

REPRESENTATION OF GAMES

I NORMAL FORM

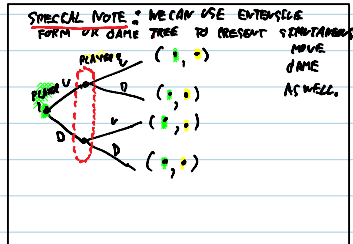
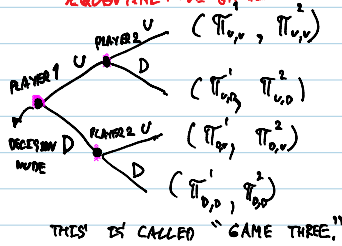
		PLAYER 2	
		L	R
PLAYER 1	U	( , )	( , )
	D	( , )	( , )

⇒ PAYOFF MATRIX

II EXTENSIVE FORM (USED TO REPRESENT SEQUENTIAL GAME)

SUPPOSE PLAYER 1 MOVES FIRST AND PLAYER 2 MOVES SECOND.

SEQUENTIAL MOVE GAME



ASSUMPTIONS

- HUMANS ARE RATIONAL BEINGS: HE/SHE TRIES TO MAXIMIZE HIS/HER REWARDS
 - HUMANS ALWAYS SEEK THE BEST ALTERNATIVE IN A SET OF POSSIBLE CHOICES.
- WHY ASSUME "RATIONALITY"?
- NARROW DOWN THE RANGE OF POSSIBILITIES
(NOTE THAT RATIONAL BEHAVIOR IS MORE PREDICTABLE THAN IRRATIONAL BEHAVIOR)
 - FOR THE PURPOSE OF PREDICTABILITY
- PROFITS,
EXCITE,
OR SUBJECTIVE
DIFFERENT

PAYOFFS BASED ON . RATIONALITY AND

- MAXIMIZATION OF UTILITY

GAME THEORY IS THEN A STUDY OF HOW TO

MATHEMATICALLY DETERMINE THE BEST STRATEGY FOR

GIVEN CONDITIONS IN ORDER TO OPTIMIZE THE OUTCOME

- HOW "PLAYERS" IN ECONOMIC "GAMES" BEHAVE WHEN THEY HAVE TO PREDICT HOW THEIR OPPONENTS WILL REACT TO THEIR MOVES.

FYI: JOHN F. NASH HAS BEEN AWARDED NOBEL PRIZE ON HIS CONTRIBUTION ON GAME THEORY IN 1994.

A BEAUTIFUL MIND: MOVIE THAT PRESENTS HIS WORK & LIFE.

TYPES OF GAME

- > SIMULTANEOUS MOVES VS. SEQUENTIAL MOVES
- > SINGLE PLAY VS. ITERATED
(ONE SHOT GAME)
 - └ FINITELY REPEATED GAME
 - └ INFINITELY REPEATED GAME
- > ZERO-SUM GAME VS. NON-ZERO SUM GAME
- > NON-COOPERATIVE VS. COOPERATIVE GAME
 GAME
 NO COOPERATION

"A Beautiful Mind" (2001)

Russell Crowe played as John F. Nash



<http://www.abeautifulmind.com/main.html>

BETWEEN
PLAYERS
OUR STUDY WILL MAINLY FOCUS ON NON-COOPERATIVE GAMES!

ADVERTISING GAME

		FORM B		UNIT: MILLION PAID
		ADVERTISE	DON'T ADVERTISE	
FORM A	ADVERTISE	10, 5	15, 0	
	DON'T ADVERTISE	6, 8	10, 2	

Q: WHAT STRATEGY EACH FIRM CHOOSES?

IF B CHOOSES "AD", A'S BEST RESPONSE IS "AD" ($10 > 6$)

IF B CHOOSES "NOT AD", A'S BEST RESPONSE IS "AD" ($15 > 10$)

SO, NO MATTER WHAT B CHOOSES, A ALWAYS CHOOSES "AD".

"AD" IS FIRM A'S "DOMINANT STRATEGY".

IS STRATEGY THAT IS OPTIMAL

NO MATTER WHAT AN OPPONENT DOES.

PROPOSITION #1 WHEN A PLAYER HAS A DOMINANT STRATEGY, HE/SHE WILL ALWAYS USE IT.

NEXT, WE ALSO SEE THAT FIRM B HAS A DOMINANT STRATEGY AS WELL, WHICH IS "AD".

THEREFORE, IN AN EQUILIBRIUM, A CHOOSES "AD" AND B CHOOSES "AD".

$$\bullet (\pi^A, \pi^B) = (10, 5)$$

$\bullet$ (AD, AD) IS AN EQUILIBRIUM "IN DOMINANT STRATEGIES"

EQUILIBRIUM IN DOMINANT STRATEGIES: OUTCOME OF A GAME IN WHICH EACH FIRM IS DOING BEST IT CAN REGARDLESS OF WHAT ITS OPPONENTS ARE DOING.

