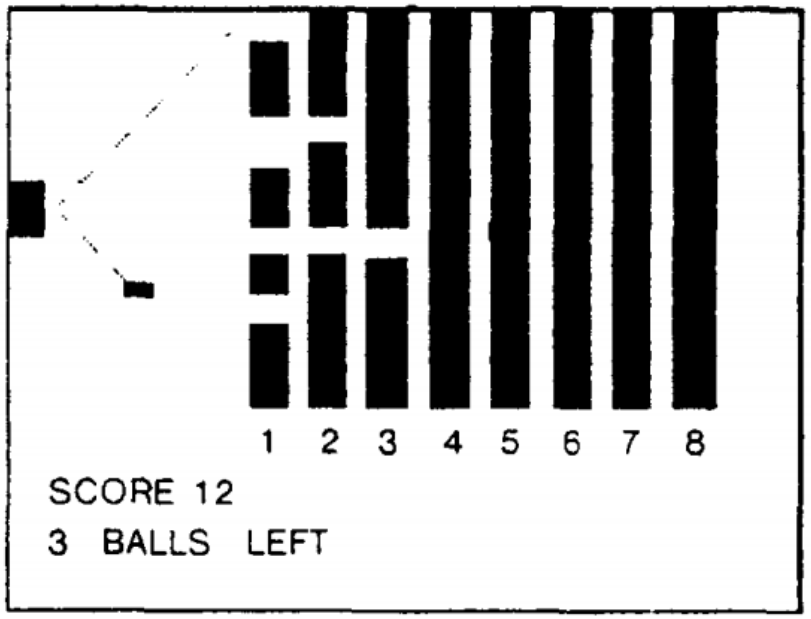
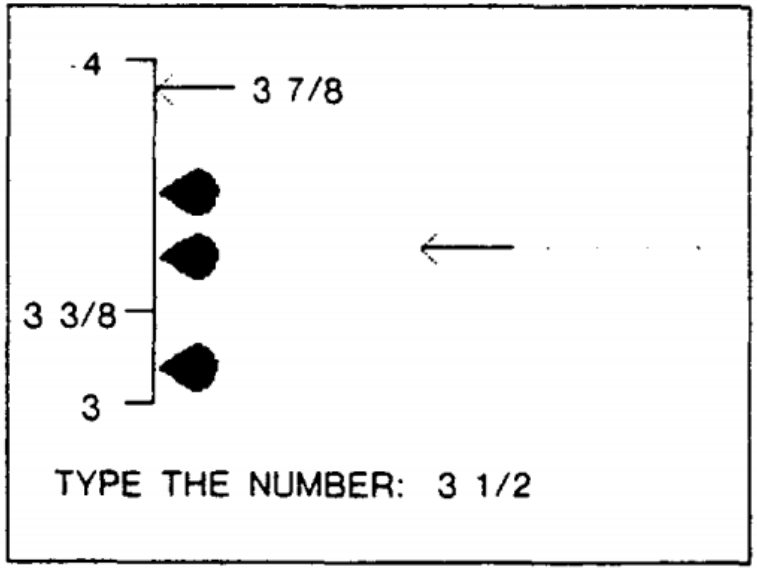
Difficulty

Why focus on difficulty ?

Challenge is one of the core aspect of fun in video games

Thomas Malone [80-82]



