*An online simulation about 2D horizontal differentiation*

# Background

- Nicolas Gruyer: Former economics professor at ENAC Toulouse.
- Since 2011, working as an independant on creating games and simulations for teaching economics.
- https://economics-games.com
  - Free (commitment to leave them free)
  - No registration
    - standard games
    - original games
    - Experiments taken from economics education papers
    - Experiments from research papers

# Background

- Often possible to make games that are fun and pedagogical.
- But sometimes, there is a conflict (repeating schemes for example)
  - Usually, when needed, we favor pedagogical over fun.
  - This time, we decided to favor the other approach (hoping that it would also be very pedagogical…)
  - Co-created with students from Toulouse School of Economics, Coline Theillac and Patrick Hubert, and beta-tested on some of their colleagues.
- I will be happy to have your opinion on this.

# The full game: model



**Instructions**

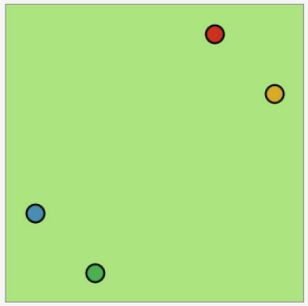
You are the manager of a firm, competing with three other to sell a product to the customers of a square country, with sides of length 100.

1000 potential customers are uniformly distributed all over the square.

Your cost is $ 50 per good sold, and each potential customer is willing to buy at most one unit of the good.

Each firm is located at a single place, inside the square.

| | Player 1 (1) | Player 2 (2) | Player 3 (3) | Player 4 (4) |
|---|---|---|---|---|
| Location | ( 10 , 30 ) | ( 70 , 90 ) | ( 90 , 70 ) | ( 30 , 10 ) |



Consider that a consumer who is located exactly at the same place as a firm, and buys one of its product at a price p, values this transaction S - p (S = 250 is the value he gives to the good, net of any payment). We also assume that a consumer who buys from a firm that is located at a distance d from his location, incurs an additional "transportation" cost equal to $0.016 * d^2$.

Consequently, each customer buys from the firm i such that $250 - pi - 0.016 * d_i^2$ is the highest, provided that this is positive (otherwise, he does not buy to any firm). The rule is simple:

**Each customer chooses to buy from the store with the smallest "generalized cost": $p_i + 0.016 * d_i^2$, as long as this is smaller than 250 (and otherwise does not buy to any firm).**

Don't worry, you will find a simulation on the decision page to help you evaluate your sales as a function of locations and prices.

**In this variant of the game, you will start by selecting your location. Then, after observing the other players' decision, you will be invited to choose your price** (there is another variant, in which you only select the prices).

Your goal is to maximize your profit, not to beat your direct competitors! (sometimes, you can not do both at the same time!).

# The full game: model

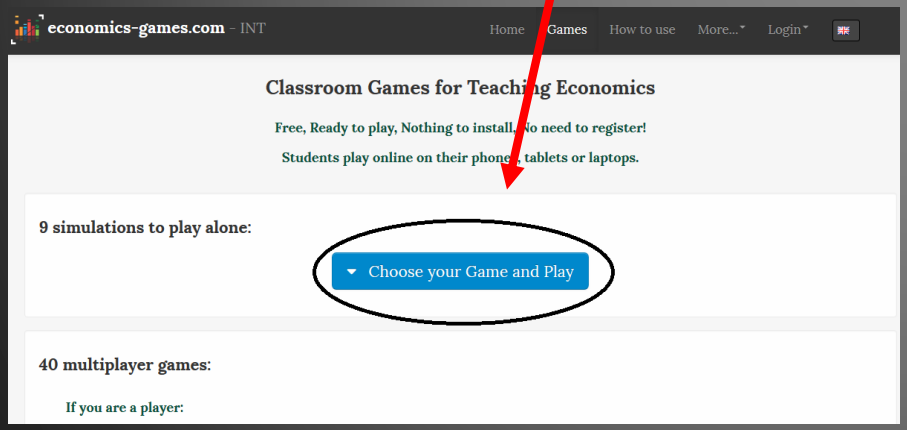
- Close to Irmen and Thisse
  - “Competition in multi-characteristics spaces: hotelling was almost right”
  - JET 1998
  - (2 players)
- Simple to understand but already complex to master if you have no economics background.
  - Gamers do not read manuals → they play the tutorial and learn the game by trial and errors
  - Let’s do this.

