Game Theory
for
Strategic Advantage

15.025

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➔ Look Forward, Think Back ➔

1. Introduce sequential games (*trees*)

2. Applications of Backward Induction:

Creating Credible Threats
Eliminating Credible Threats
Strategic Timing

Building Capacity
Licensing
Product Launch

Market Entry

"Pros and Cons of Entering a Market"

Challenges

- Entering a profitable market segment (vs. an incumbent)
- Overcoming barriers to entry
  - Legal
  - Minimum efficient scale
  - Sunk costs
  - Network externalities
  - Cross-subsidies

Requirements

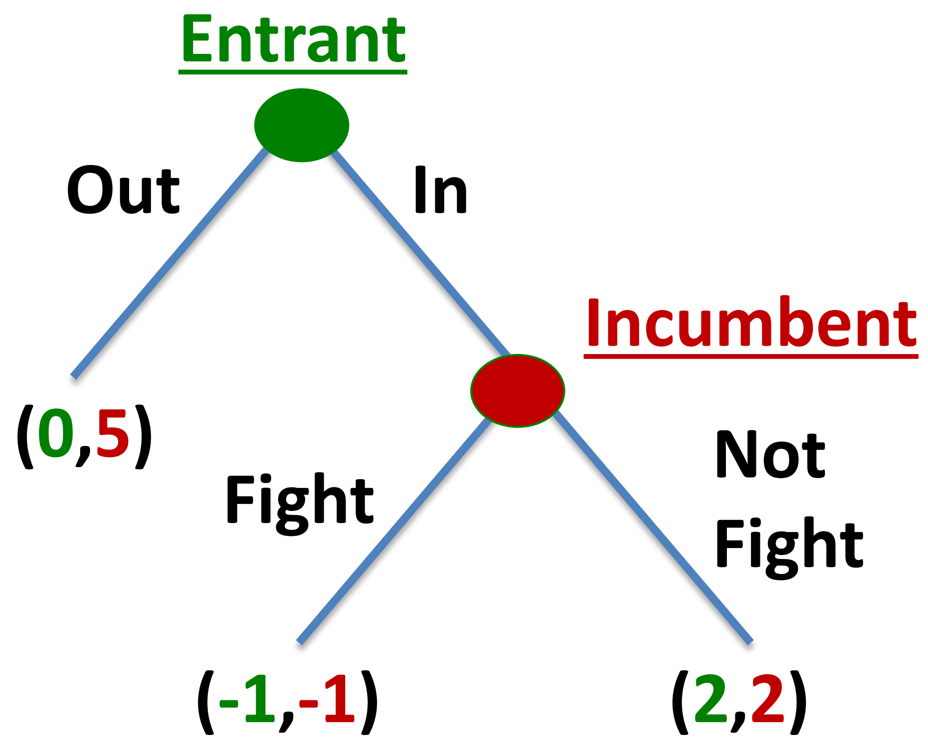
- Product novelty
- Cost advantage
- Fit
- Synergies