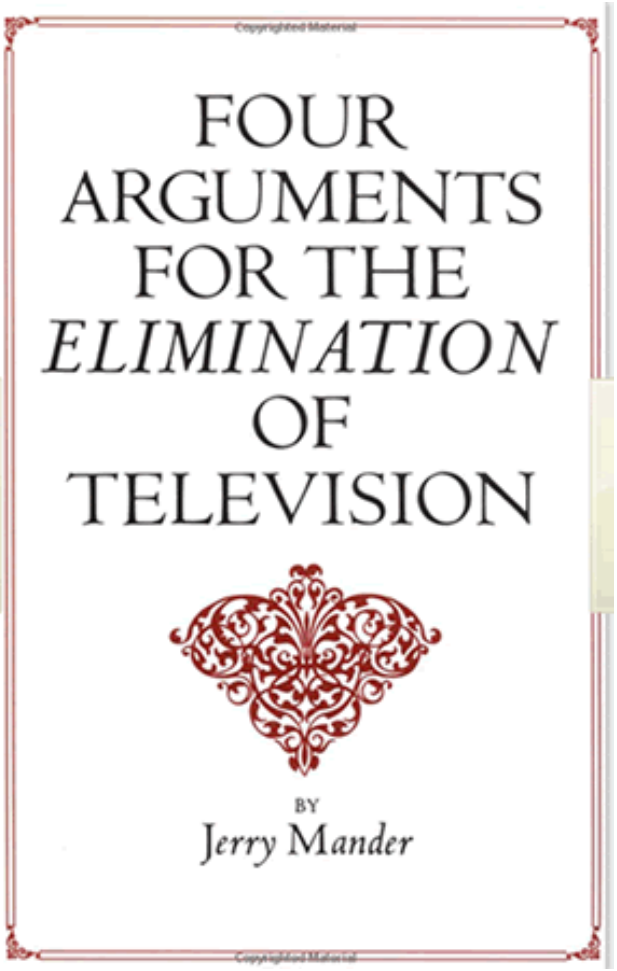


Challenge


Curiosity

Cognitive Curiosity

Sensitive Curiosity




Fantasy

NATIONAL BESTSELLER

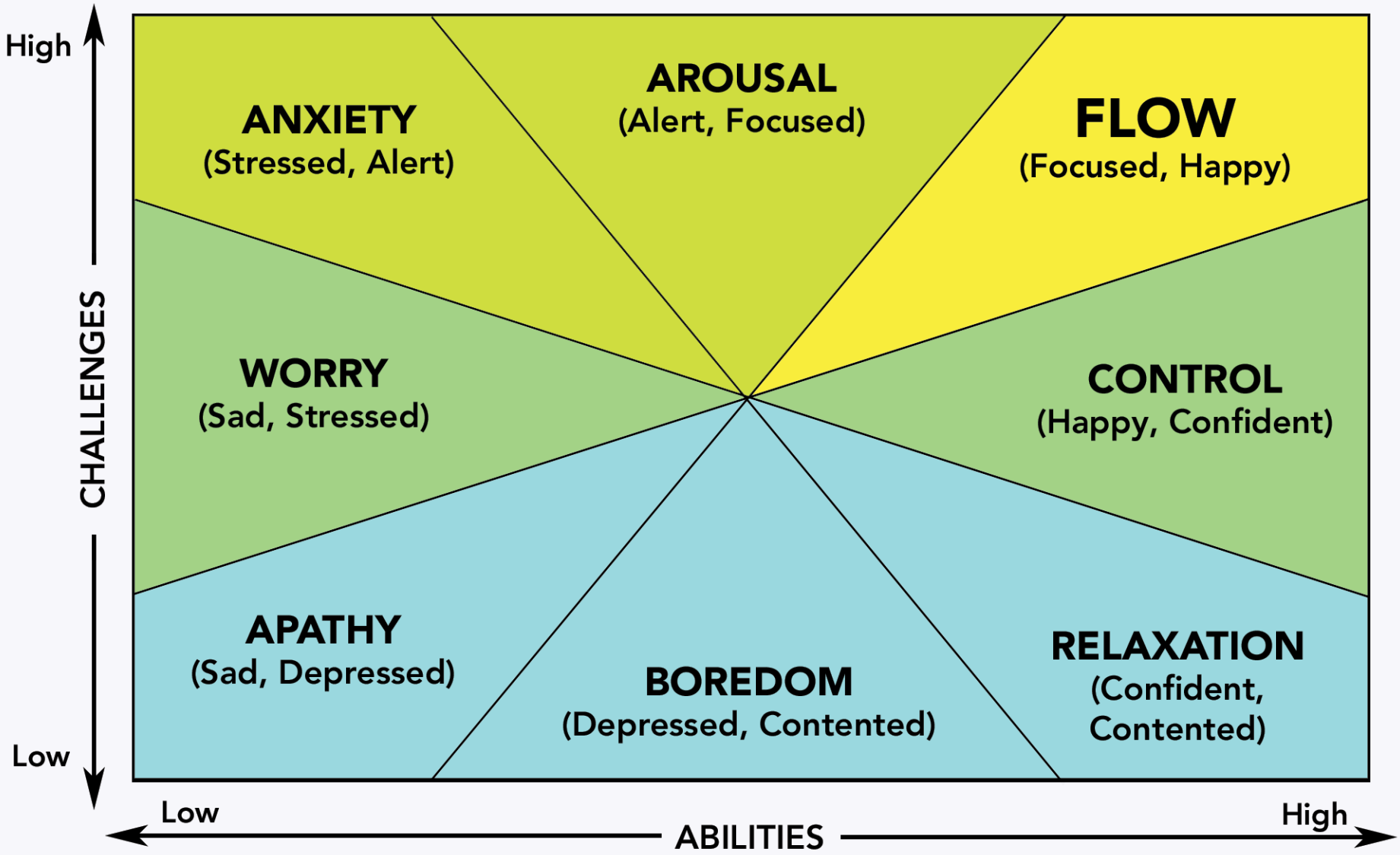
FLOW

THE PSYCHOLOGY OF OPTIMAL EXPERIENCE

STEPS TOWARD ENHANCING THE QUALITY OF LIFE

MIHALY CSIKSZENTMIHALYI

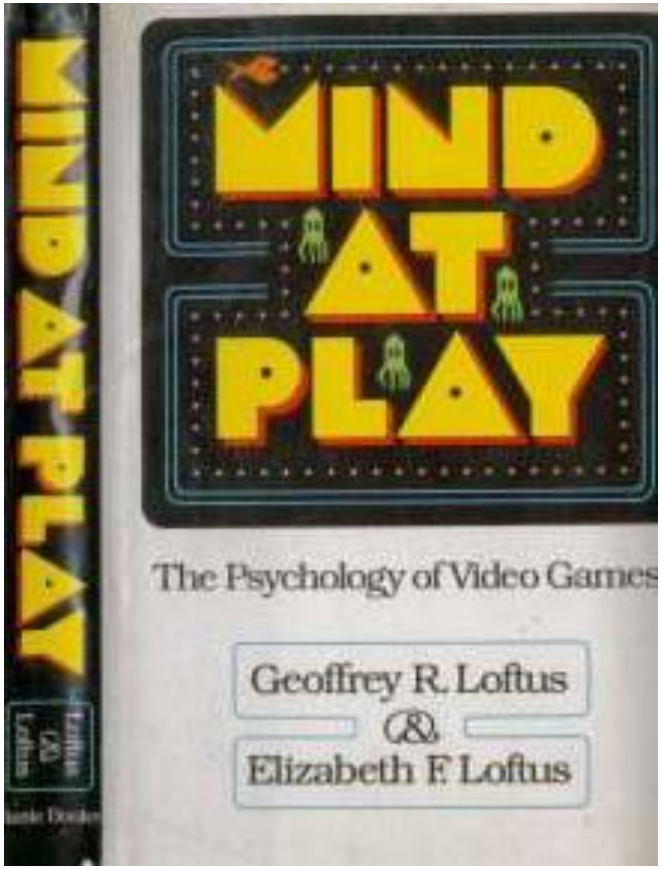
"*Flow* couldn't come at a better time for us. An inspiring, worthwhile read."
—*Chicago Sun-Times*

