Game Analysis and Research
(a.k.a The Science of Game Design)

Prof. Perttu Hämäläinen 2021

Course contents

- Day 1: Game design and research intro
- Day 2: Game design math, balancing, analytics
- Day 3: Psychology of game design: Behavioral game design, behavioral economics, monetization, free-to-play
- Day 4: Psychology of game design: Intrinsic motivation, emotion
- Day 5: Understanding the human body: Motor learning and performance for action game design, movement-based games

Lecture slides, code & spreadsheets:
https://github.com/PerttuHamalainen/GameAnalysis

Passing the course

- Participate at least 80% of the time
- Final assignment: learning diary, essay, Colab game analysis exercise, or a research game prototype. More instructions in the final_assignment_instructions.pdf in Github

Contents (today)

- Why research & theory?
- Game definitions
- Game analysis and design frameworks

Why research and theory?

Science of game design?

- Core problem: How can we elicit desired player behavior and experience?
- Example: player stays motivated and completes the game, and has a strong emotional experience that they reflect and discuss with their friends.
- We can only indirectly affect the behavior and experience, through the game's design
- Behavior and experience are hard to predict => slow and iterative trial-and-error design process.
- Research, books and papers can help us **ask the right questions**, and also **make predictions** such as if you do A, players are likely to do and experience B

Sources

Books

Second Edition

The Art of Game Design

A Book of Lenses

Books

Books

Books

Books

Papers & talks

- Course slides include paper names and authors

- High-quality conferences and journals: CHI PLAY, CHI, UIST, SIGGRAPH, PACM HCI, ACM Transactions on Graphics

- Also good: DIS, FDG, Digra, IEEE CoG/CiG

- GDC talks can be good, but they are not peer-reviewed before presenting

Main types of research

- Confirmatory
  - Answers research questions through testing and confirming research hypotheses
  - Example hypothesis: New drug makes patients recover faster
  - Example hypothesis: Novel user interface decreases task completion time
  - Example hypothesis: Novel game mechanic increases enjoyment
  - Needs enough data for reliable statistical analysis
- Exploratory: What interesting hypotheses or questions might there be? Often precedes confirmatory research, e.g., exploratory in-depth interviews with a small sample of participants followed by confirmatory questionnaire study with a large sample
- Descriptive: How do people experience or play games? What processes do game developers and designers use?
- Technical / constructive / problem solving: Inventing solutions to problems. Usually combined with confirmatory or at least exploratory investigation of whether and how the solution works

What CHI PLAY conference is looking for

- Design theory
- How players experience games
- How to predict player behavior, e.g., retention
- How people talk and write about games
- How and why people spectate games (eSports research)
- Design guidelines and heuristics
- Novel game testing methods
- Innovative game design case studies
- Novel technologies
- Novel game mechanics
- Computational intelligence in games
- Games for X (serious games)
- Gamification / persuasive tech

INTERACTIONS

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DIGITAL EDITION: To appreciate the special editorial and graphical connections in the November-December issue, the editors-in-chief and contributors recommend viewing the content via *Interactions'* Digital Edition on a full-size screen in "Page View."

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FEATURES

XXIII.3 May + June 2016
Page: 38
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RESEARCH CONTRIBUTIONS IN HUMAN-COMPUTER INTERACTION

Authors:

Jacob Wobbrock, Julie Kientz

All scholarly fields strive to contribute new knowledge. In the field of human-computer interaction (HCI), this new knowledge increasingly comes in rich forms like videos and demos, but the archival research paper remains the most widely used and accepted capture and delivery mechanism for research knowledge. The knowledge contribution made by a research paper—or more precisely, made by the work a research paper describes—is any research paper's central feature. For example, a theoretical physics paper may contribute a new mathematical model for the behavior of light near black holes. A civil engineering paper may contribute a new method for…

https://courses.cs.washington.edu/courses/cse510/16wi/readings/wobbrock_7contributions_submitted.pdf

Exercise: Identify the contribution types of these papers by Aalto games faculty

Kajastila, Raine, Leo Holsti, and Perttu Hämäläinen. "The augmented climbing wall: High-exertion proximity interaction on a wall-sized interactive surface." *Proceedings of the 2016 CHI conference on human factors in computing systems*. 2016.

Evin, Inan, et al. "3pp-r: Enabling natural movement in 3rd person virtual reality." *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*. 2020.

Bopp, Julia Ayumi, Elisa D. Mekler, and Klaus Opwis. "Negative emotion, positive experience? Emotionally moving moments in digital games." *Proceedings of the 2016 CHI conference on human factors in computing systems*. 2016.

Daneels, Rowan, et al. "The 'eudaimonic experience': A scoping review of the concept in digital games research." *Media and Communication* 9.2 (2021): 178-190.