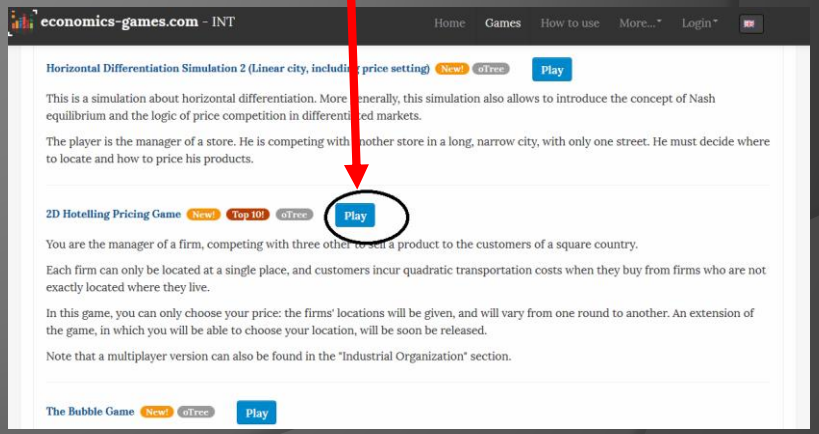
# How many computers?

- If possible, let's constitute teams of 2-3 persons, such that there are 4 * n teams.
  - 1 - Tutorial, vs robots  (whose behavior is based on actual behavior from beta tester). Only price setting
  - 2 – Multiplayer game, price setting and location choice (still in beta test)
    - And a few scenario events (including a competition inducing public good)

# Run the games

- Tutorial vs robots:
  - Go to the shortcut url: simu.io
  - Click on the button for the monoplayer simulations
  - Click play next to '**2D Hotelling Pricing Game**'
    - **(Be careful, you can only be connected to one game with the same browser)**



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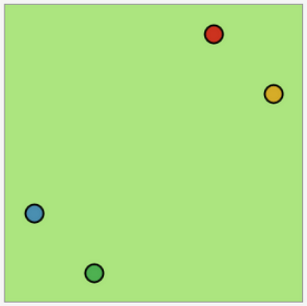

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# Price setting

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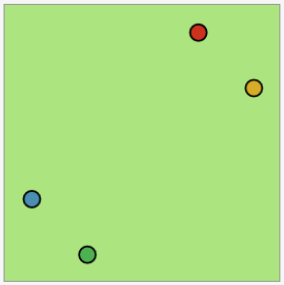
Check every firms' location in the table and map below and choose your price.

At the bottom of the page, a simulation can help you visualize the impact of locations and prices on sales.

**You are Player 1**

| | Player 1 | Player 2 | Player 3 | Player 4 |
|---|---|---|---|---|
| **Location** | (10,30) | (70,90) | (90,70) | (30,10) |



**Your price ( $ 50 - $ 250 ) :**

Next

**Each customer chooses to buy from the store with the smallest "generalized cost": $p_i + 0.016 * d_i^2$, as long as this is smaller than 250 (and otherwise does not buy to any firm).**

Your goal is to maximize your profit, not to beat the robot! (sometimes, you can not do both at the same time!). Your unit cost is $ 50 per unit sold.

