Strategic Corporate Management 45870M

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Second Mini 2025

Lecture 1
The Strategic Form

This lecture starts from the self-evident truth that a person who can affect the payoffs and rewards of someone else does not necessarily act in the interests of that other person. We define the notion of a best reply in the context of strategic interactions, and argue it is a compelling way to guide and explain human behavior. A Nash equilibrium is defined by a strategy for each player that is a best reply to all the other players.

Key words and phrases:

Teamwork, rivalry, players, strategies, game theory, best reply, Nash equilibrium.

Six Sigma

- Many of you are familiar with six sigma.
- Summarizing the methodology, a team is assigned a project to:
  1. define the problem and the project goals.
  2. model the various dimensions of the existing process.
  3. analyze output data in detail to identify major flaws.
  4. design improvements to the existing process.
  5. control the implementation of the improvements.
- This methodology is very useful in addressing a wide range of problems in business in:
  - production scheduling and supply chain management.
  - personnel and human resource management.
  - marketing new products.

Relaxing the team player premise

- But what if the "team members" consist of different:
  - stakeholders (shareholders, workers, customers)
  - firms (rivals, upstream suppliers, downstream demanders)
  - legal entities (corporations, regulatory bodies, enforcement agencies)
- This considerably complicates the methodology of six sigma. With respect to the five steps:
  1. The projects goals might differ by player type.
  2. The model must incorporate the strategic interactions between the different players.
  3. The output data may only be partially observed by some of the players.
  4. Evaluating improvements for one player must account for the reaction by the others.
  5. It is hard to predict the outcomes of changes in multiplayer settings, let alone control them.

A Generalization

- In principle we can readily generalize the six sigma to situations that go beyond team play.
- Indeed this course does exactly that:
  1. Multiple players
  2. Turn decision tree into game tree
  3. Each player has individual payoffs rather than one team payoff
  4. Not everyone sees all the past actions (like forgetting in a single agent problem)

Adapting six sigma to games

- In six sigma the notion of improving a process is unambiguous because there is only the objectives of one player called the team to consider.
- In a multiplayer game the benefits to one player might be associated with costs to another.
- For example, in zero-sum games a fixed amount is divided between players, so one player's gain is always another player's loss.
- Rather than thinking about system improvements (such as optimizing) we focus on changing the game.

Adapting six sigma beyond teamplay

- Why then does six sigma step around these issues, sometimes ignoring them entirely? The short answer:
  . . . . . it's hard.
- This course compromises detail on the other dimensions, to analyze strategic interaction between multiple players.
- Here being "strategic" means rationally seeking your own goals in situations that involve other rational parties who do not share your goals.
- To make progress we use three main tools to analyze strategic interaction:
  1. Game theory.
  2. Experiments.
  3. Statistics

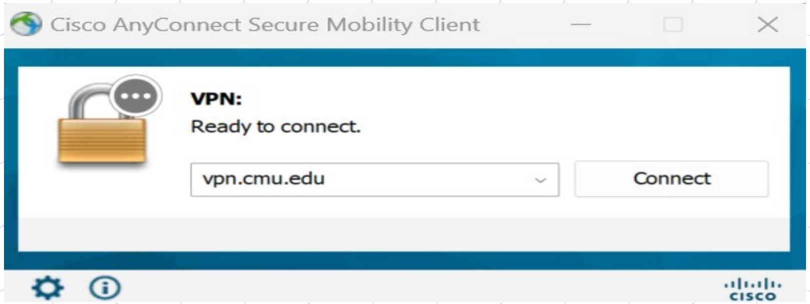
The prisoner’s dilemma

- In the celebrated prisoners’ dilemma game, 2 players choose, simultaneously, between remaining silent and confessing.
- A bi-matrix depicts choices and payoffs.
- For example if green confesses and blue remains silent, then green gets nothing and blue loses six.
- Arguably their team goal is to reach the cell (-1, -1).

Row Player \ Column Player	Confess	Remain silent
Confess	1: -4 (row), -4 (column)	3: 0 (row), -6 (column)
Remain silent	2: -6 (row), 0 (column)	4: -1 (row), -1 (column)