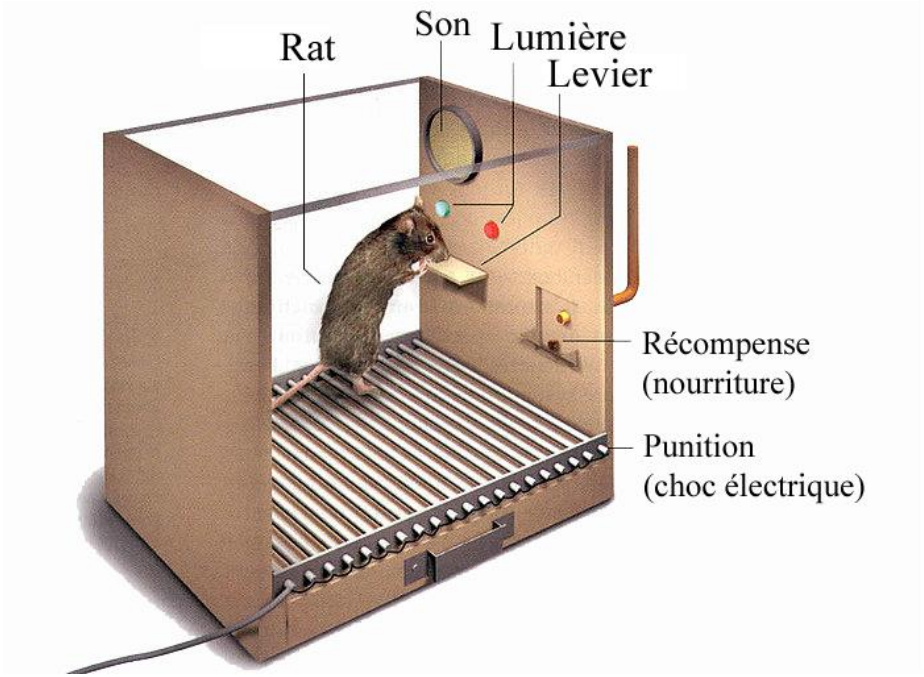


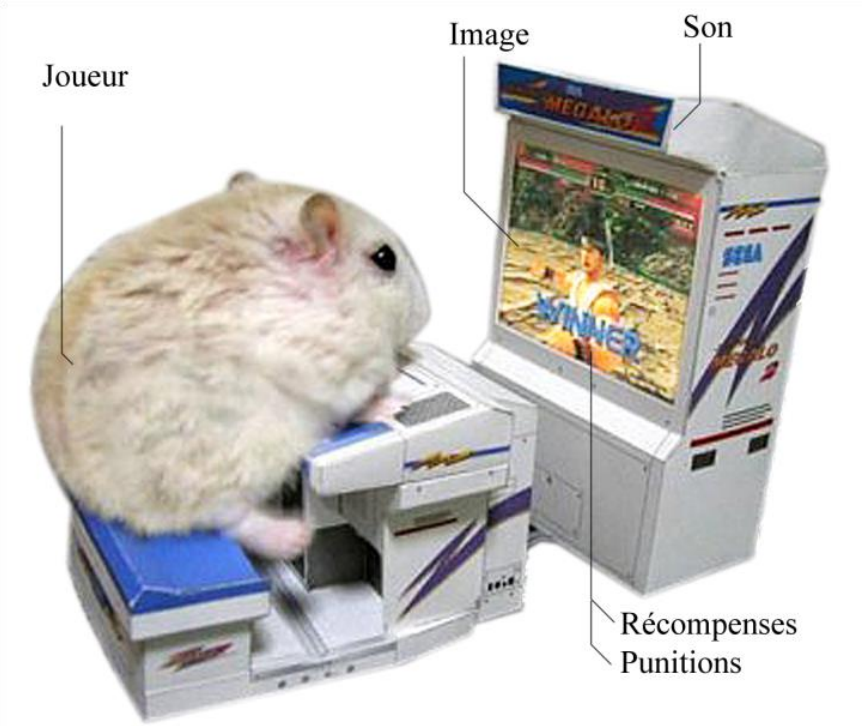
Mihály Csíkszentmihályi's model of flow as related to challenge and ability.

Autotelic activities

Loftus et al [83]