AD B

	AD	NO AD
AD	10, 5	15, 0
NO AD	6, 8	10, 2

AD

SOLUTION TO THIS GAME CAN BE FOUND BY USING

"ELIMINATION OF DOMINATED STRATEGY" (E-O-D-S)

WE ELIMINATE THE STRATEGY THAT PLAYERS WILL NEVER CHOOSE (= DOMINATED STRATEGY)

MODIFIED ADVERTISING GAME

MODIFIED ADVERTISING GAME

		B	
		AD	NO AD
A	AD	10, 5	15, 0
	NO AD	6, 8	20, 2

IF B CHOOSES "AD", A'S BEST REPLY IS "AD" ($10 > 6$)
 IF B CHOOSES "NO AD", A'S BEST REPLY IS "NO AD" ($20 > 15$)
 SO, A HAS NO DOMINANT STRATEGY.
CONSIDER FIRM B:

IF A CHOOSES "AD", B'S BEST REPLY IS "AD" ($5 > 0$)
 IF A CHOOSES "NO AD", B'S BEST REPLY IS "AD" ($8 > 2$)
 SO, B HAS A DOMINANT STRATEGY.

IN EQUILIBRIUM, BOTH WILL CHOOSE "AD".

[WE SOLVE THIS GAME BY USING "LOGICAL DEDUCTION".

		B	
		AD	NO AD
A	AD	10, 5	15, 0
	NO AD	6, 8	20, 2

$$NE \Rightarrow (s_A^*, s_B^*) = (AD, AD)$$

N.E IS A STABLE OUTCOME:
 NO PLAYERS HAS AN
 INCENTIVE TO "DEVIATE".

NASH EQUILIBRIUM CONCEPT

EACH PLAYER CHOOSES
 "A BEST RESPONSE" TO
 THE CHOICES MADE BY
 ALL OF THE OTHER PLAYERS.

IN OTHER WORDS,

I'M DOING THE BEST I CAN
 GIVEN WHAT YOU'RE DOING &
 YOU'RE DOING THE BEST YOU CAN
 GIVEN WHAT I'M DOING.

28.03.14

PRODUCTION CHOICE PROBLEM

		FIRM 2	
		CRISPY	SWEET
FIRM 1	CRISPY	-5, -5	10, 10*
	SWEET	10, 10*	-5, -5

FIND A NASH EQUILIBRIUM.

THERE ARE TWO NASH EQUILIBRIA: (SWEET, CRISPY), (CRISPY, SWEET)

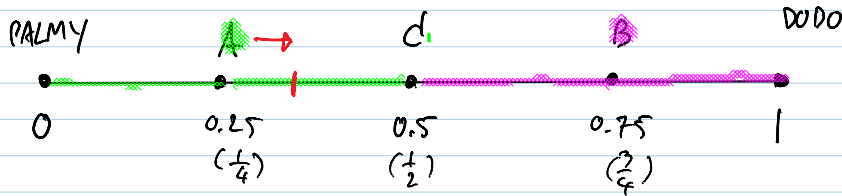
Q: WHICH NASH EQUILIBRIUM IS LIKELY TO OCCUR?

A: IN THE REAL WORLD, FIRMS WILL TRY TO "SIGNAL" WHAT
 PRODUCT IT MAY ADOPT IN ORDER TO AVOID ANY

POSSIBLE CRASH W/ ANOTHER RETAIL.

SELLING ICECREAM ON A BEACH

HAROLD HOTELLING "STABILITY IN COMPETITION",
ECONOMIC JOURNAL (EJ), 1929.



THERE ARE 2 SELLERS SELLING NON-DIFFERENTIATED PRODUCTS.

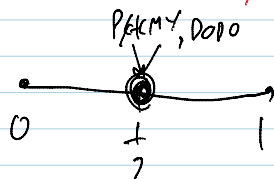
$$(s^{PALMY}, s^{DODO}) = (0.25, 0.75) \quad (\frac{1}{4})$$

THE GREATEST ONE-WAY WALK TO ANY SHOP BY A CUSTOMER = 0.25 km,

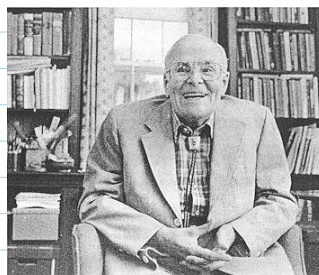
THE AVERAGE DISTANCE SPENT BY CUSTOMERS = $\frac{1}{8}$ km.

A NASH EQUILIBRIUM : $(s^{PALMY*}, s^{DODO*}) = (\frac{1}{2}, \frac{1}{2})$

NOTE THAT



THE GREATEST ONE-WAY WALK TO ANY SHOP BY A CUSTOMER = 0.5 km
AVERAGE DISTANCE SPENT BY CUSTOMERS = $\frac{1}{4}$ km !