VPN Connect when not in the same classroom

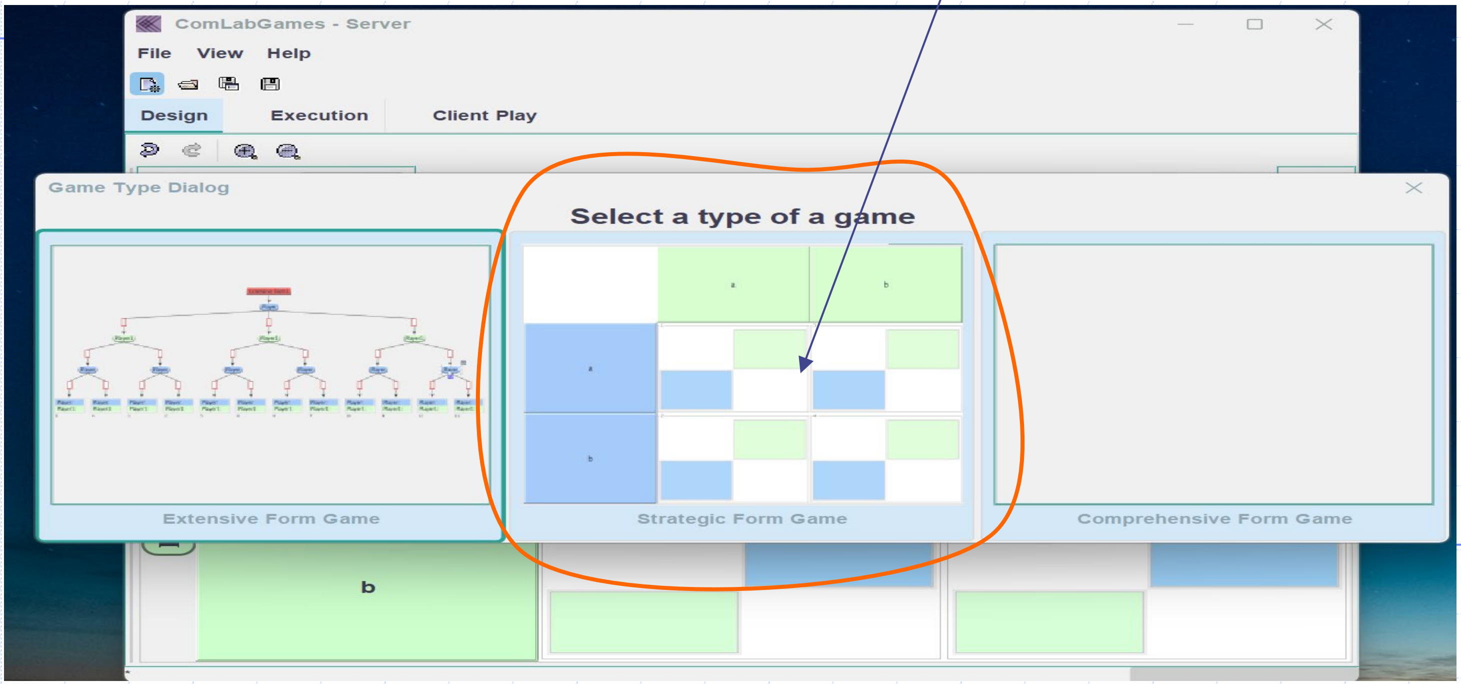
1. Before starting Comlabgames software , make sure to connect to the same network that the server runs the game. This instructions are for subjects who login from different locations that are not part of the same network.
2. Open Cisco AnyConnect Secure Mobility Client and Connect to CMU VPN address.



Login instructions

1. Double click on the ComLabGames app to start the software.

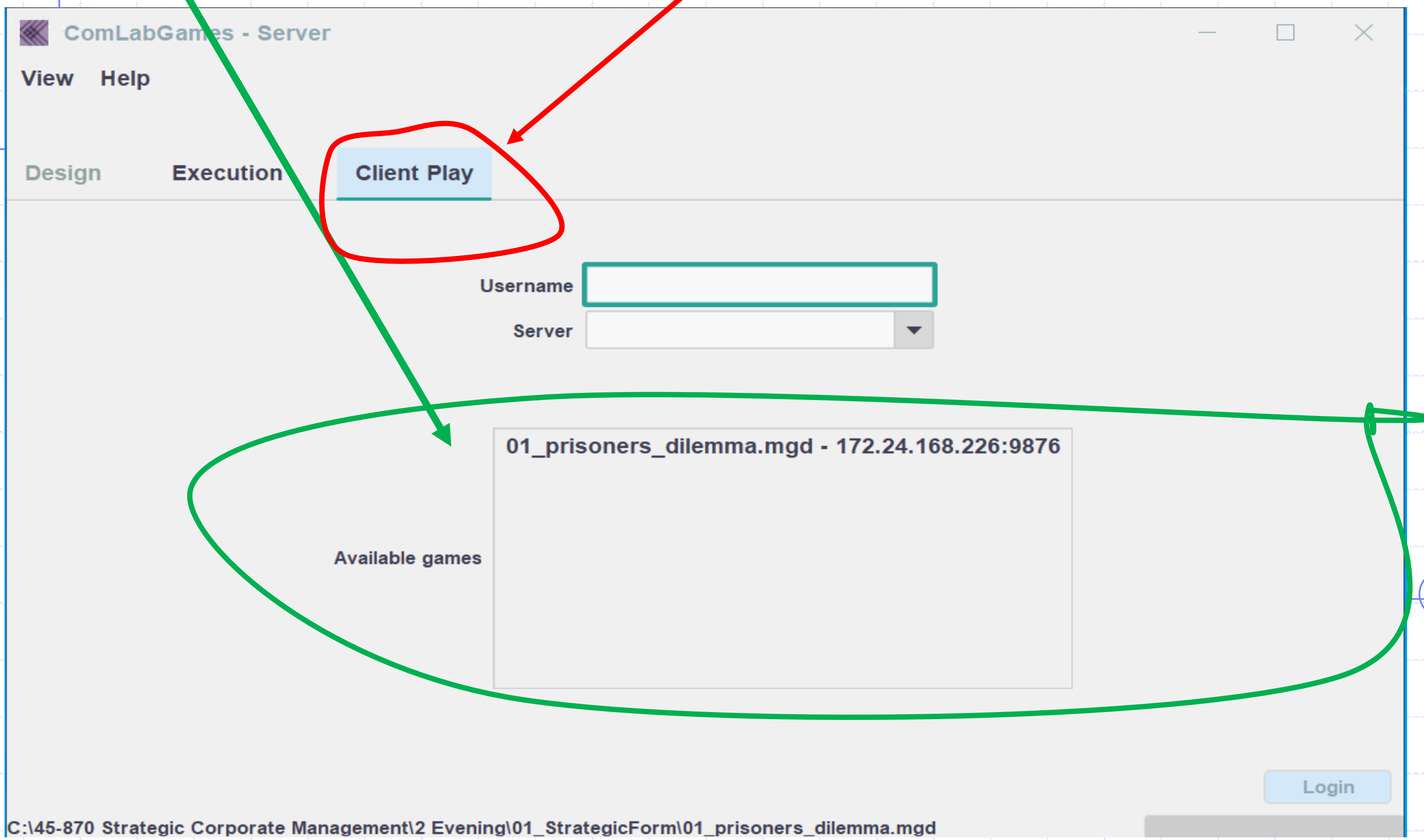
2. The first time ComLabGames prompts you to "*Select a type of game*" : Click on "*Strategic Form Game*"