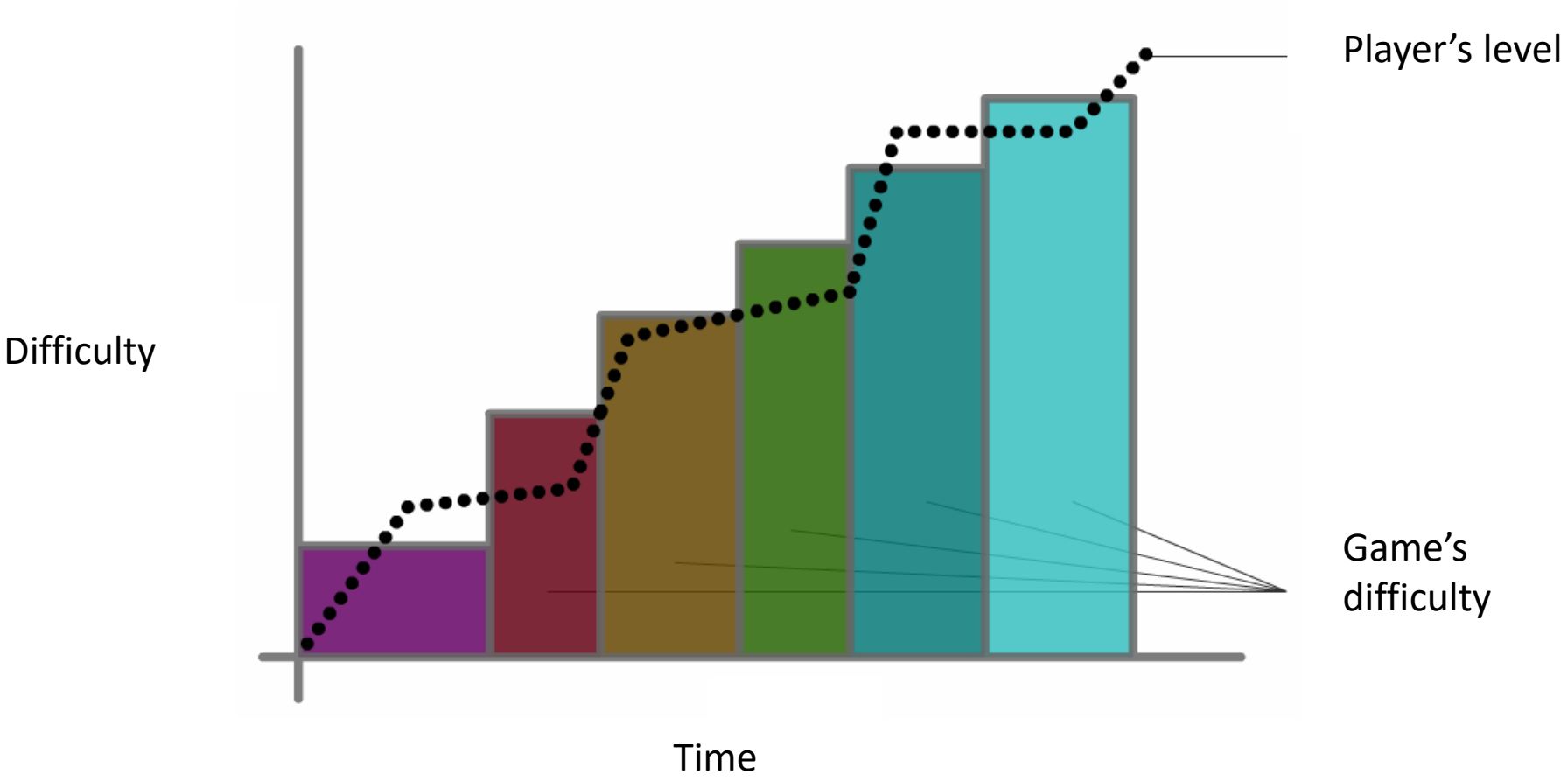






Partial reinforcement
(you never know when you're going to win)

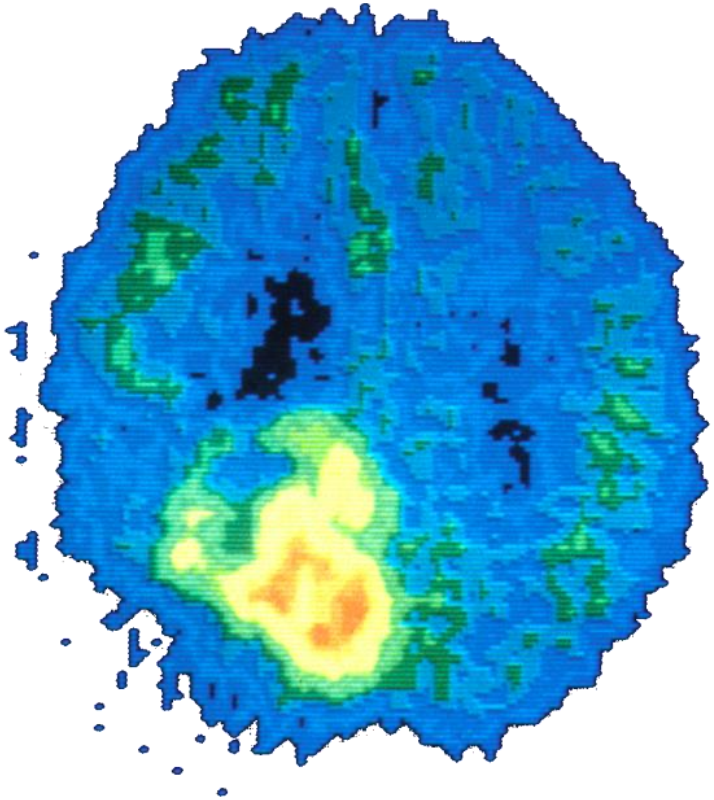
Difficulty curve



Definition

- **Difficulty of a game**: « Evaluation of the player's **effort** needed to attain the **goals** provided by the game » (gl)