Show the Simulation

# Help interactive simulation

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Next

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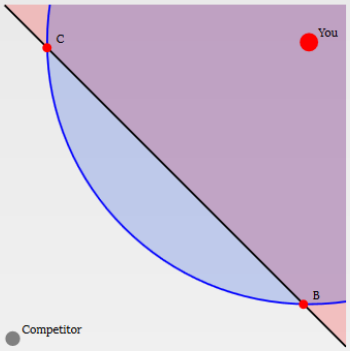
Hide the Simulation

This simulation illustrates how customers behave when faced with two potential sellers. Choose a location and price for you and your competitor and check your market share.




| | | | |
|---|---|---|---|
| **You:** | Price: $ 170 | X: 90 | Y: 90 |
| **Competitor:** | Price: $ 130 | X: 10 | Y: 10 |

- The blue disk displays customers who would buy one of your product, if you were the only firm in the market. Those who are outside of the disk would not buy to you, even if you were alone on the market.
- The pink area shows customers who prefer buying to you rather than to your competitor (but remember that some of them, those who are outside of the disk, do not want to buy to you... They just even less want to buy to your competitor)
- Customers who actually buy to you are those who are in both areas at the same time, i.e. those who are in the purple area.

# Results (robot decisions based on real humans decisions)

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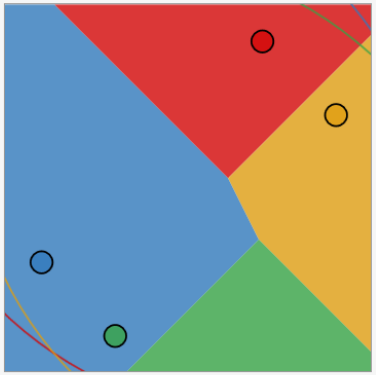
**2D Hotelling - Results (Round 1)**

**You are Player 1**



| | Player 1 | Player 2 | Player 3 | Player 4 |
|---|---|---|---|---|
| **Location** | (10,30) | (70,90) | (90,70) | (30,10) |
| **Price** | $ 58 | $ 84 | $ 89 | $ 79 |
| **Sales** | 467.28 | 219.12 | 183.93 | 129.67 |
| **Profit** | $ 3738.2 | $ 7450.1 | $ 7173.3 | $ 3760.4 |

The colors on the map indicate which firm is the most interesting for a customer who is located at a given point.

However, remember that customers may also decide not to buy any product, if they are all too expensive and too far away: A colored circle shows the frontier beyond which consumers would not accept to buy from the firm of this color, even if it was a monopoly.

Consequently, sales made by a firm correspond to the part of the colored area which is closer to the firm than the circle (this is usually the case for the whole colored area... except if prices are very high).