3. The Design window is displayed by default after the first start of the program.

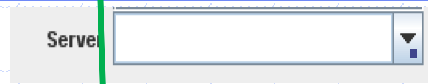
Continuing login instructions

1. To play a game, click on "*Client Play*".
2. Click on "01_prisoners_dilemma.mgd…" in Available games:

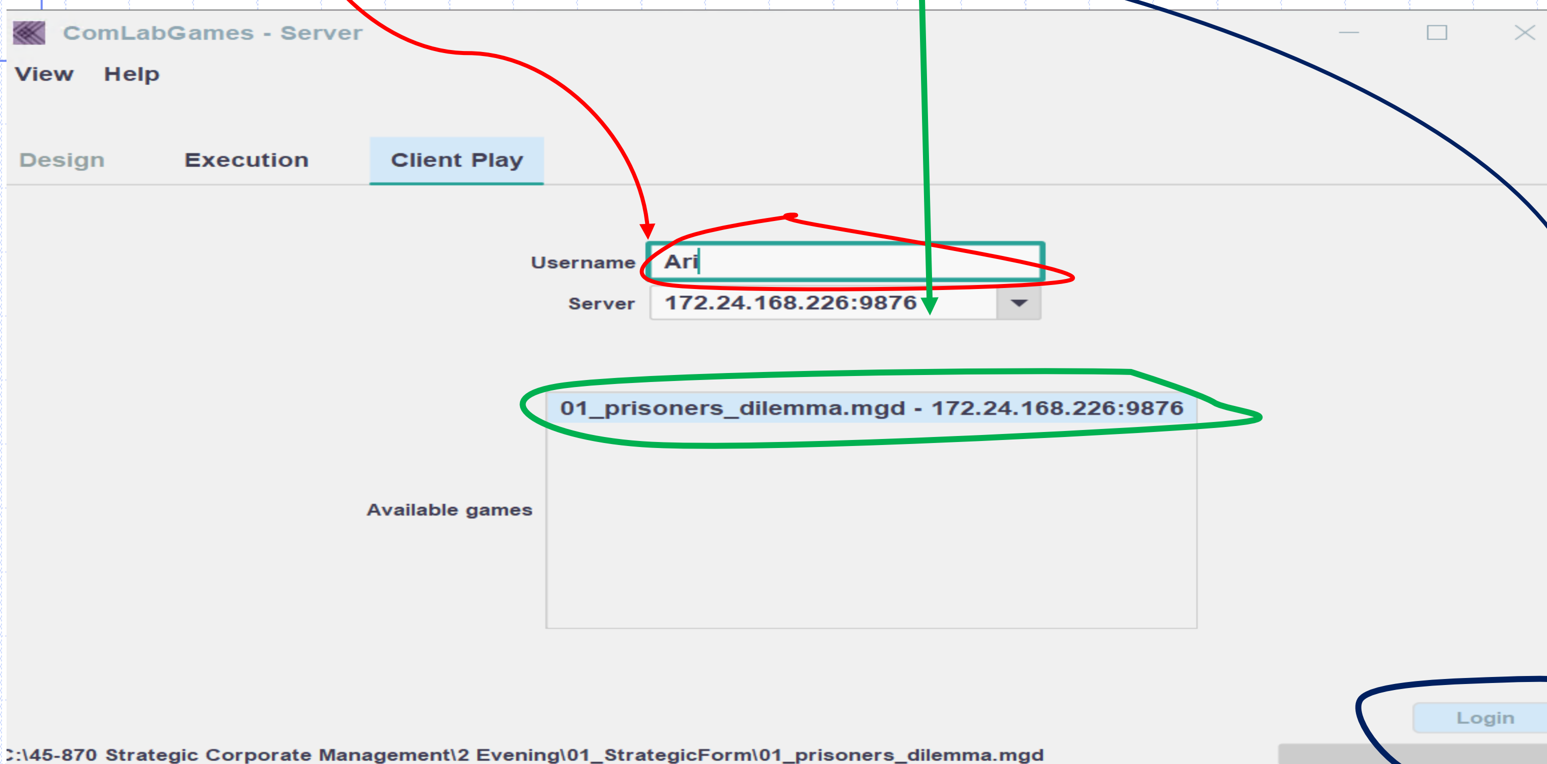


Continuing login instructions

1. Server address: 172.24.168.226 will appear automatically after selecting "01_prisoners…". If not type 172.24.168.226 in

