEARNING

Belief Learning

- Form beliefs about opponent's future play using past experience
- Plays best response to those beliefs

e.g. Panic Buying during Covid-19
Believe that everyone else will panic buy
⇒ More inclined to panic buy

Belief that Player i will play strategy j at round t

No. of times player i played strategy j until round $t-1$ & $N_i(0)=1$

$$B_i^j(t) = \frac{N_i^j(t-1)}{\sum_M N_i^M(t-1)}$$

Sum of no. of times player i played each strategy until round $t-1$

Reinforcement Learning

- Plays strategies that worked well previously, based on the reinforcement level of previous rounds

eg. Unpleasant experience at restaurant X
⇒ Less likely to go back

payoff of strategy if chosen

$$A_i^j(t) = \begin{cases} \phi A_i^j(t-1) + \pi, & \text{if } i \text{ chosen} \\ \phi A_i^j(t-1), & \text{if } i \text{ not chosen} \end{cases}$$

forgetting rate

Experience Weighted Attraction (EWA) Learning (Camerer & Ho, 1999)

- Combines both belief and reinforcement learning
- Considers forgone payoff overlooked by reinforcement learning

$$\leftarrow N(t) = \rho N(t-1) + 1$$

depreciate past experience

discount factor for forgone payoff

$$A_i^j(t) = \frac{\phi N(t-1) A_i^k(t-1) + \underbrace{\delta \pi_i(s_i^j, s_{-i}(t))}_{\text{actual/forgone payoff}}}{N(t)}$$

when $\delta = 0$, $\rho = 0$, $N(0) = 1$, EWA ≡ Reinforcement

$$B_{-i}^k(t) = \frac{\rho N(t-1) B_{-i}^k(t-1) + I(s_{-i}^k, s_i(t))}{\rho N(t-1) + 1}$$

$$E_i^j(t) = \frac{\rho N(t-1) E_i^j(t-1) + \pi_i(s_i^j, s_{-i}^k)}{\rho N(t-1) + 1}$$

LEVEL-K THINKING

- Game Theory assumes unlimited cognitive ability to solve games optimally to achieve Nash Equilibrium
- Not realistic and Nash Equilibrium often not played

Someone who is entirely random in actions → Level-0 thinker
Assume everyone is Level-0 thinker and responds bestly → Level-1 thinker
Assume everyone is Level-(K-1) thinker and responds bestly → Level-K thinker
NOT EQUILIBRIUM, SINCE PEOPLE'S BELIEFS ABOUT OTHERS INCORRECT

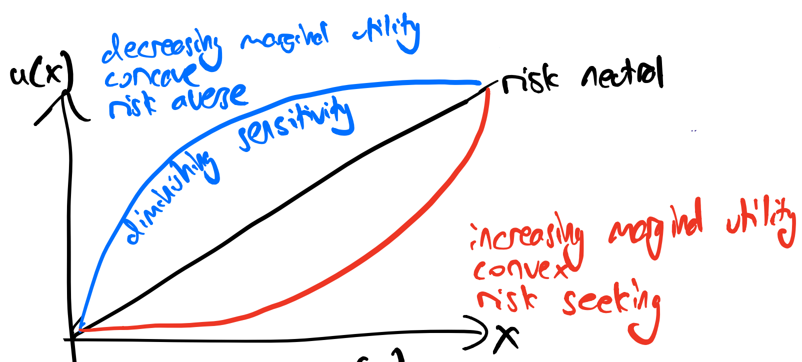
Multiplayer games → Too simplistic to assume everyone is at same level
Poisson-CH model more accurate $f(k) = e^{-u}\frac{u^k}{k!}$

PROSPECT THEORY

probability objective e.g. SG Sweep **RISK vs UNCERTAINTY** probability unknown/subjective e.g. Horse Racing