Today

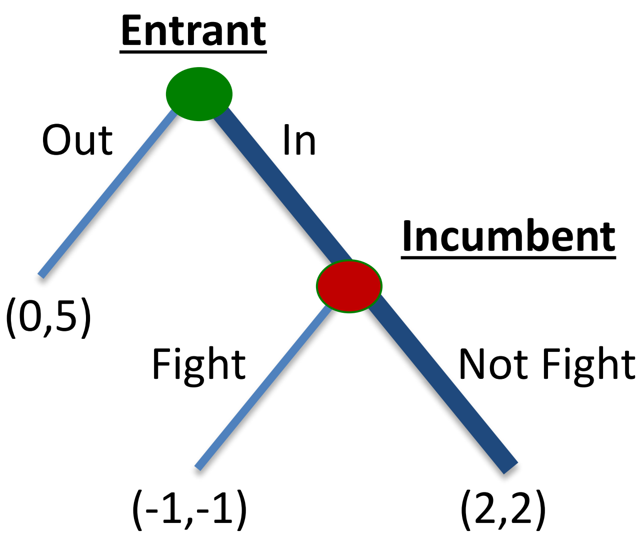
- Strategic thinking
- Timing

Game 1: Market Entry

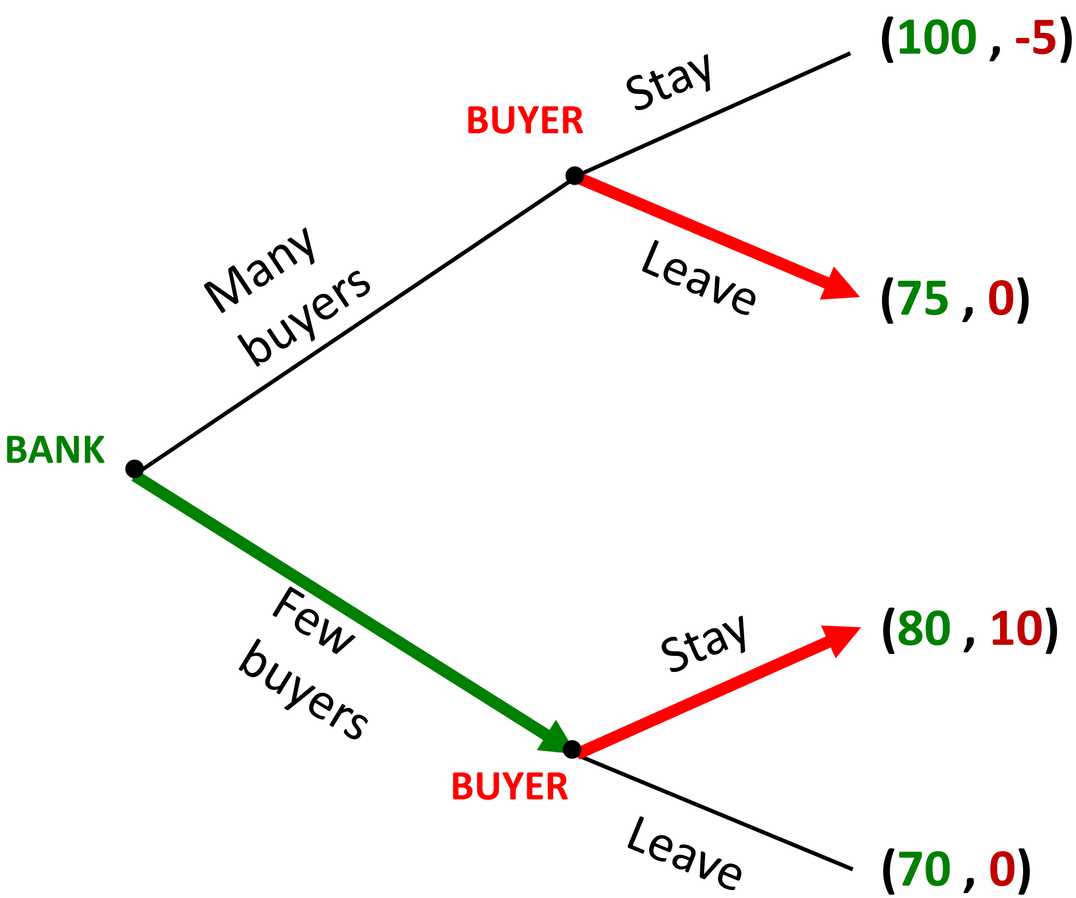
1. Entrant plays *Out* or *In*.
2. If Entrant plays *Out*, the game ends, with payoffs 0 to Entrant and 5 to Incumbent.
3. If Entrant plays *In*, Incumbent gets the move and plays either *Fight* (with payoff -1 to each player) or *Not Fight* (with payoff 2 to each player).