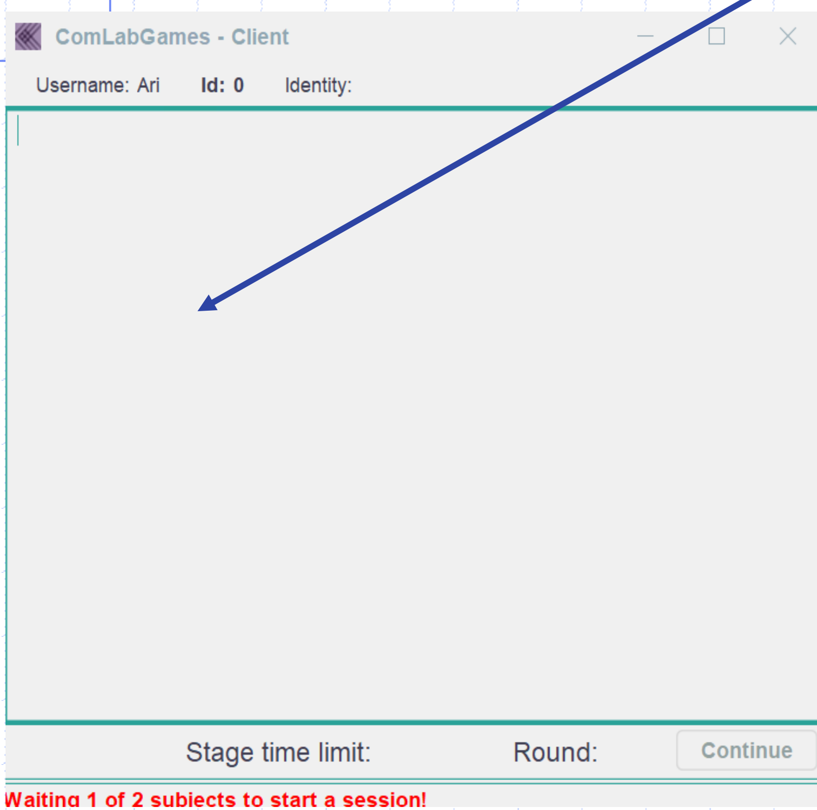


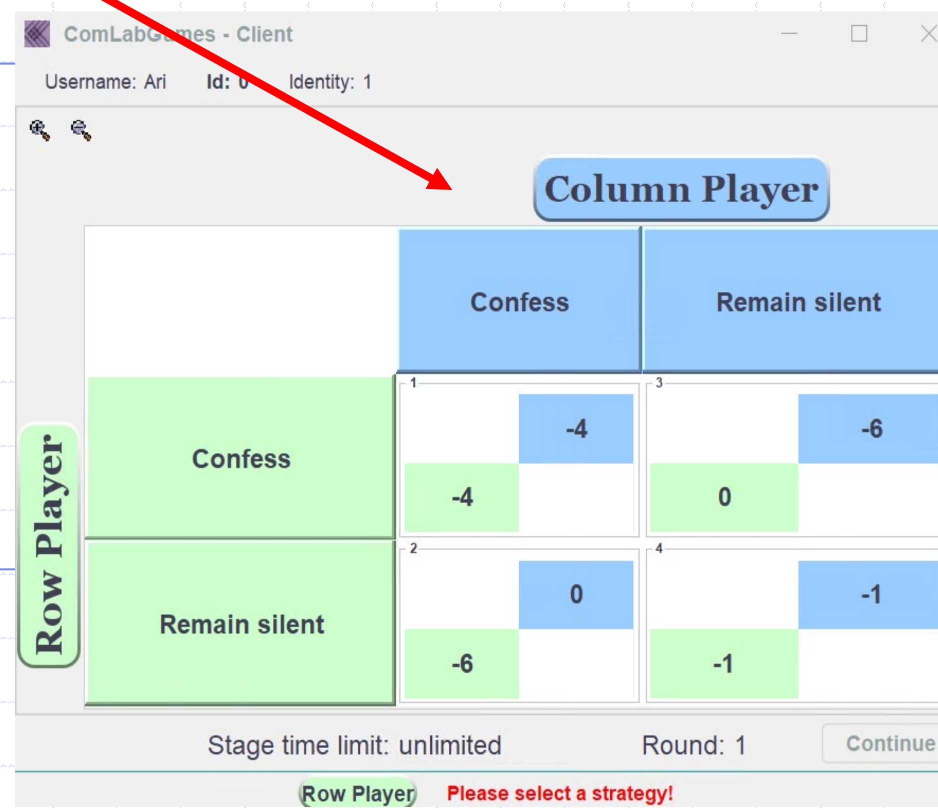
2. Write a username.
3. Click on "Login".



Game window

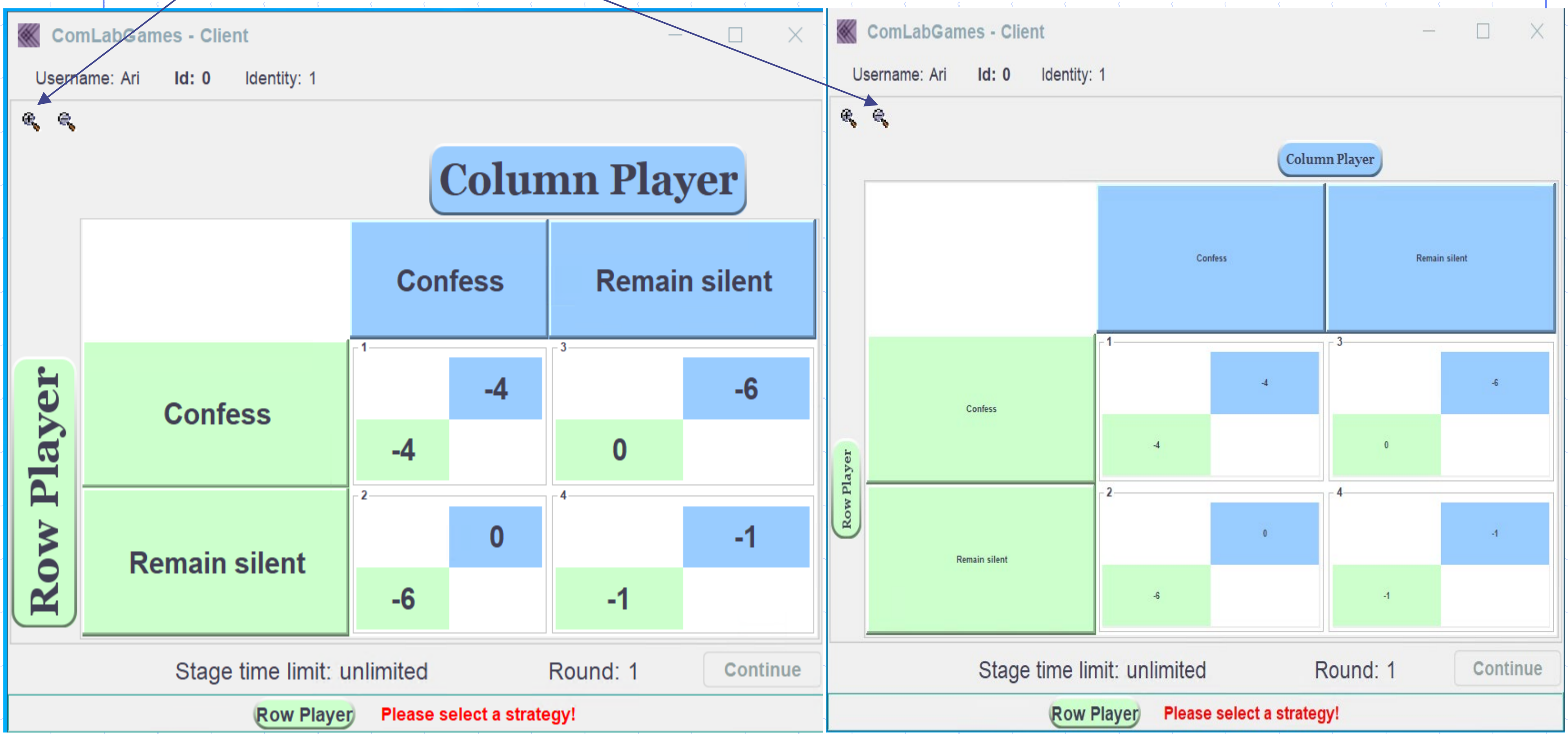
1. Two subjects must login to start this game.
2. The first subject to login will see a blank screen with username: Username: Ari
3. When another subject logins to the game the blank window is replaced with:





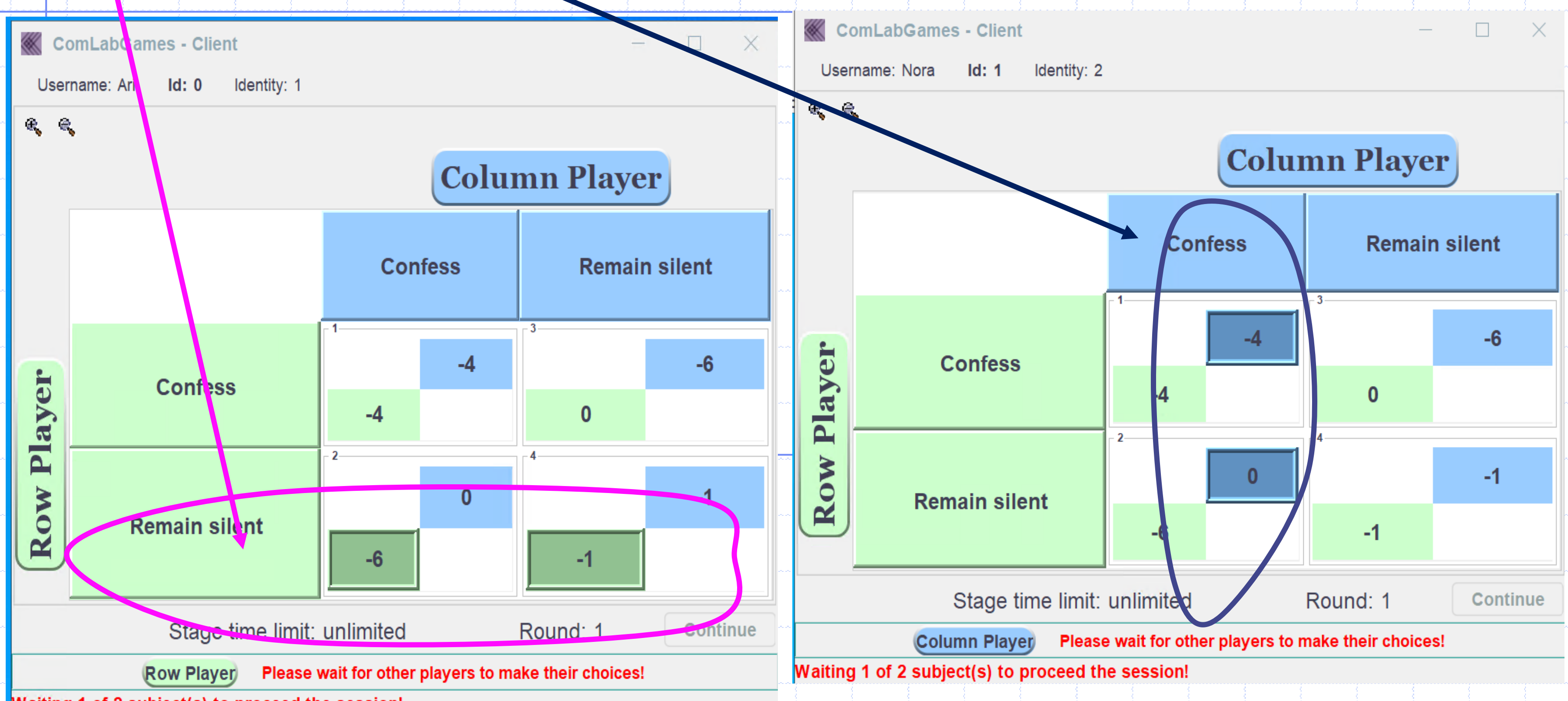
Increasing/reducing font size

1. Click on (+) to increase the font size or "Ctrl+mouse button"
2. Click on (-) to reduce the font size or "Ctrl+mouse button"