Two types of thinking

SYSTEM 2: EXPLICIT/CONSCIOUS: SLOW, ALGORITHMIC, EFFORTFUL
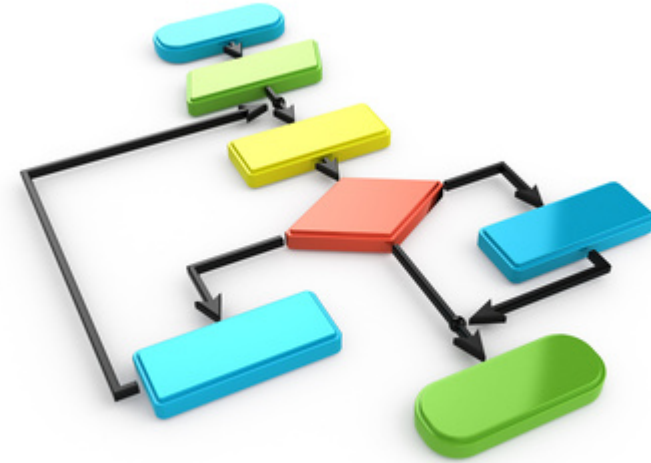
ATTENTION, PRIMING, INHIBITION

IDEAS, ASSOCIATIONS, IMPULSES (AUTOMATION)

SYSTEM 1: IMPLICIT/UNCONSCIOUS: FAST, ASSOCIATIVE, EFFORTLESS, INTUITIVE
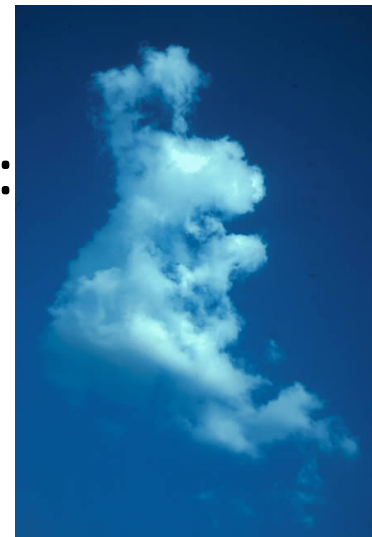
ASSOCIATION
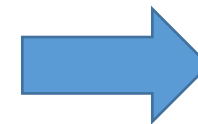
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Generating ideas: Asking the right questions