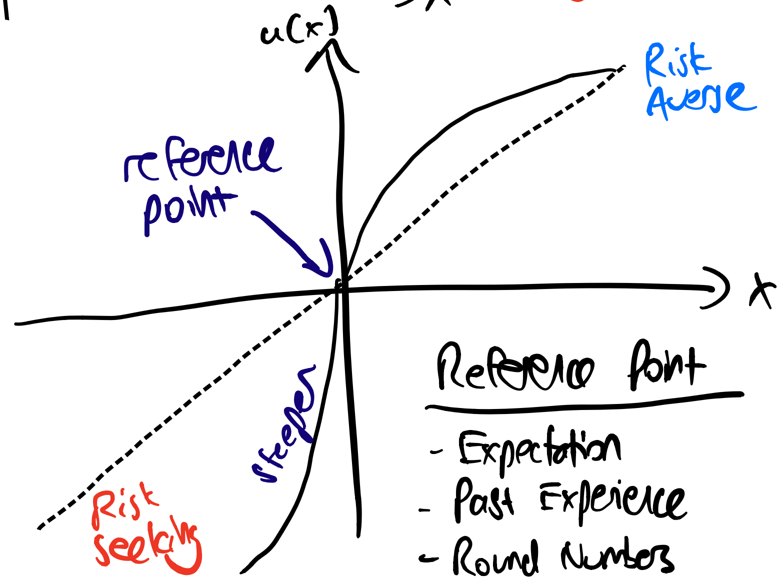
Expected Utility Theory

- People either risk averse, risk neutral or risk seeking
- Need only know x to determine utility



Prospect Theory

- People are risk-averse in the gain domain and risk-seeking in the loss domain
- Need to know reference state to determine utility
- Loss more powerful than gains (Loss Aversion)



Reference Point

- Expectation
- Past Experience
- Round Numbers

FAIRNESS

- Fairness is an important reference point
- Children: 3-4 year olds behave selfishly
  7-8 year old removed inequality (egalitarian)
- Cultural differences determine when kids learn to play fair

All children rejected disadvantageous deals, some rejected advantageous deals, but at a later age

Pay what You want

- Last minute sales
- For charity
- Customer has personal relationship with business

⇒ Lower earnings per customer
More visits

RECIPROCITY

Negative Reciprocity: Hostile Actions → Nasty and brutal response
Positive Reciprocity: Friendly Actions → Nicer and co-operative response
Response even if no gains can be expected / pay a price to reciprocate
Altruism: Unconditional kindness, not a response

Ultimatum Game mean 40-50% vs Dictator Game mean 20%
P is strategic (to avoid rejection) and altruistic
negative reciprocity of unfairly treated

Games with dominant strategy, constant-sum, winner-take-all reward eliminate social preference

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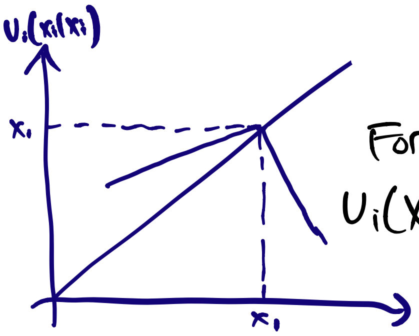
Inequity-Aversion: People care about their own payoffs and their relative payoff
(Fehr & Schmidt, 1999)
Envy & Guilt
Include other player's payoff into own utility function



For social allocation $x = (x_1, x_2, ..., x_n)$, $\underbrace{\beta_i \le \alpha_i}_{\text{Guilt < Envy}}$, $\underbrace{0 \le \beta_i \le 1}_{\text{Guilt < Wanting payoff}}$

$$U_i(x) = x_i - \underbrace{\frac{\alpha}{n-1} \sum_{k \neq i} \max(x_k - x_i, 0)}_{\text{Envy}} - \underbrace{\frac{\beta}{n-1} \sum_{k \neq i} \max(x_i - x_k, 0)}_{\text{Guilt}}$$