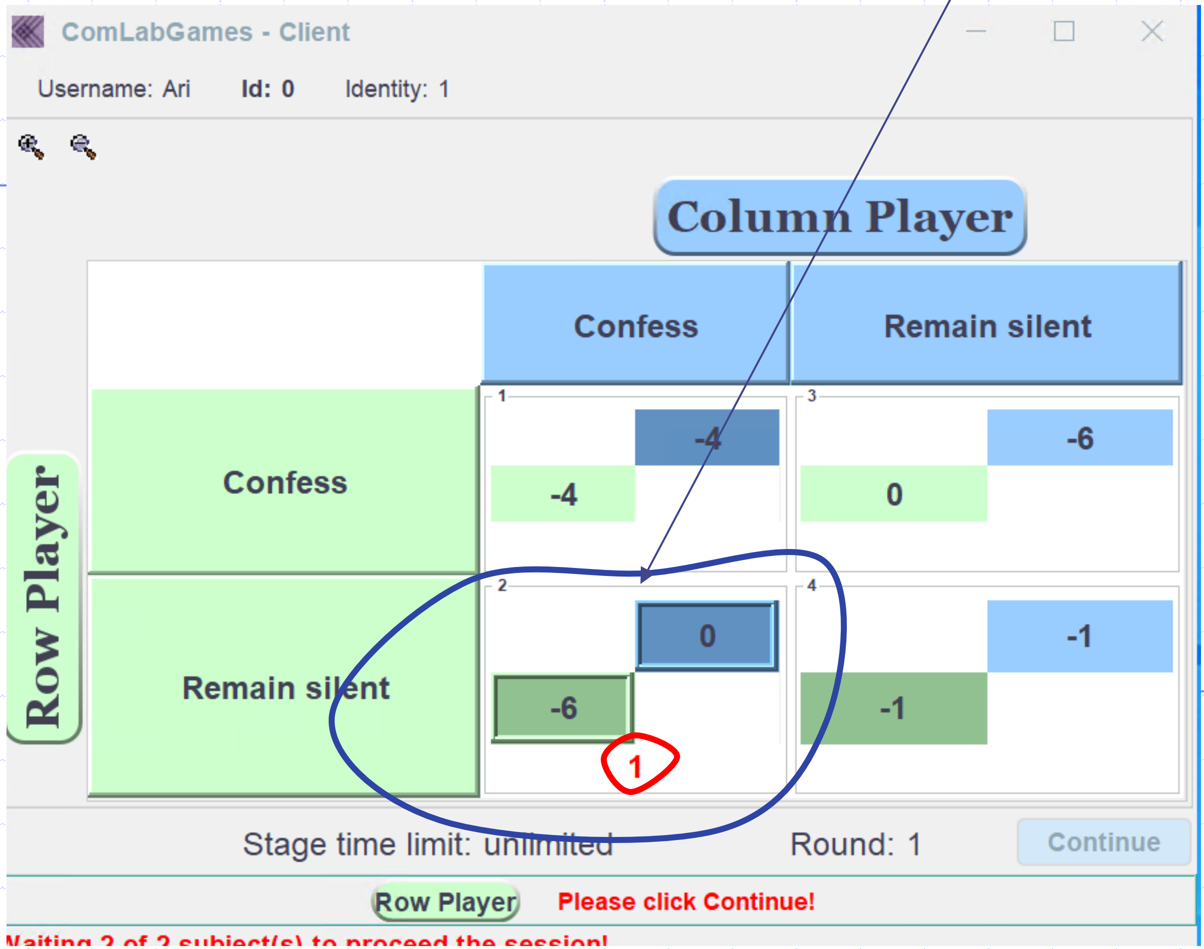
Selecting a strategy

1. Moving the mouse between rows/columns without clicking highlights your alternatives.
2. Clicking on the row/column to select a strategy highlights row (column).
3. Once you have made a selection, you cannot undo it.



Results from strategy selection

1. After both subjects make select their strategy the payoffs are highlighted.
2. The outcome cell counter is displayed in red.



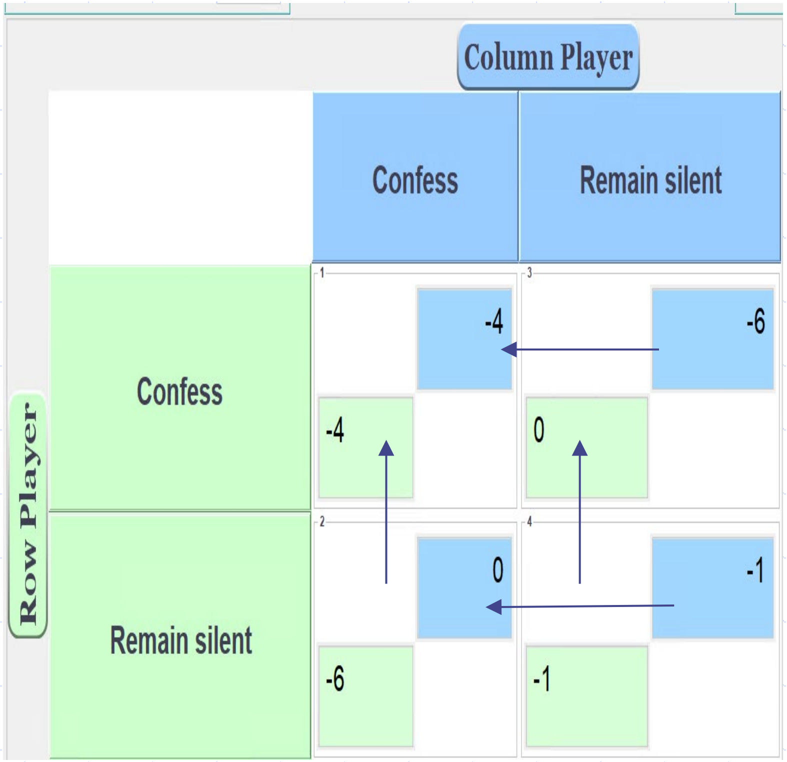
Best replies

- For any strategy green picks, the best reply of blue is defined as the strategy for blue that maximizes her (expected) payoff.