We cannot measure it



Neither cheap nor convenient

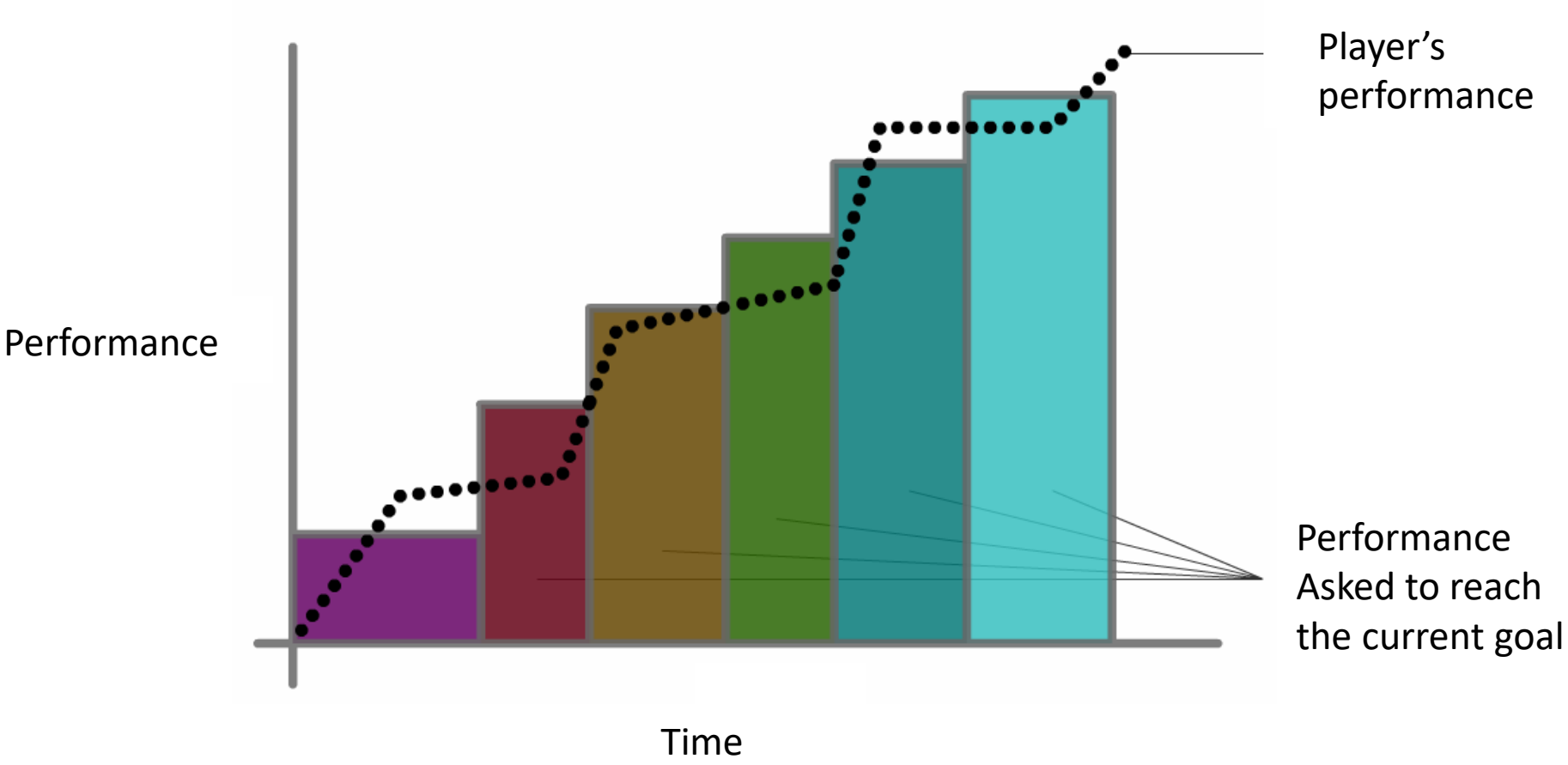
Definition's Implications

- We need to define these **goals**
- Difficulty is a function of both **goal and player**, it depends on their level.
  - A game's difficulty means nothing (or we think a bout a generic player)
- Player's level is **changing** :
  - difficulty changes over time for a specific player
- We cannot directly evaluate effort . We will use a **variable related** to this effort, and thus make assumptions.

Performance

- Let's use **player's performance**
- It's linked to the **amount of effort** they are putting in the game.
- It's also very often **part of the design** (we already evaluate it in one way or another)

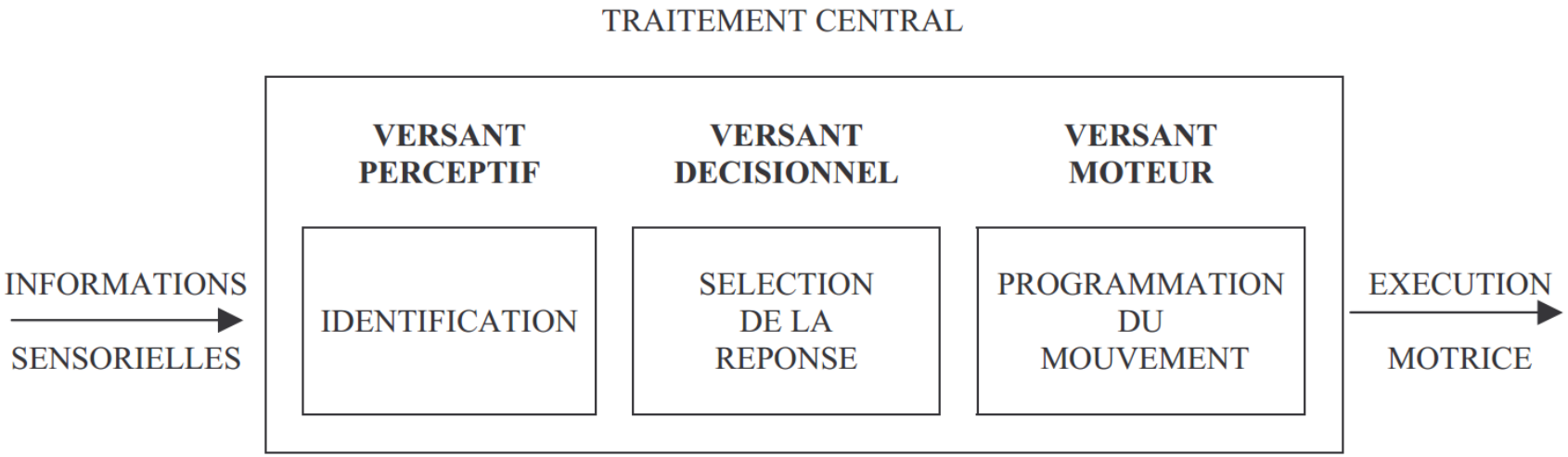
Difficulty curve



Types of difficulty

Perceptive / Logical / Motor

Three phases of information processing



Temprado 93 (EPS)

Perceptive difficulty

Indiana Jones et le secret de l'Atlantis

Perceptive difficulty

- Definition:
  - Player's **effort** to find **new** and **relevant information** about the game's state.
  - **New** information is both something they do not **know**, and something they **cannot deduce** from what they already know.

Perceptive difficulty

Aces of the galaxy

Perceptive difficulty

- Metrics:
  - Screen readeability:
    - Amount of occluding / distracting objects
    - Light / contrast…
  - Mean distance between player and useful objects
    - In number of actions/playtime