System 1   System 2
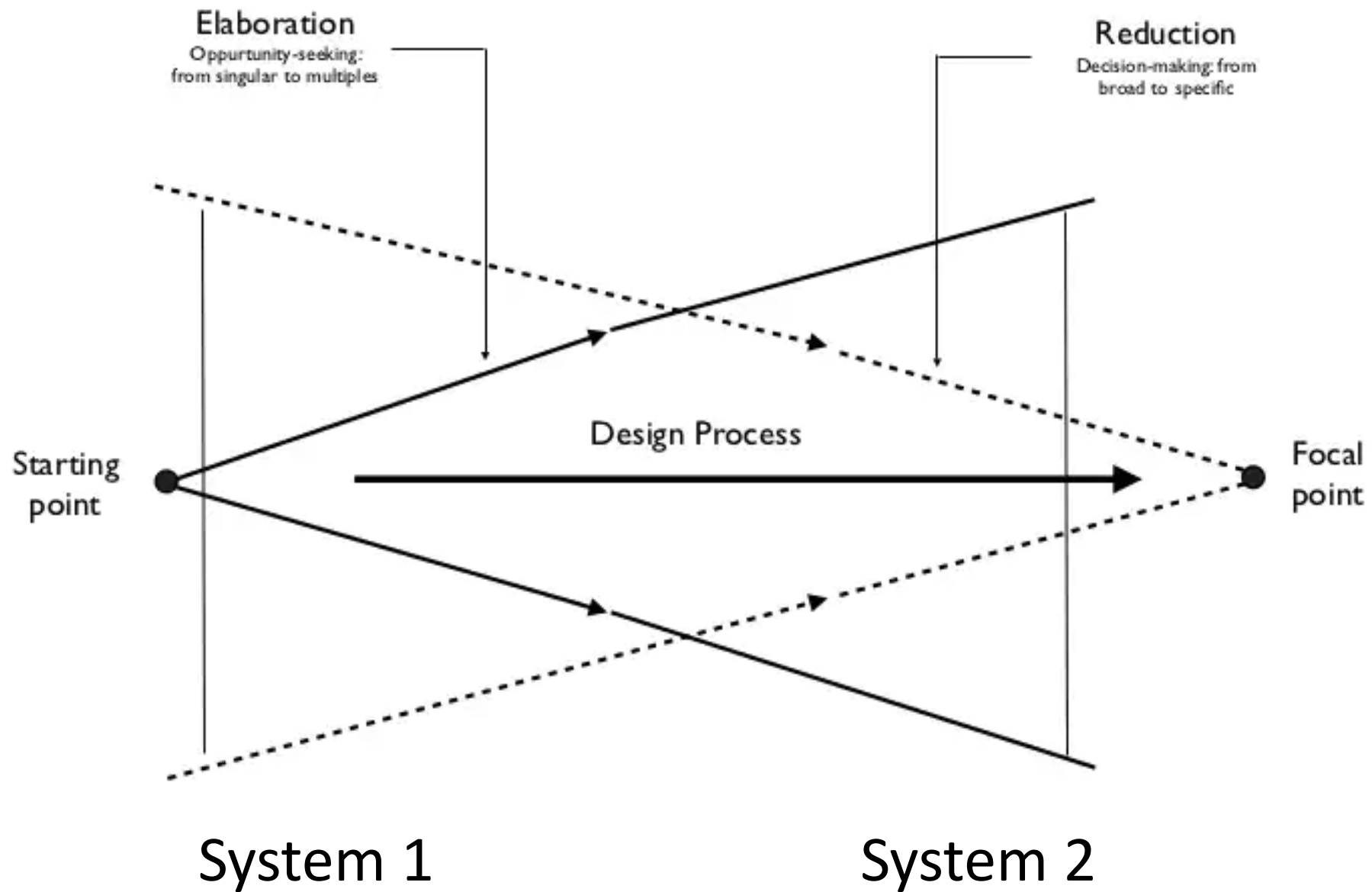
Example: connect the dots with four connected straight lines
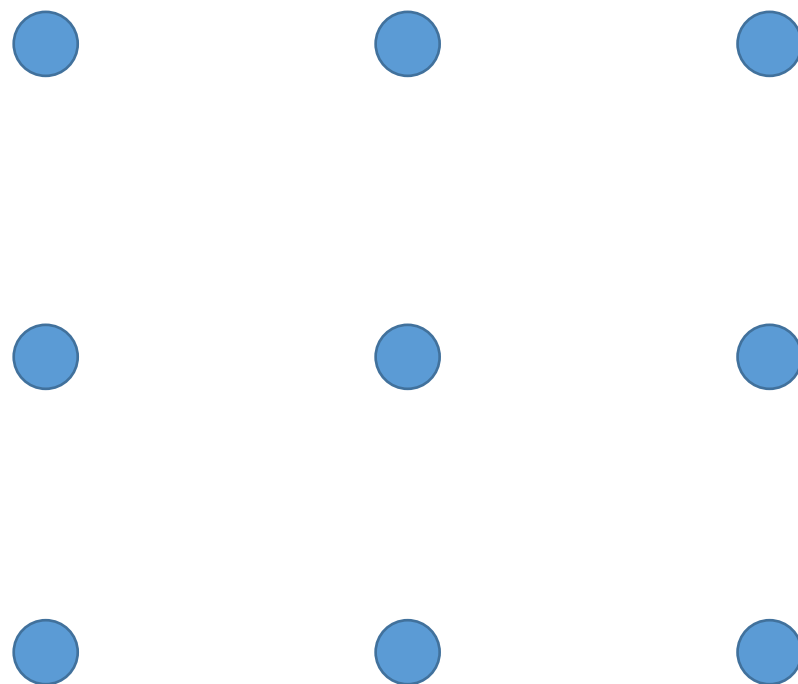