- The best reply for blue is to confess, regardless of which strategy green chooses.

- The best reply for green are illustrated with vertical arrows.

- The best replies for blue are illustrated with horizontal arrows.



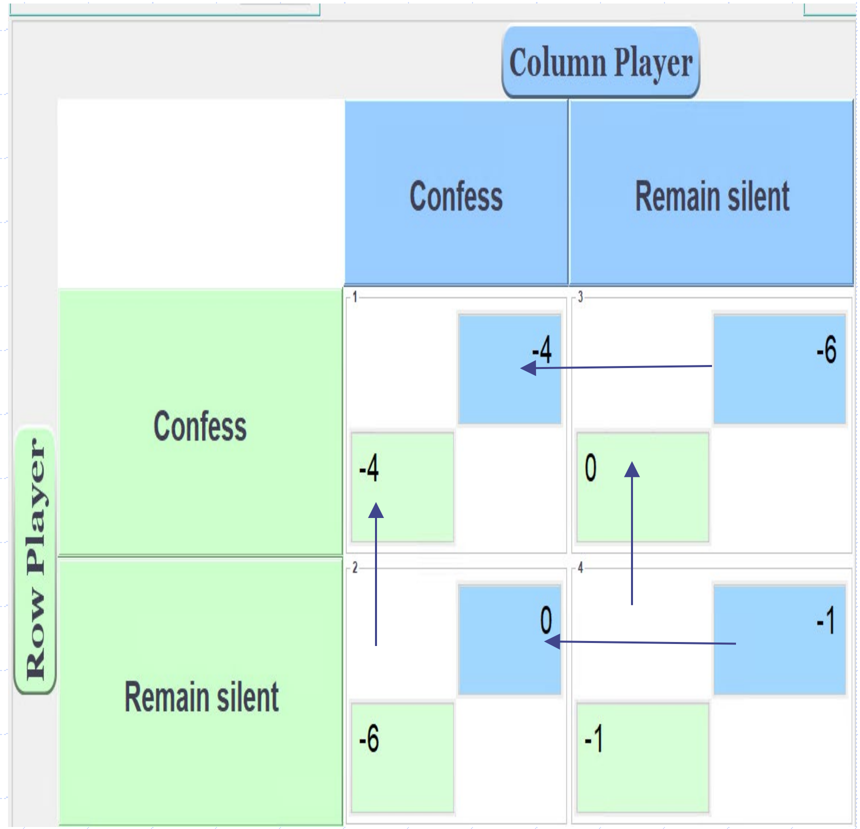
Intuition for best replies

- The easiest way to think about a best reply is to first imagine a strategic opportunity where:
  - you are one of the players (or parties) involved.
  - the choices of the other players affects your payoffs.
  - the behavior of the other players is random (a draw from a probability distribution), or perfectly predictable.
- The best reply is a personal strategy that maximizes your expected payoffs (or achieves your feasible goals) given:
  - this strategic opportunity
  - the behavior of the other players.

Nash equilibrium in two player games

- In a Nash equilibrium both players choose a strategy where:
  1. Green chooses a best reply to blue.
  2. Blue chooses a best reply to green.

- The Nash equilibrium is defined by the cell in which neither the vertical nor horizontal arrows point out of the cell.



Why is the prisoner's dilemma famous?

- The prisoner's dilemma illustrates two features of strategic interactions in a very simple way:

- First, it shows the three elements of the strategic form that can be used to define any game:
  1. Players (blue and green)
  2. Strategies (confess or remain silent)
  3. Expected payoffs (the numbers in the cells).

- Second, it suggests that not every strategic interaction results in a "win/win", and that we should not necessarily expect such an outcome.

Is the prisoner's dilemma specialized?

- In short "yes":
  1. There are only two players
  2. There are only two strategies for each player.
  3. The best reply of each player does not depend on what the other one does.

- The first two special features are easy to generalize.

- The third feature has a special name:

  When a player's best reply does not depend on what the other players do, it is called a dominant strategy.

- When a player has a dominant strategy, ignoring the payoffs and strategies of other players is sensible.

- What happens when this is not the case?

Redefining the game

- There are essentially three ways to change this game.

- One can add or subtract:
  1. players (yellow and green in this case)
  2. strategies (confess or remain silent)
  3. numbers to the expected payoffs (the numbers in the cells).

- One question in Assignment 1 asks you to analyze what happens when the payoff in a game changes where there two players, each with two strategies.

- That said, the prisoner's dilemma is a very simple example: isn't there a more general way of presenting these concepts?

The empirical distribution

- If a dominant strategy doesn't exist, the best reply depends on what the other players do!
- To make headway on this question, it is useful do first analyze how subjects behave in these experimental settings.
- In the strategic form, the empirical distribution of game play, or more simply, the empirical distribution, is defined for each player by his or her choice of strategy.
- It is the relative frequency with which each strategy is picked.
- Equivalently the empirical distribution gives the probability of reaching a given outcome in practice, that is regardless of whether players are in NE or not.

Product innovation

Low quality producer | High quality producer

	introduce new model	upgrade existing model	reduce price of existing model
introduce new model	2 / 2 / 10	3 / 1 / 6	2 / 3
upgrade existing model	3 / 1	2 / 2 / 2	2 / 2
reduce price of existing model	2 / 3 / 13	1 / 0 / 3	0 / 1 / 2

- There are two producers:
  - A high quality yellow producer can introduce a new model, upgrade the existing model, or reduce the price on the existing model.
  - A low quality green producer has the same set of strategies.
- The producers move simultaneously: in other words, they must commit to their own strategy before seeing the strategy of their rival.