Albert W. Tucker (1905-1995)

THE PRISONER'S DILEMMA (PD GAMES)

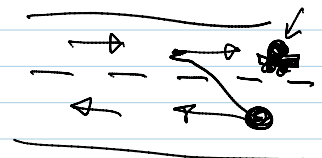
		PRESUMER Y REMAINS SILENT	
PRESUMER X REMAINS SILENT	CONFESSES	(-5, -5) *	(0, -20)
	REMAINS SILENT	(-20, 0)	(-1, -1)

WIRETO-OPTIMAL
OUTCOME

TWO PRISONERS ARE CAUGHT AND
PUT INTO SEPERATED CELLS FOR
A SERIES CRIME THAT THEY DIDN'T
COMMIT.

THE PROSECUTOR HAD ONLY A
HARD EVIDENCE TO CONVECT THEM
FOR A MINOR OFFENSE, IN WHICH
(E.G. STOLEN GOODS)

THE PENALTY IS 1-YEAR IN JAIL,



EACH PRISONER IS TOLD THAT ...

IF HE CONFESSES BUT THE OTHER DO NOT, HE WILL BE FREE AND THE OTHER WILL BE SENTENCED FOR 20 YRS.

IF BOTH CONFESSES, THEY WILL BE IN JAIL FOR 5 YEARS.

ONLY A NASH EQUILIBRIUM IS (CONFESS, CONFESS) WHICH IS CONSIDERED AS "PARETO SUPERIOR OUTCOME"

(SELENT, SELENT) DOES NOT ACTUALLY OCCUR EVEN THOUGH IT IS A PARETO SUPERIOR OUTCOME FOR BOTH!

WHY DO PEOPLE SHOUT AT COCKTAIL PARTIES? OTHER CONVERSATION PARTIES

SPEAK NORMALLY SPEAK MORE LOUDLY

SPEAK NORMALLY YOU AND YOUR PARTNERS	SECOND BEST FOR YOU AND OTHERS	BEST FOR OTHERS WORST FOR YOU
	BEST FOR YOU WORST FOR OTHERS	THIRD BEST FOR YOU AND OTHERS

Q: WHY DO CIGARETTE COMPANIES ADVERTISE "TOO MUCH"?

2 REASONS FOR ADVERTISING ① PERSUADE NEW CUSTOMERS TO EXPERIENCE ON THEIR GOODS.

(DOWELL) FORM 2 ② PERSUADE EXISTING SMOKERS TO "SWITCH" TO THEIR BRANDS.

FORM 1 (DOWELL) DON'T ADVERTISE	DON'T ADVERTISE	500	750
	ADVERTISE	500	0
ADVERTISE	DON'T ADVERTISE	0	250
	ADVERTISE	750	250

DOWELL FORM 2	DON'T CORRUPT	500	750
	POLITICAL CAN	500	0
CORRUPT	DON'T CORRUPT	0	250
	POLITICAL CAN	750	250

WHEN ADVERTISING'S MAIN EFFECT IS BRAND SWITCHING, THE DOMINANT STRATEGY IS TO ADVERTISE HEAVILY. (LOWER - RIGHT CELL), EVEN THOUGH FIRMS AS A WHOLE DO BETTER BY NOT ADVERTISING (UPPER - LEFT CELL)

Q: IS THERE ANY DEVICE TO MOVE THEM TO PLAY "DON'T ADVERTISE"?

A: GOVERNMENTS MIGHT IMPLEMENT BAN ON CIGARETTE ADVERTISEMENT FOR THE SAKE OF PUBLIC HEALTH.

MAXIMIN STRATEGY

FORM 2 DON'T INVEST INVEST UNCT: MILLION PAID DISAP THE END

MAXIMIN STRATEGY

		FORM 2	
		DON'T INVEST	INVEST
FORM 1	DON'T INVEST	0, 0	0, 10
	INVEST	-100, 0	20, 10

UNIT: MILLION PAULI

READ THE FULL STORY IN PINDYCK TO UNDERSTAND THE NATURE OF THIS GAME

(1) FIND A NASH EQUILIBRIUM:

CONSIDER FORM 1: IF FORM 2 PLAYS "DON'T INVEST", FORM 1'S BEST RESPONSE IS "DON'T INVEST"
 SINCE $\pi^1_{(DON'T\ INVEST, DON'T\ INVEST)} > \pi^1_{(INVEST, DON'T\ INVEST)}$

IF FORM 2 PLAYS "INVEST", FORM 1'S BEST RESPONSE IS "INVEST"
 SINCE $\pi^1_{(INVEST, INVEST)} > \pi^1_{(DON'T\ INVEST, INVEST)}$

CONSIDER FORM 2: IF FORM 1 PLAYS "DON'T INVEST", FORM 2'S BR IS "INVEST"
 SINCE $10 > 0$

O/C - - - -

IF FORM 1 PLAYS "INVEST", FORM 2'S BR IS "INVEST"
 SINCE $20 > 10$

SEE THAT FORM 2 HAS A DOMINANT STRATEGY: INVEST