Can you think **outside the box**?
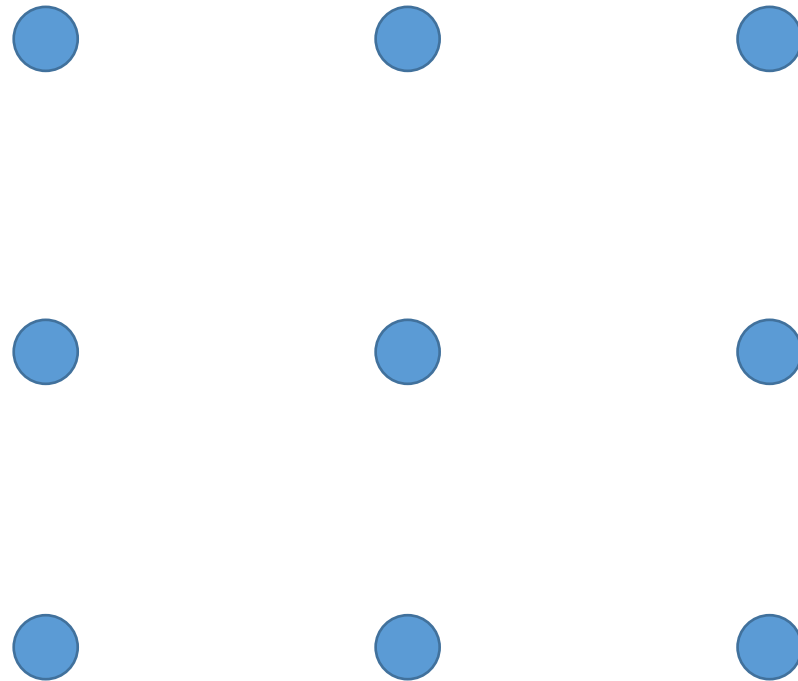
Can you think **outside the box**?
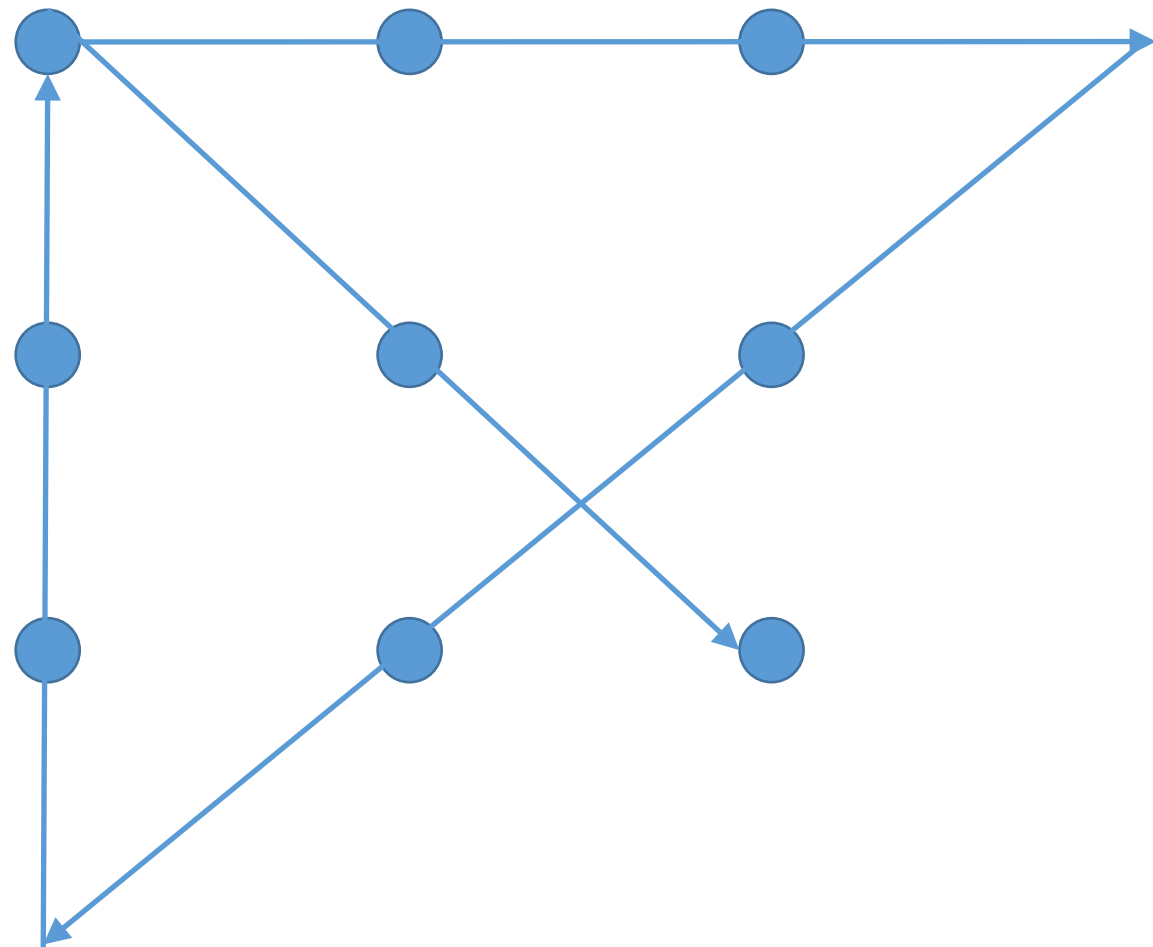
Criticizing and pruning ideas