The empirical distribution of game play

One of my classes completes: 10 + 6 + 2 + 13 + 3 + 2 = 36 games.

The empirical distribution of a player in a strategic form game, is the fraction of outcomes the player chooses each strategy.

Low quality producer | High quality producer

		introduce new model (23/36)	upgrade existing model (11/36)	reduce price of existing model (2/36)
16/36	introduce new model	2, 2 (10)	1, 3 (6)	3, 2
2/36	upgrade existing model	1, 3	2, 2 (2)	2, 2
18/36	reduce price of existing model	3, 2 (13)	0, 1 (3)	1, 0 (2)

Yellow:

- introduces new model 16 times.
- upgrades 2 times.
- reduces price 18 times.

Green:

- introduces new model 23 times.
- upgrades 11 times.
- reduces price 2 times.

Best reply to the empirical distribution

- We now define the best reply to the empirical distribution for the strategic form of a game.

- In the strategic form the best reply for a player is:

the strategy yielding the highest expected payoff to that player, given the empirical strategy of all the other players.

Product introduction revisited

Given the empirical strategy of Green, the expected payoff to Yellow from playing:

- *Introduce new product* is: (23*2 + 11*1 +2*3)/36 = 63/36.
- *Upgrade existing model* is: (23*1 + 11*2 +2*2)/36 = 49/36.
- *Reduce price* is: (23*3 + 11*0 +2*1)/36 = 71/36.

⟹ Yellow's best response is to *Reduce price*.

Low quality producer | High quality producer

	introduce new model (23/36)	upgrade existing model (11/36)	reduce price of existing model (2/36)
introduce new model (16/36)	2, 2 [10]	1, 3 [6]	3, 2
upgrade existing model (2/36)	1, 3	2, 2 [2]	2, 2
reduce price of existing model (18/36)	3, 2 [13]	0, 1 [3]	1, 0 [2]

Given the empirical strategy of Yellow, the expected payoff to Green from playing:

- Introduce new product is (16*2 + 2*3 +18*2)/36 = 74/36.
- Upgrade existing model is (16*3 + 2*2 +18*1)/36 = 70/36.
- Reduce price (16*2 + 2*2 +18*0)/36 = 1.

⟹ Green's best response is to *Introduce new product*.

The best reply in product introduction

Given the empirical strategy of Green, the expected payoff to Yellow from playing:

- *Introduce new product* is: (23*2 + 11*1 +2*3)/36 = 63/36.
- *Upgrade existing model* is: (23*1 + 11*2 +2*2)/36 = 49/36.
- *Reduce price* is: (23*3 + 11*0 +2*1)/36 = 71/36.

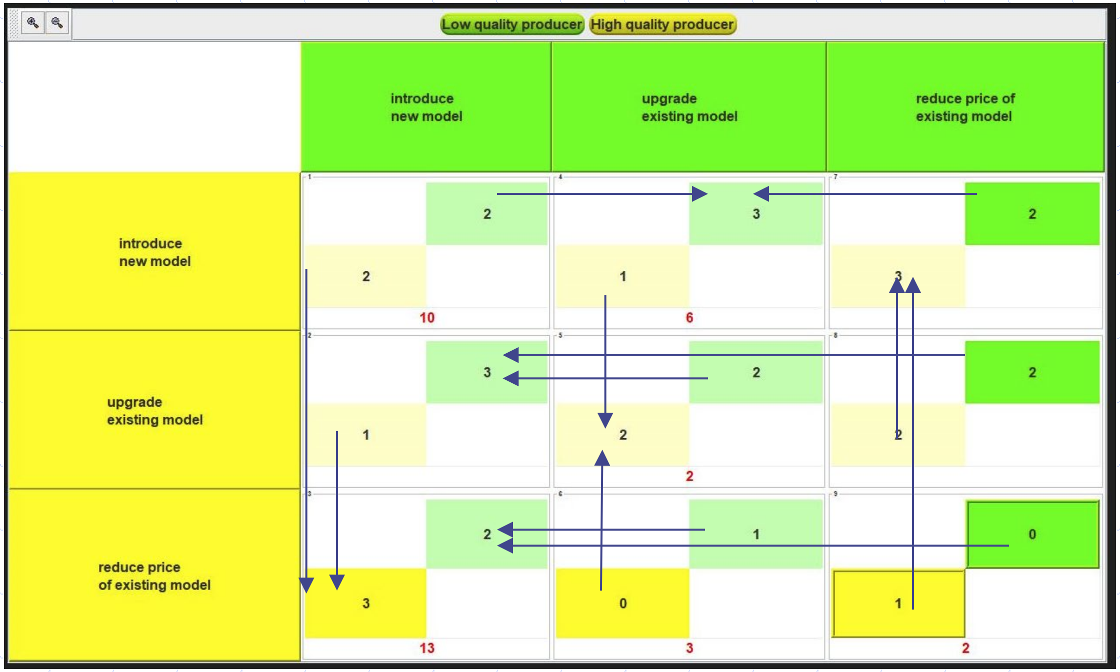
23/36 11/36 2/36

The best reply of yellow is to reduce price, and the best reply of Green is to introduce new product. (By chance this corresponds to the unique NE!)

16/36

2/36

18/36



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Why is knowing NE important?

- The examples given today illustrate why NE is regarded as such an important concept for analyzing strategic situations:

  1. It provides an analytical benchmark prediction for what might happen. For example, a supervisor designing cooperative duties, or a *game*, for her subordinates, should anticipate they might play Nash equilibrium outcomes

  2. Even though it is quite unlikely that everyone will play their part of a NE strategy, it provides helpful guidance for predicting the strategies for the other players.

  3. The NE is quite often a best reply, either because:
     - it is a dominant strategy.
     - other players are playing strategies "sufficiently close" to their NE strategies. (We will see this throughout the course.)