Logical difficulty

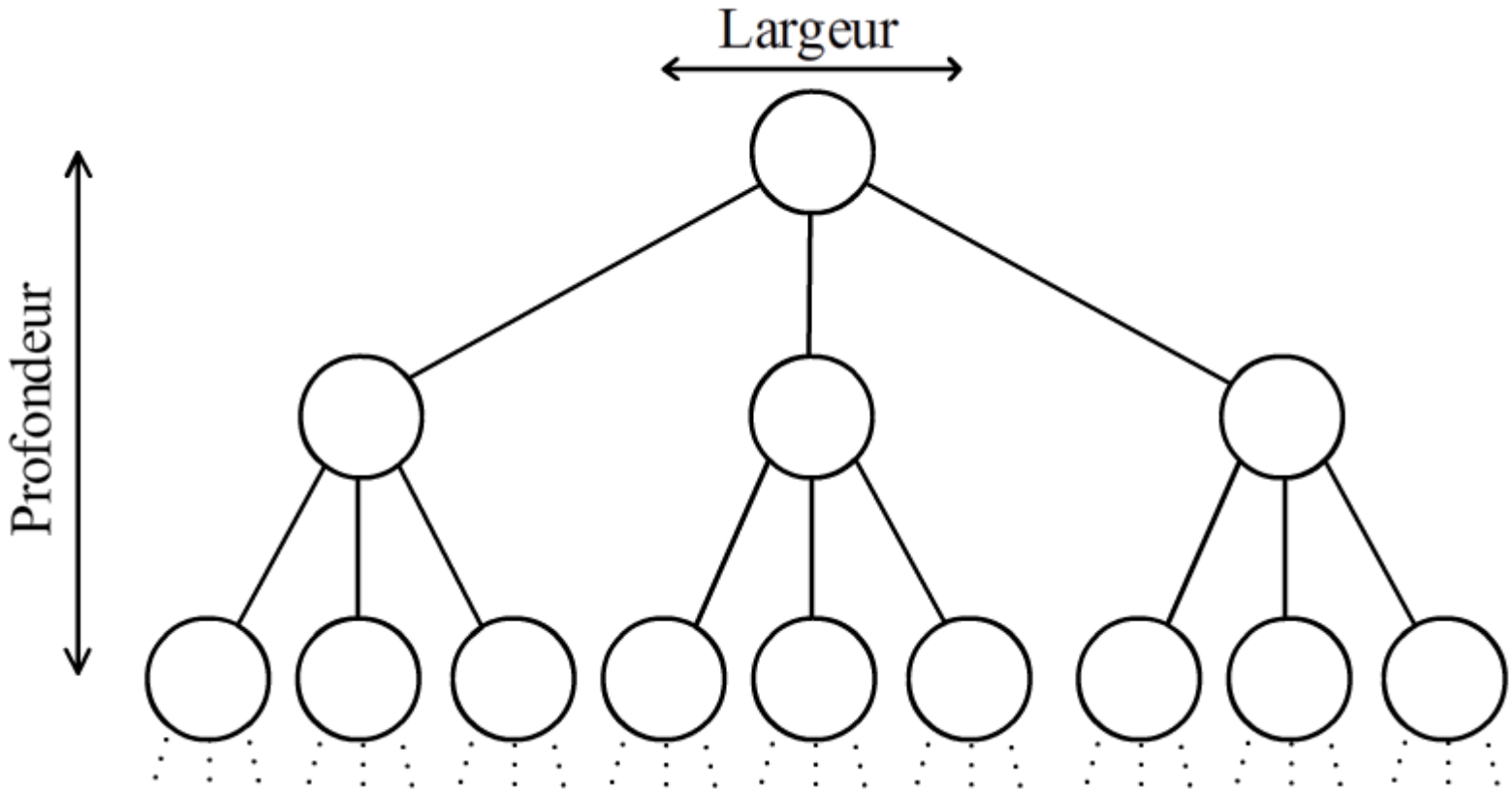
Heroes of Might and Magic

Logical difficulty

- Definition:
  - **Player's effort to use the information they already have.**
    - **Understand the game's behavior by induction**
    - **Select the next move by deduction**

Logical difficulty

- Deduction metric



Motor Difficulty

Doom

Motor difficulty

- Definition:
  - **Spatial** and **temporal** accuracy needed to perform an action.
  - Metrics are then realted to temporal and spatial accuracy

Summary

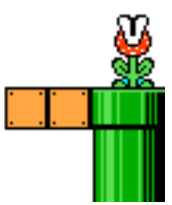
- Perceptive:
  - Explorer the game's world to find new relevant information.
- Logical:
  - Heuristics induction, facts and actions deduction.
- Motor:
  - Spatio-temporal constraints on execution

Measuring difficulty

Bananas and health points

How can we measure difficulty?

- Create a heuristic

Nb( ) + PV() + H() =

Shortcomings

- Not generic: units are related to a specific gameplay
- Complex Meaning: hard to interpret, may be biased