Game design as tree search
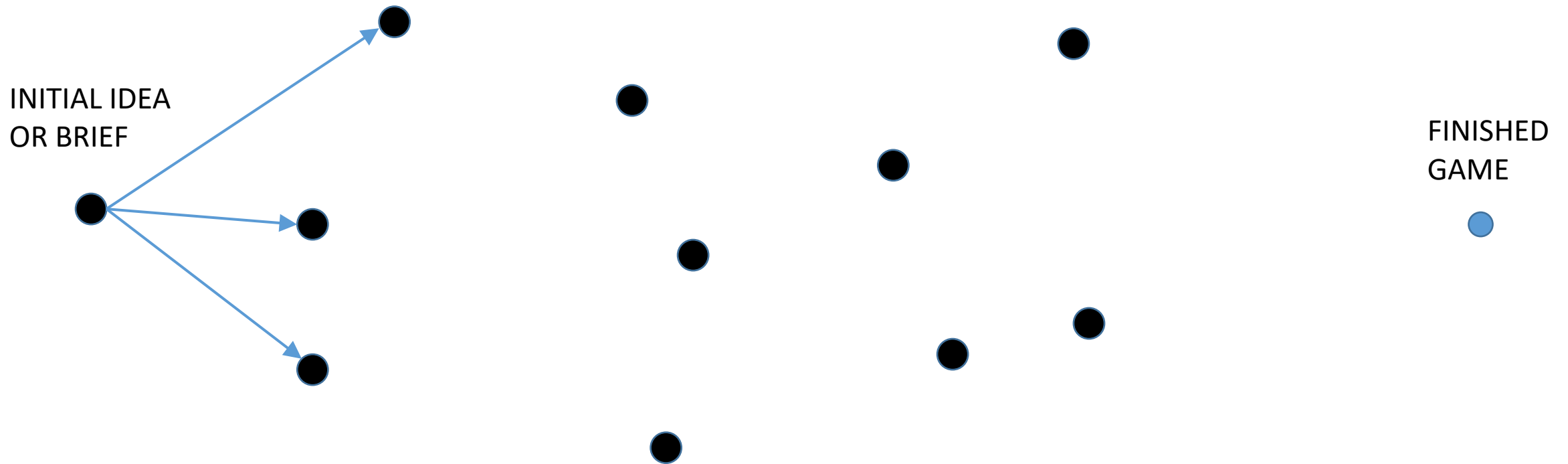
Game design as tree search
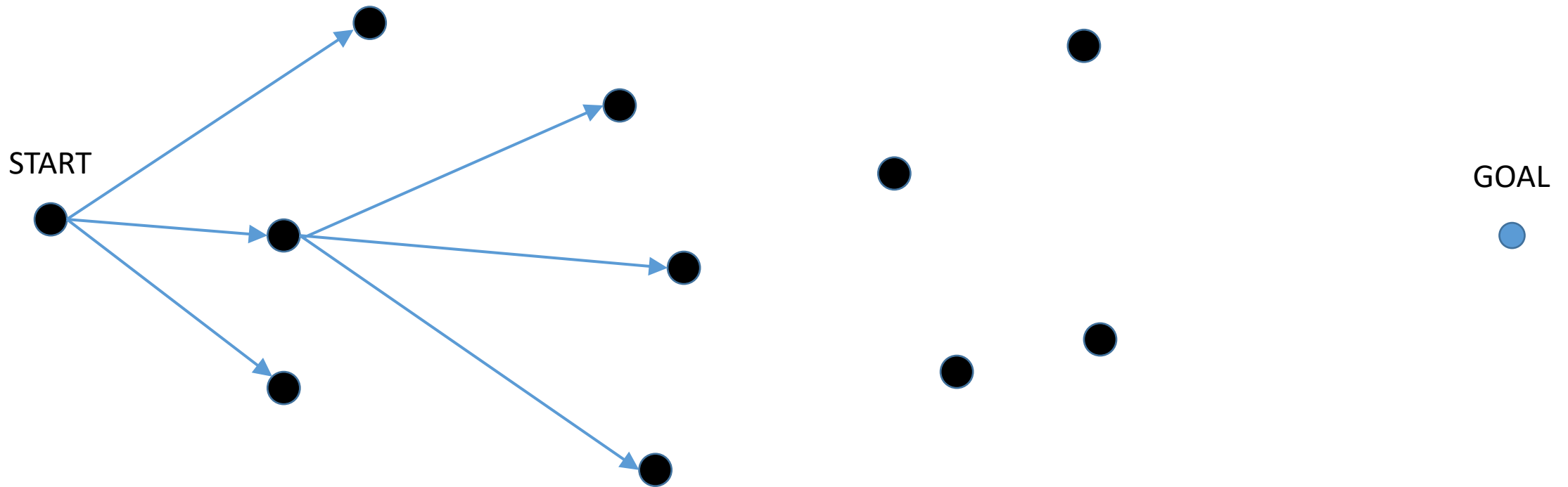
Game design as tree search