- At the <u>second node</u>, if Incumbent gets the move, she is better off playing *Not Fight* (earns 2) instead of *Fight* (earns -1)
- If Entrant believes that Incumbent will play *Not Fight*, then at the <u>first node</u>, if Entrant plays *In*, the outcome will be (2,2), whereas if Entrant plays *Out*, the outcome will be (0,5), so Entrant is better-off playing *In.*
- Thus, the backwards-induction outcome of the game is (*In, Not Fight*).

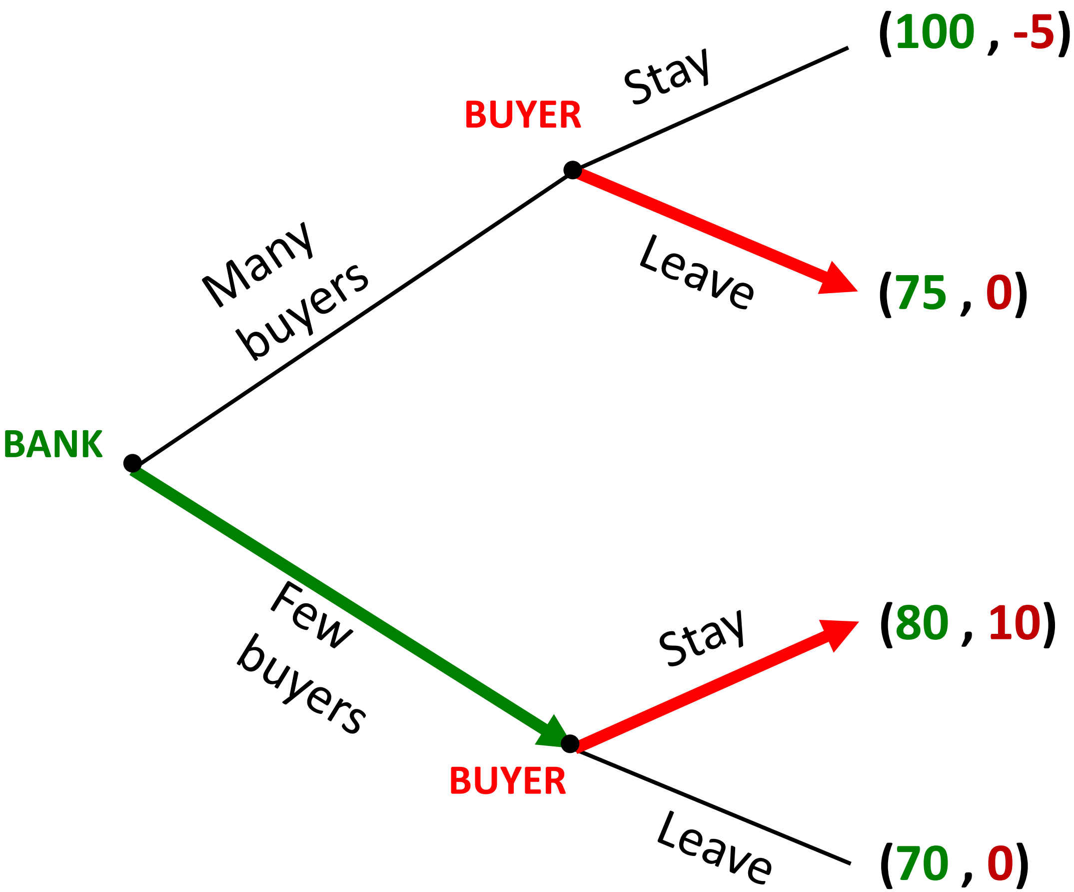


Game 2: Investment Banking
(a diversion from entry, to learn tool)



- Due diligence costs 5 to the buyer.
- If buyer does DD and faces many buyers, he will lose or win at a high price
- If buyer leaves, Bank's outlook is better if many buyers were invited

Tree vs. Matrix



- "Many" dominates "Few" for the Bank!
- Unique Nash Equilibrium = (Many, Leave).
- Why not choose it in the dynamic game then?