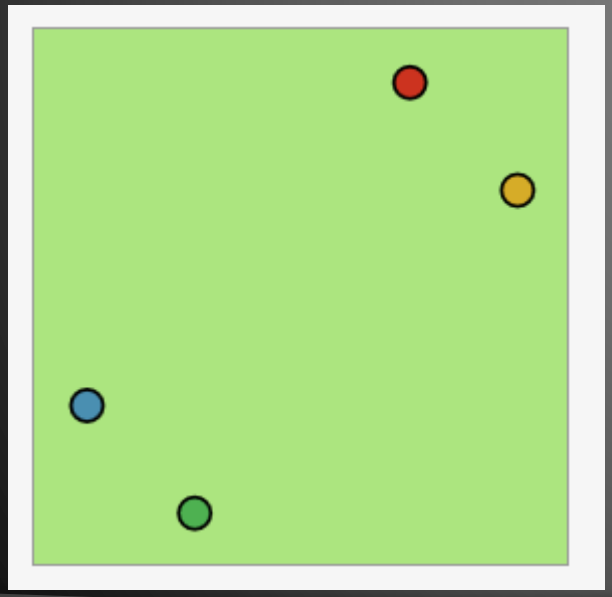
Next

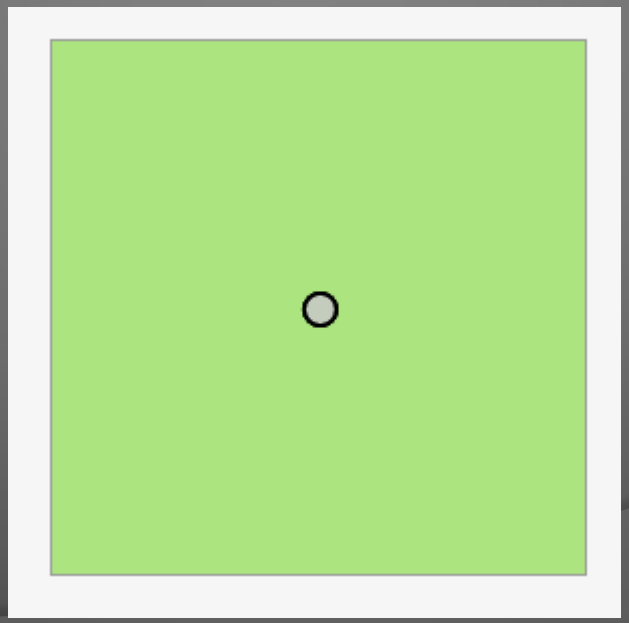
# Tutorial

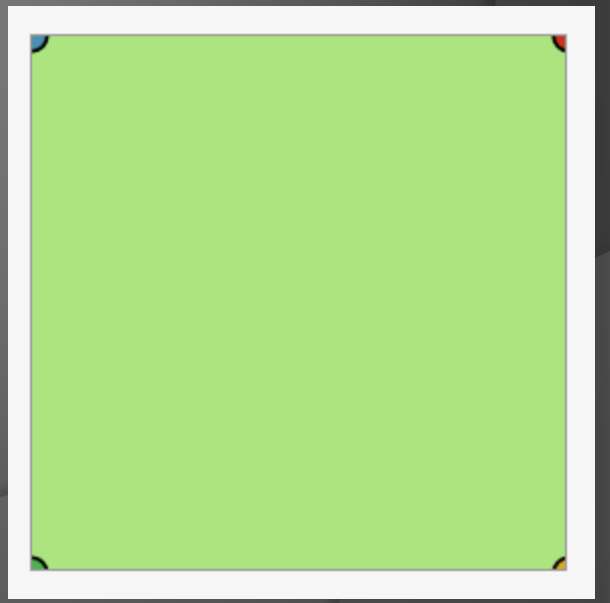
- But enough words, now it's time to let you try

# Progression during the tutorial

- Nearly unwillingly we have a first key takeaway, here:
  - The closer firms are, the tougher price competition is.







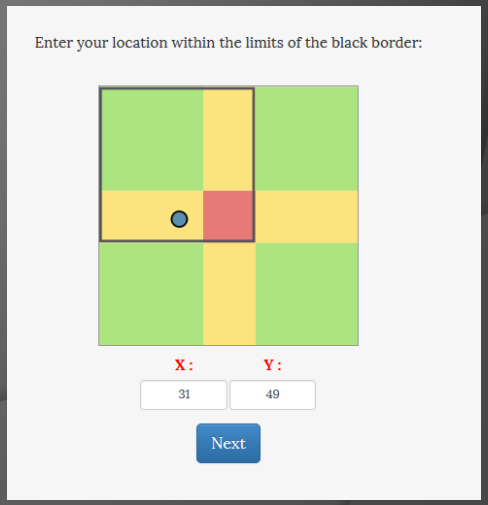
- Already on the public site
- Possible to run 4 human players games
- Admin interface