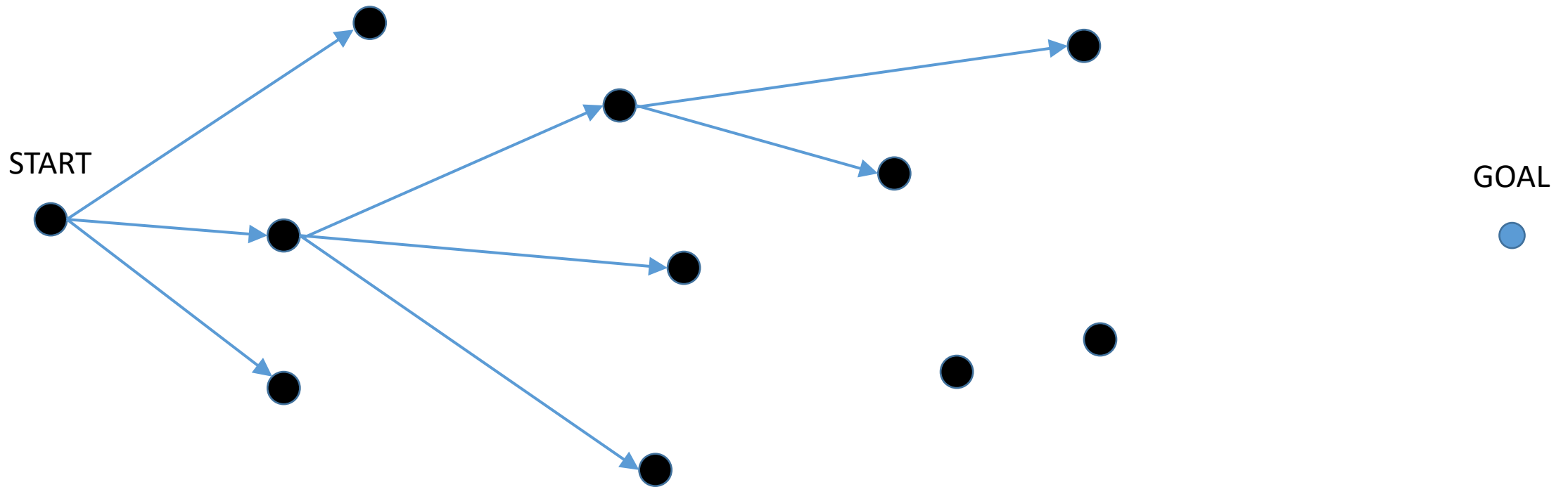
Game design as tree search
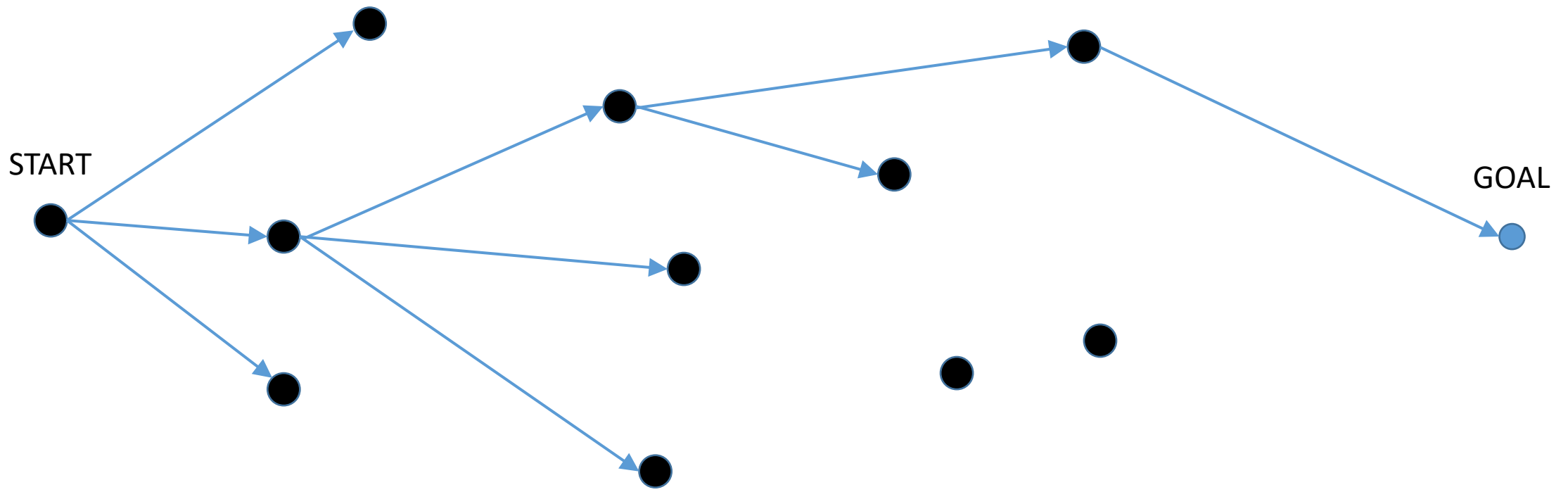
"We're agile and iterative"