Changing the order of moves can be a powerful tactic!!

Bank	**Buyer**	**Stay**	**Leave**
	Many	**(100, -5)**	**(75, 0)**
	Few	**(80, 10)**	**(70, 0)**

Recap: Sequential Games

A sequential game is:

- **Decision nodes**
- **Action edges**
- **Terminal payoffs**

Backward induction procedure:

- start at the *terminal decision nodes* in the game tree, and determine what players there choose
- work backwards through the tree, where at each stage players *anticipate* how play will progress
- this results in a (usually) unique prediction called a *subgame-perfect equilibrium* (a "special" Nash eq.)
- note the rationality assumptions

Game 3: Timing of Product Launch

- WHEN matters more than IF
  - Windows Vista vs. Mac OS X
  - iOS 6 vs. Android “Jelly Bean”
  - Nokia Lumia vs. Apple iPhone

- “Why Most Product Launches Fail” http://hbr.org/2011/04/why-most-product-launches-fail/ar/pr

Timing of Product Launch

- "Game theory can explain the tendency to execute real options earlier than optimal..."
- 40 ways to crash a product launch...
- Flaw #2: the product falls short of claims and gets bashed ... e.g. Windows Vista

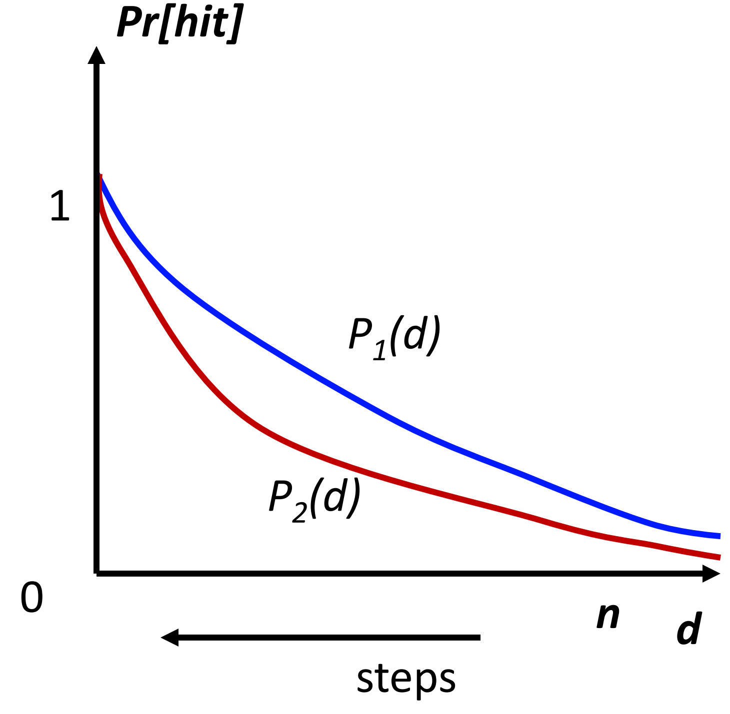
Timing a Product Launch (*Duel*)

- Two players, with one *new product* each
- Start on opposite sides of the room, take turns
- At each turn, player can *launch the product* (at the other player) or take a *step forward*
- If the product *hits*, game over!
- If it *misses*, the game continues ☺ ☺ ☺

Duel: Game-Theoretic Setup

Extra assumptions

- abilities of the players (*i=1,2*) are known
- $P_i(d)$ = probability of *i* hitting from distance *d*
- $P_1(0) = P_2(0) = 1$
- Both $P_i(d)$ are *decreasing* in *d*
- Start at *d = n*



Duel: Key Observations

Above a critical distance ***d****:

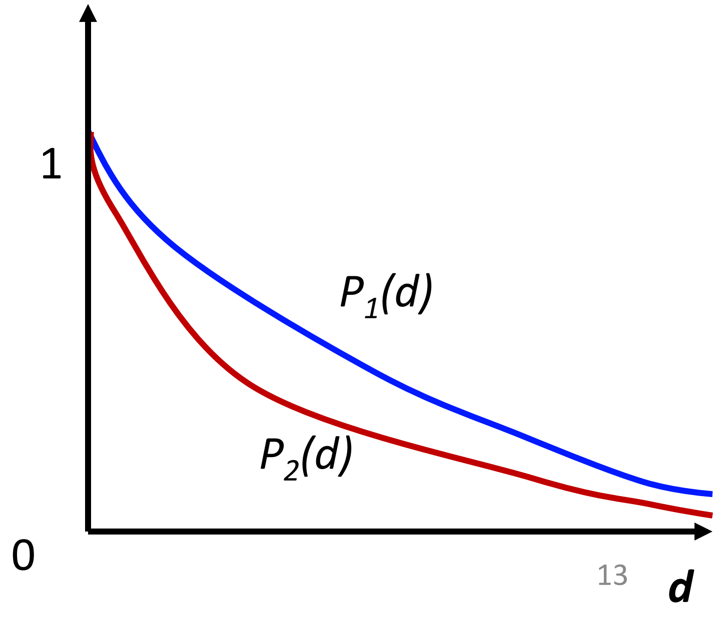
1. If *i* knows that *j* will not shoot next, *i* should step

2. If *i* knows that *j* will shoot next, *i* should still step (because ***i's current hit-prob < j's miss-prob next turn***)

Critical distance

$$P_i(d^*) = 1 - P_j(d^*-1)$$

Below ***d**** your best response depends on opponent's action



Duel: Key Observations

Below distance ***d****:

1. If *i* knows that *j* will not shoot next, *i* should step

2. If *i* knows that *j* will shoot next, *i* should shoot

   (because ***i's current hit-prob > j's miss-prob next turn***)

When will *i* and *j* shoot?

d

Duel: Analysis

Backward induction! Start at ***d = 0***, work back,

- ***d = 0*** (suppose it's 2's turn): Player 2 will shoot
- ***d = 1*** (Pl. 1's turn): next turn, Pl. 2 will shoot and hit for sure, so Pl. 1 will shoot now.
- ***d = 2*** (Pl. 2's turn): because *1* will shoot next, *2* will shoot now if and only if $\boldsymbol{P_2(2) > 1 - P_1(1)}$
- Is the inequality true? It depends on skill…
- If not: Pl. 2 doesn't shoot at *d=2*, the game ends at *d=1*.
  - Pl. 1 won't shoot at *d=3* (she will wait for *d = 1*)
  - Pl. 2 is not willing to shoot from *d=2*, forget about *d=4*…

Duel: Analysis (cont'd)

- Suppose the inequality is true: $P_2(2) > 1 - P_1(1)$
  Then Pl. 2 will shoot at *d=2*.
- ***d = 3*** Pl. 1 shoots if $P_1(3) > 1 - P_2(2)$
- Will Pl. 1 shoot or not?
- If not, we know the first shot gets fired at *d=2.*
- If "shoot," look at player 2 at *d=4…*
- B.I. takes us to ***d**** (with mover *i*), i.e.,