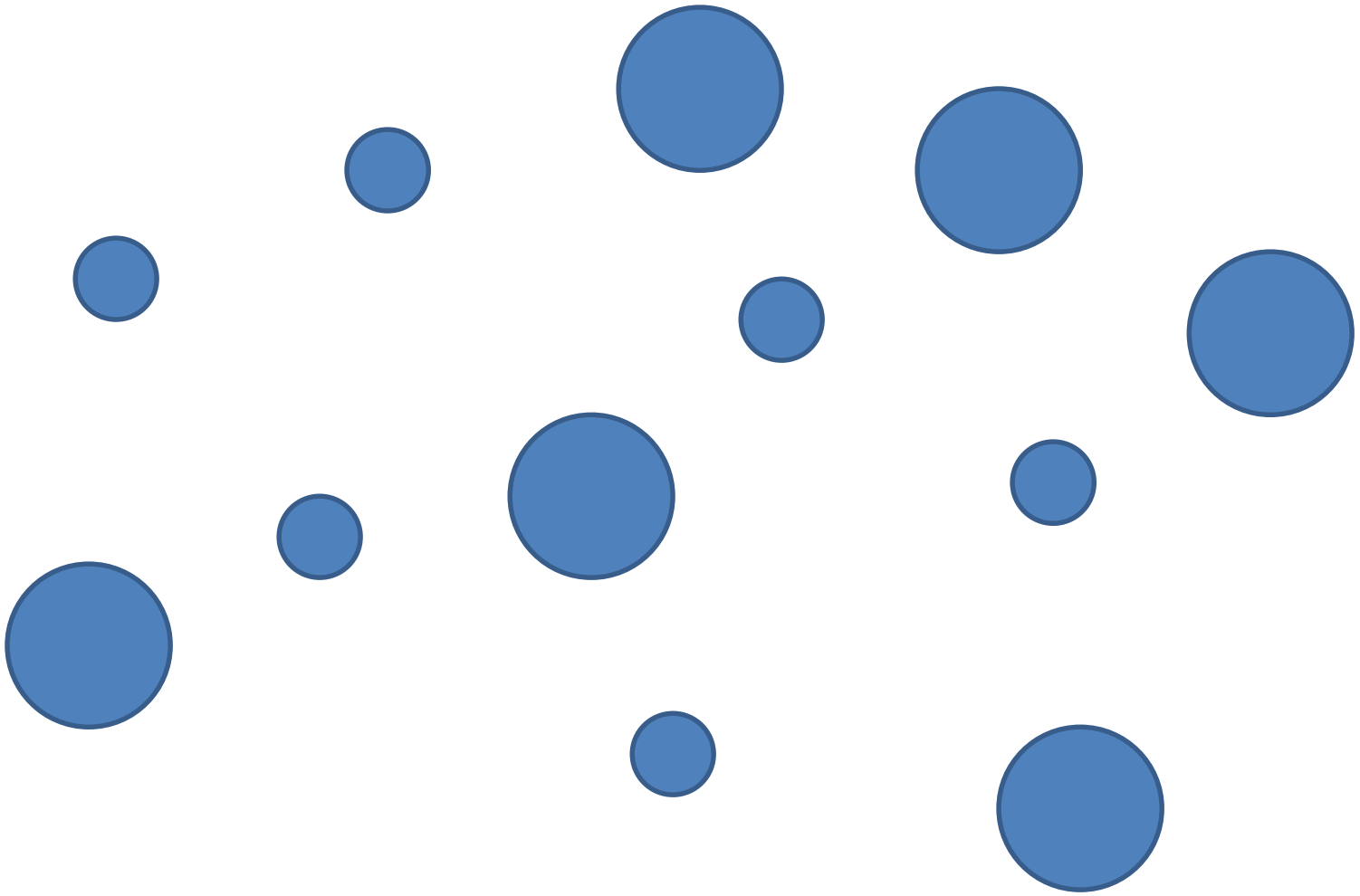
Proposed Measure

Challenges & Skills

Use the probability to lose

- It is **generic :**
  - We can make comparison between games. Only need to find binary goals.
- Simple **meaning :**
  - 0.5 chances to lose actually means something.

Step 1: split the game into challenges



Step 1: split the game into challenges

- Clear goal, with binary outcome
- No parallel goals: make a new one if it happens
  - Challenge A
  - Challenge B
  - Challenge (A & B)
- Find some parameter for this goal
- Make it as simple as possible: the more complex the model is, the more data you'll need to train it.

Example : a shooter

- Kill a specific group of enemies
  - Find the best way to abstract a group of enemies
  - That's when we still use heuristics and design intuitions
  - E.g. 1: number of enemies?
  - E.g. 2: number of snipers, number of melee?
  - E.g. 3: total of hit points divided by current's gun damage per second ?

Example : a shooter

- Keep moving
  - Do not stay still for x seconds

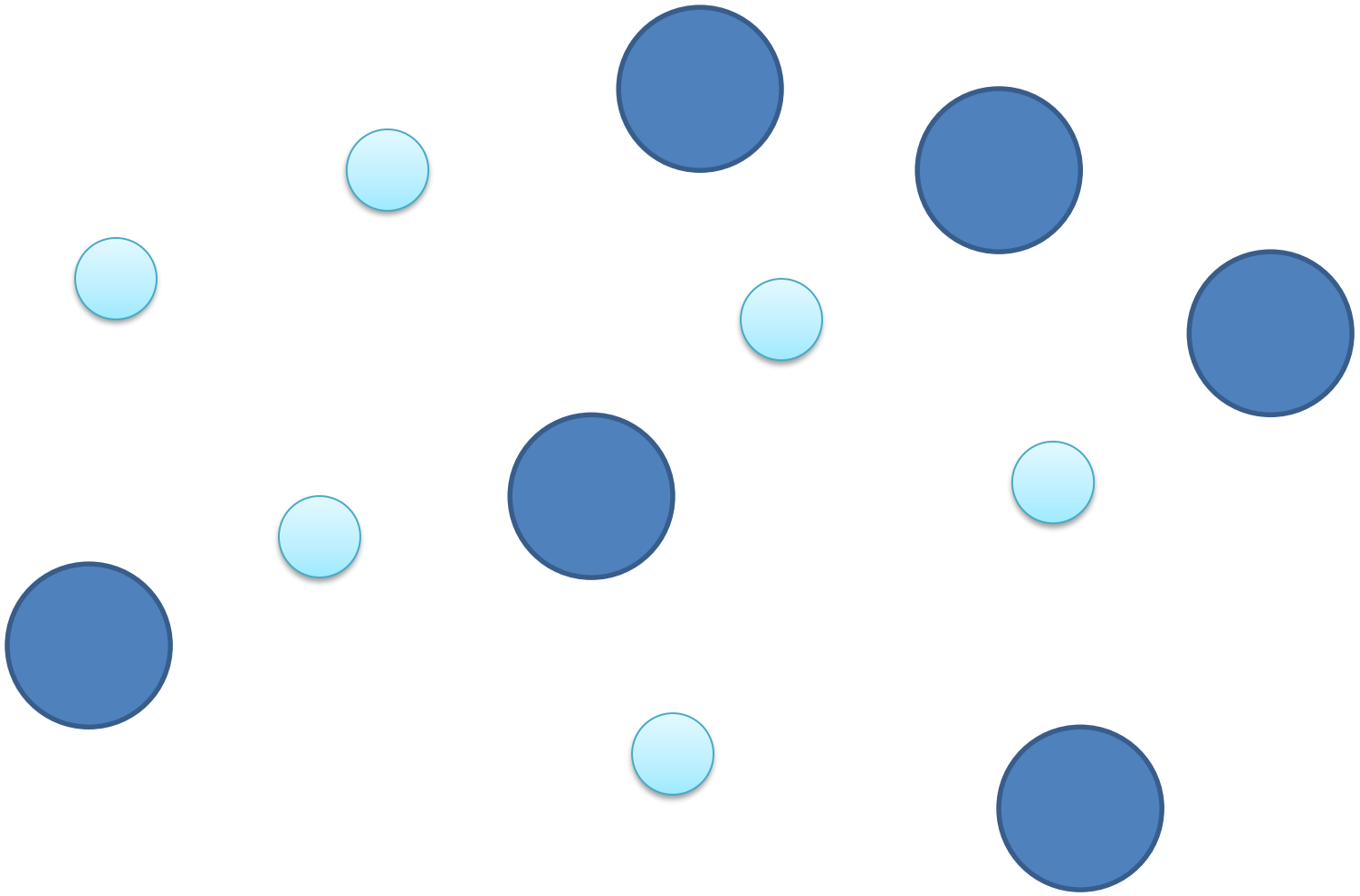
Example : a shooter

- Make a good shot
  - Shoot and hit (hit = win, not hit = fail)