"We really don't know shit, it's just trial and error"

Tree search efficiency

- Time spent in implementing and evaluating a branch – Using agile tools and methods that speed up the feedback cycle
- Search depth – Scoping the game.
- Confidence in making decisions and selecting what alternatives to evaluate – Research of what works and what does not

Science of game design: Of the myriad conscious and unconscious design decisions needed in creating a game, which ones can be informed by research and/or theory, and where does design intuition and agile iteration still provide the best results?

Game definitions

Costikyan 2002

"Interactive structure of endogenous meaning that requires players to struggle toward a goal"

Caillois 1961

"An activity which is essentially:

- Free (voluntary)

- Separate (in time and space)

- Uncertain

- Unproductive (as opposed to work)

- Governed by rules (different that ordinary laws)

- Make-believe (accompanied by an awareness of a second reality)

Schell

"A problem-solving activity approached with a playful attitude"

Suits 1978

"The voluntary attempt to overcome unnecessary obstacles"
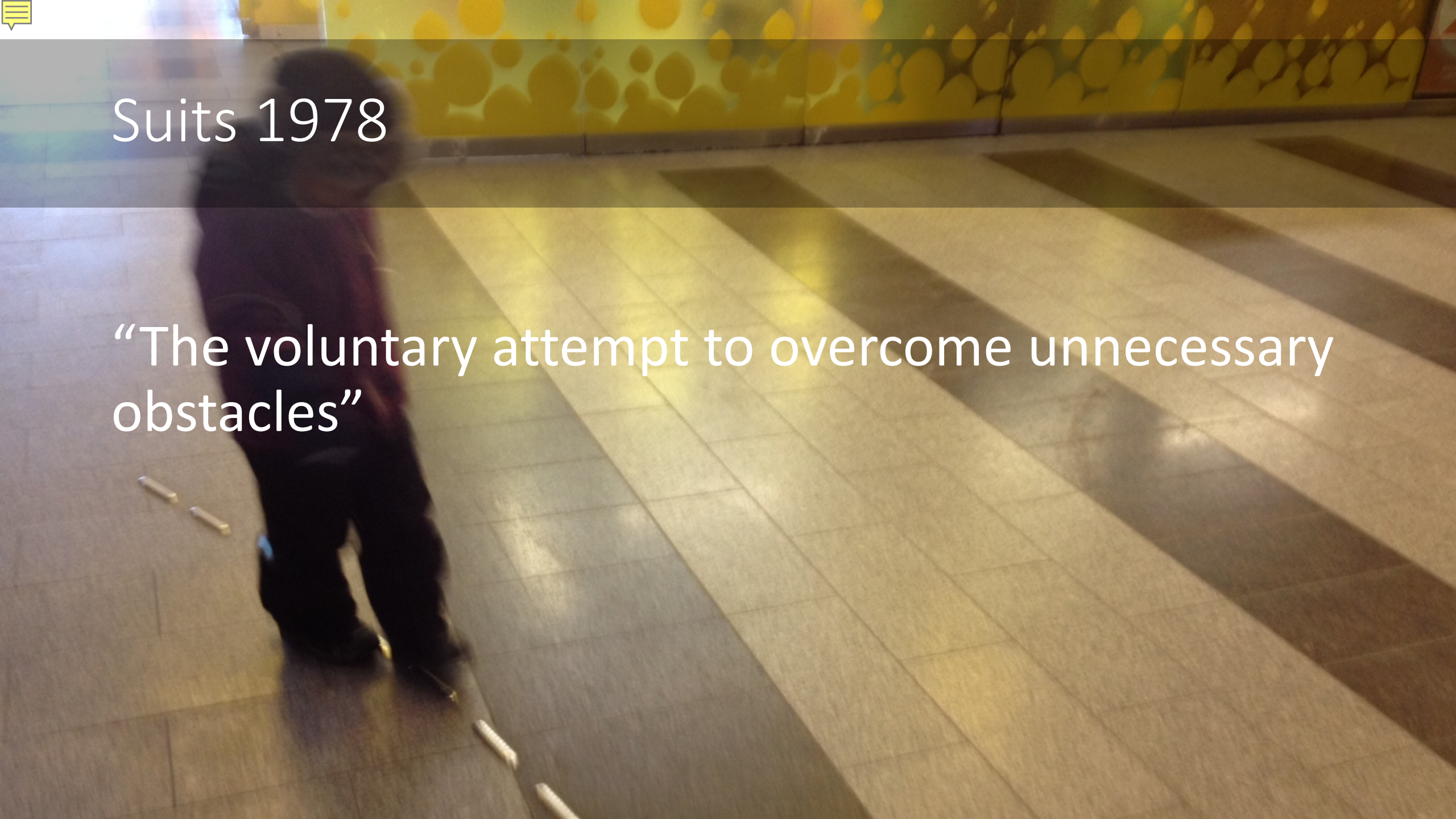
Game design and analysis frameworks

Caillois' 4 types of play

- Agon, or competition. (Chess)
- Alea, or chance. (Slot machines)
- Mimicry, or role playing.
- Ilinx (Greek for "whirlpool"), or *vertigo*

Data-driven analysis: Zagal 2010

- What topics do reviews address? What adjectives are used?
- Natural Language Processing (NLP) analysis of 100k+ user-submitted game reviews

Zagal, J. P., & Tomuro, N. (2010, October). The aesthetics of gameplay: a lexical approach. In *Proceedings of the 14th International Academic MindTrek Conference: Envisioning Future Media Environments* (pp. 9-16). ACM.