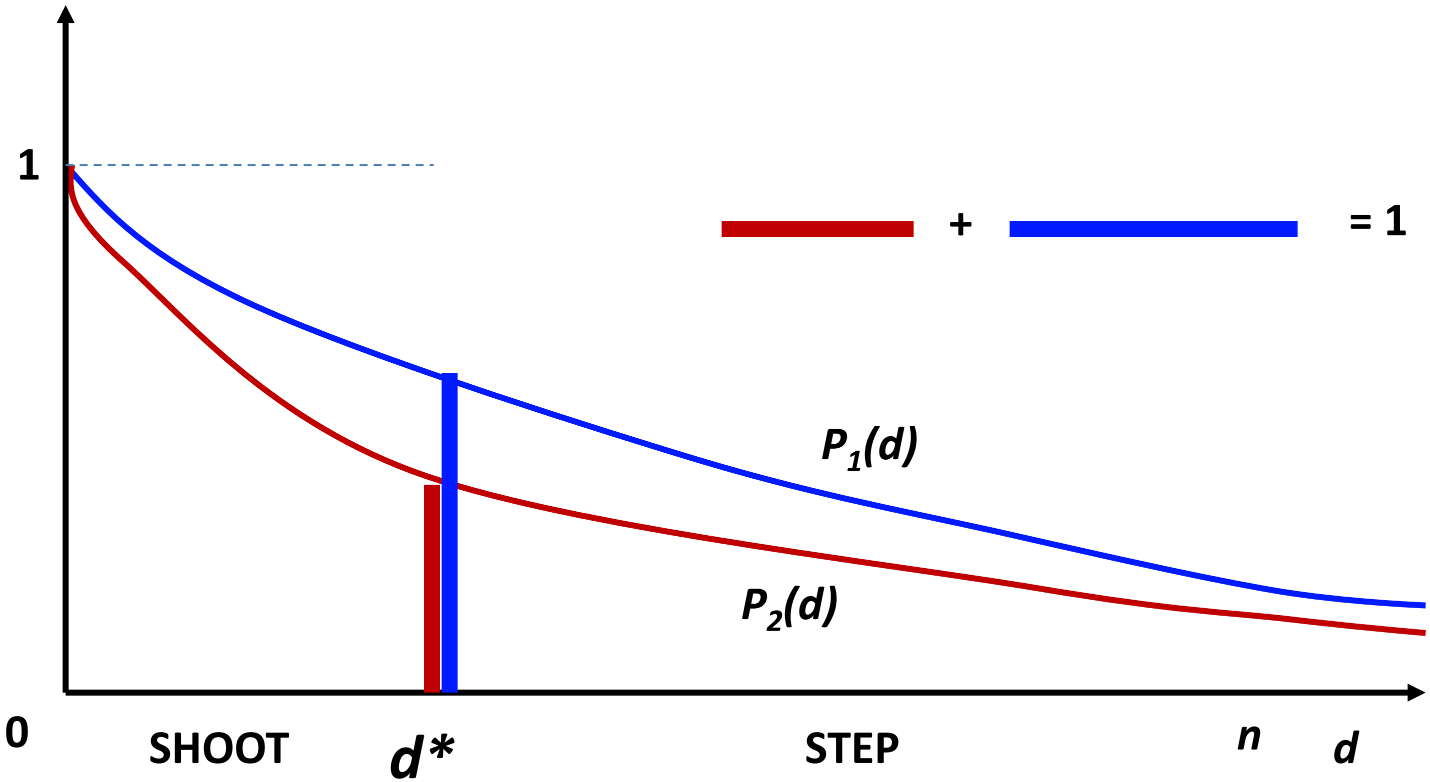
  $P_i(d^*) > 1 - P_j(d^*-1)$ (hence *i* will shoot)

  and

  $P_j(d^*+1) < 1 - P_i(d^*)$ (*j* steps at the previous round)

Duel: Summary

- If steps are small, then d^* solves $P_i(d^*) + P_j(d^*) = 1$



Duel: Discussion

- Who is more likely to win?
- Microsoft launched first: is Xbox the better product?
- Who shoots first? The better player? Why not?
- What if your opponent's skills or degree of sophistication are uncertain?

Duel Takeaways

- Timing games: hard problems that can be solved!
- Backward Induction provides a simple rule:
  "Shoot when sum of hit-probabilities = 1"
- Reality: uncertain skills, but a good starting point!
- Common pitfalls:
  - Overconfidence
  - Overvaluing being pro-active