# The Full Game (still in beta test)

# Location choices

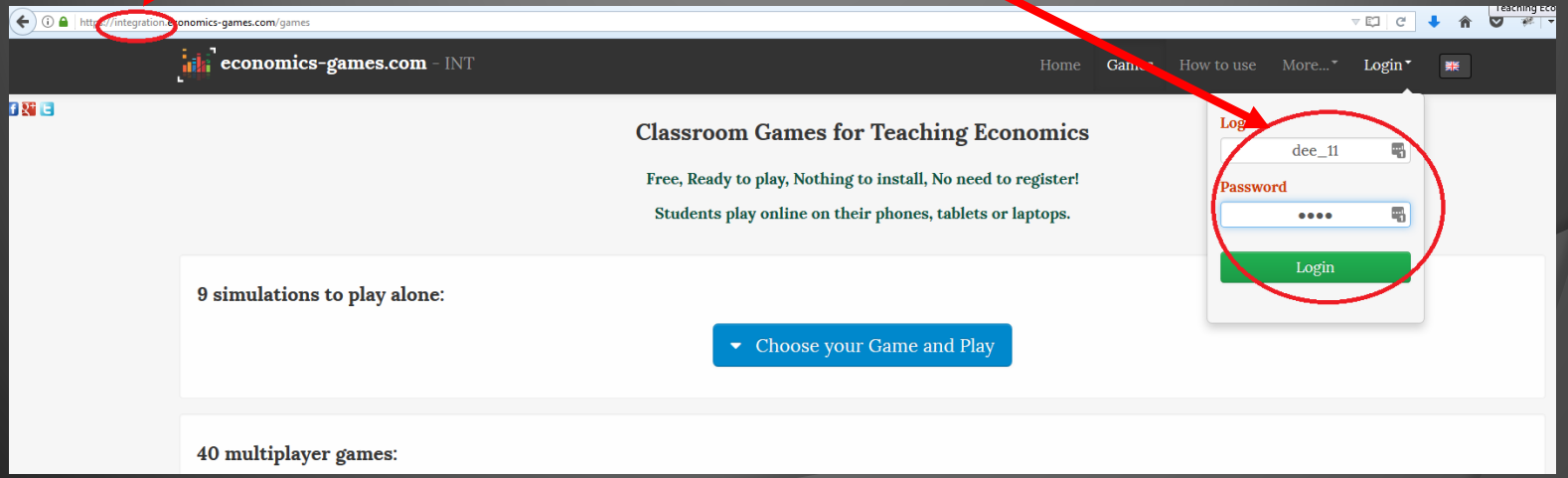
1. Location choice phase
2. Price setting phase

- allowing everyone to locate anywhere would result in a bad « random / strategy balance » → restricted areas in round 1.
- Then it will be possible to move at round 2, but at a cost.



# Run the games

- Multiplayer game (on our beta test site)
  - Go to the url simu.io (shortcut that will redirect you)
  - Add « integration » at the start of the address in the address bar (→ integration.economics-games.com/games)
  - Enter login dee_# , replacing # with the number I gave you on the « post-it » and using password « pass »



# Round 3

- There is a way to increase the number of potential customers at the center of the country by improving some transport infrastructure.
- Considering that you would be the first to benefit from it, the public authorities would like you to fund the project and asks you to make funding offers:
- If the sum of your contributions exceeds $ 1000, the project is a success:
  - Each of you pays an amount equal to his offer and an additional 100 consumers (1/10 of all current customers) are added on a 10x10 square at the center of the map.
- Otherwise, the project is rejected and noone pays anything.

# Public Good – Public Bad Trap

- Looks like a public good, and is not very expensive, so in some cases, the improvement should be funded
- But in fact , this is often a public bad (from the point of view of the firms) since by improving the benefit from being close to the center, it induces closer locations… and eventually a tougher price competition, that may offset the increase in the number of customers.

# Comments: What do players maximize?

- Usually, they maximize their ranking
  - → When harming direct competitors allows to improve ranking, you usually observe extremely agressive behavior.
  - Need to adapt the experiment to restore incentives:
    - Players should not all interact in the same pool.

# Conclusion

- Key takeaway: trade-off between positioning for more market share and the intensity of price competition (more important when players locate close to one another)
- Irmen and Thisse 1998:
  - In their setting: Maximum differentiation in one of the dimensions, minimum differentiation in the other
- What would you do to improve the game?

# Incoming IO (free) tournament

- Based on another game, an IO model of Bertrand differentiated competition.
- Challenging but no need for students to know any economics (no need to closely monitor the students).
- 2 weeks (one week preselection, one week final).
- I will try to run this in october or november.
- If you want to be informed, leave me your email address or send me an email, at nicolas@lud.io