Example : a shooter

- Defeat boss #3
  - You kill it : win
  - You die : fail

Step 2 : Find the core challenges



Core and other challenges

- Some challenges will be :
  - Generic
  - Short in time
  - These are the core challenges:
    - We have win / fail events very often for one player
    - We can evaluate p(lose) waiting for too long, and thus with the assumption that the player's level is somehow constant
    - They are spread all over the game

Core and other challenges

- Others will be :
  - Specific
  - Long in time
  - We cannot easily evaluate the probability to lose
    - We cannot wait for the player to try and kill 10 times the boss

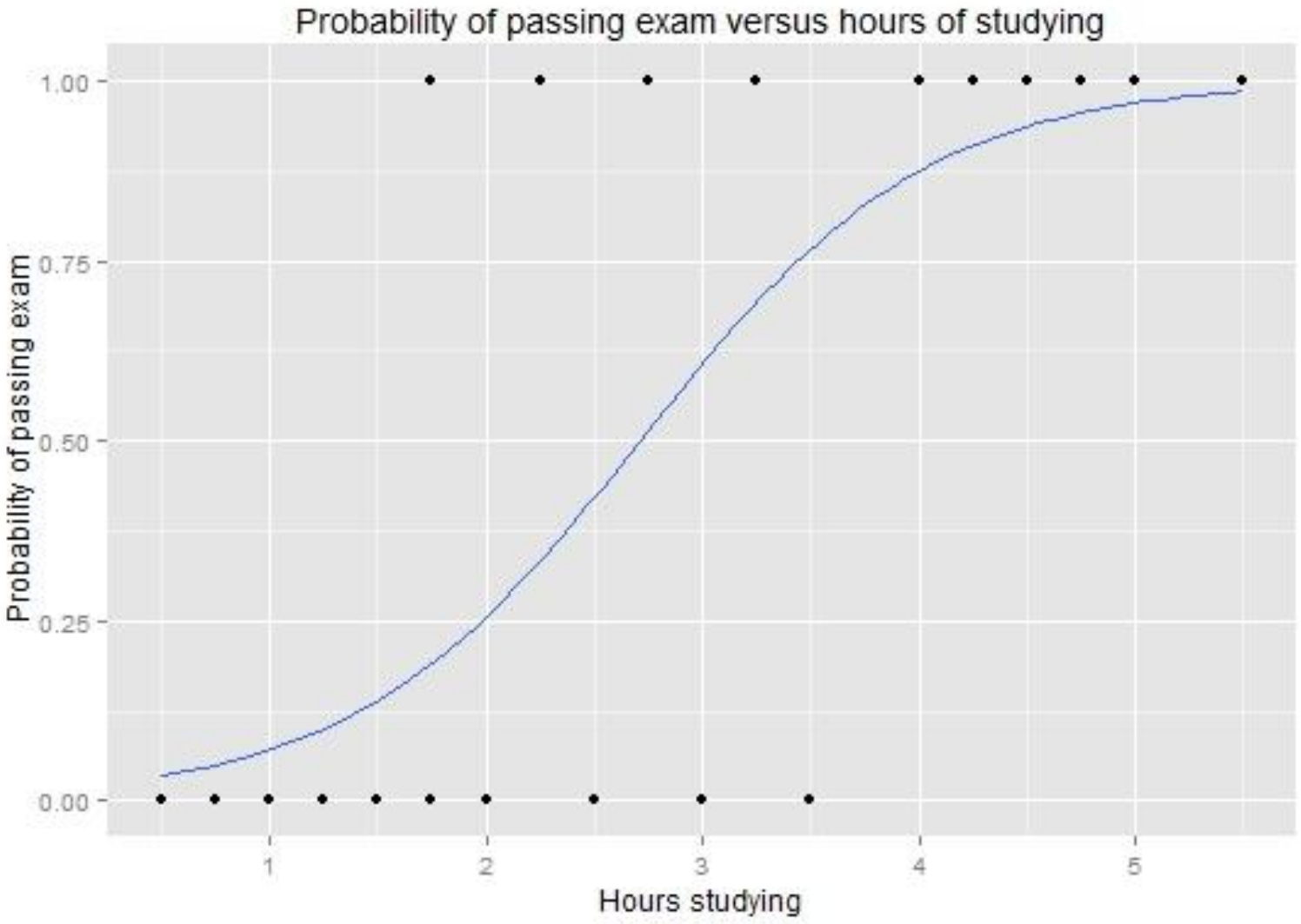
Evaluating core challenges

- Detect when it starts (player shoots)
- Log player result (shot missed)
- Compute average of last nth results and you have an evaluation of p(lose), and thus player's level for this skill

For other challenges

- We need the data of all the players
- We can use core challenges to group players with similar skills
  - Then, within each group, we can comptute the challenge's difficulty
  - Or we can use a logisitc regression to find p(lose | skills)

Logistic regression



What if my challenge is neither « core », nore « one shot »

- You make a procedural game
- You instantiate a challenge multiple times
- Your challenge is parametric
  - You have the data of only one player (game is not online) :
    - logistic regression to compute p(lose | param)
    - You need to keep param as small as possible
    - You need to explore first using another algorithm to adapt difficulty
  - You have all players data :
    - Use core challenges and all data to compute p(lose | params, skills)
    - Can be logisitc regression as well as many other models…