Table 3 - Primary Elements of Gameplay Aesthetics

Pacing - The perception of how often game events occur.	**Scope -** The size of the possibility space afforded by a game.
Complexity - The measure, or sense, of the number of parts in a system and how they are interrelated.	**Demands -** The requirements imposed upon the player by the gameplay
Cognitive Accessibility - The measure, or sense, of the opacity of a system and the challenges it poses in understanding it.	**Impact -** What we feel games "do to us" when we play them, and how they make us feel.

Describing the interface and controls

easy, frustrating, clunky, dumb, normal, hard, intuitive, tight, responsive, sloppy, simplified, sluggish, complicated, awkward, confusing, intelligent, clumsy, faulty, problematic, inconsistent, direct, cumbersome, tricky, managed, precise, sketchy, twitchy, unresponsive, adaptive, dodgy, efficient, inept, loose, practical, unorthodox, jumpy, reduced, sensitive

Novel points of view

- For example, Reeves et al. 2005: "Designing the Spectator Experience"
- Years before eSports became a thing

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Schell's lenses

Second Edition

The Art of Game Design
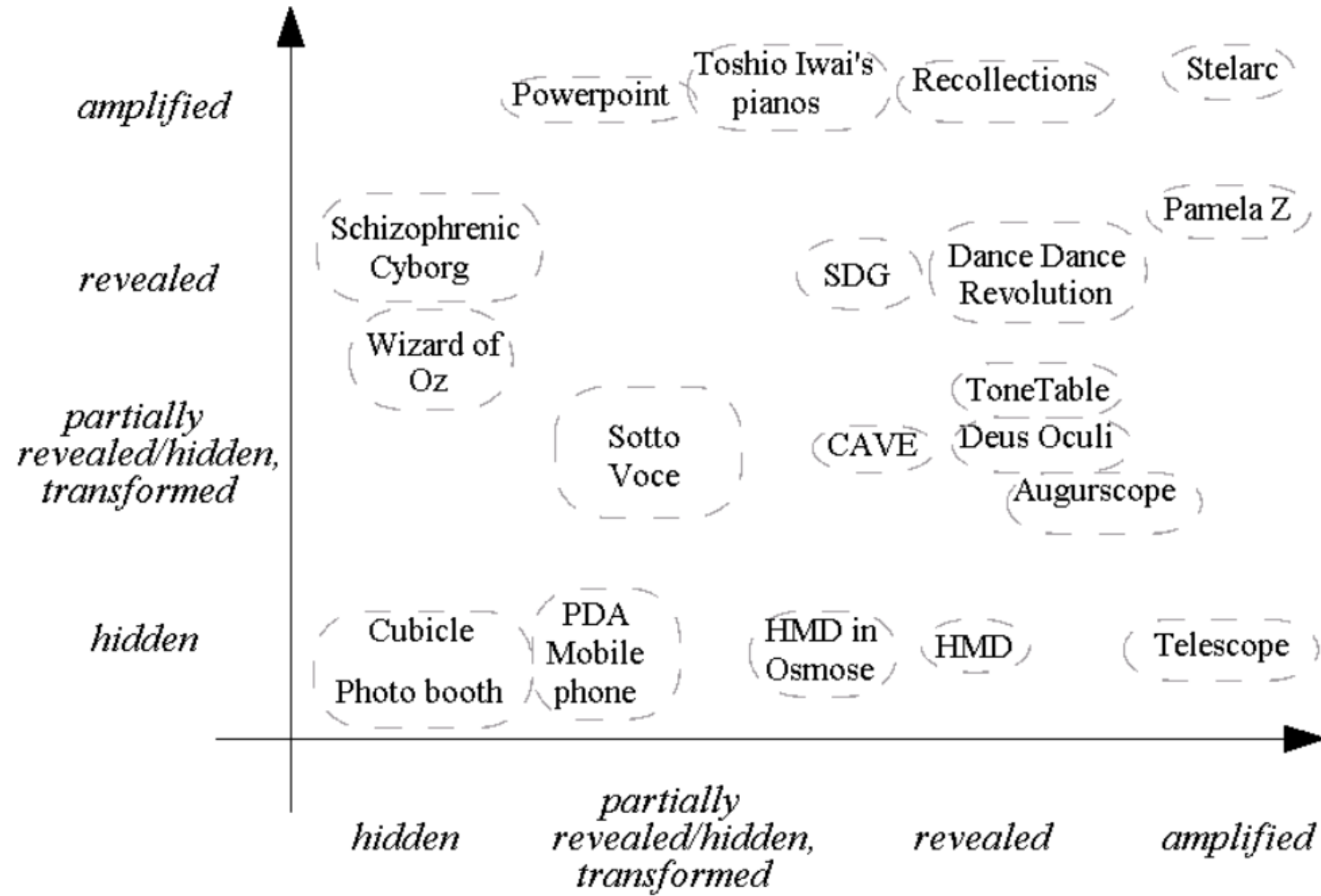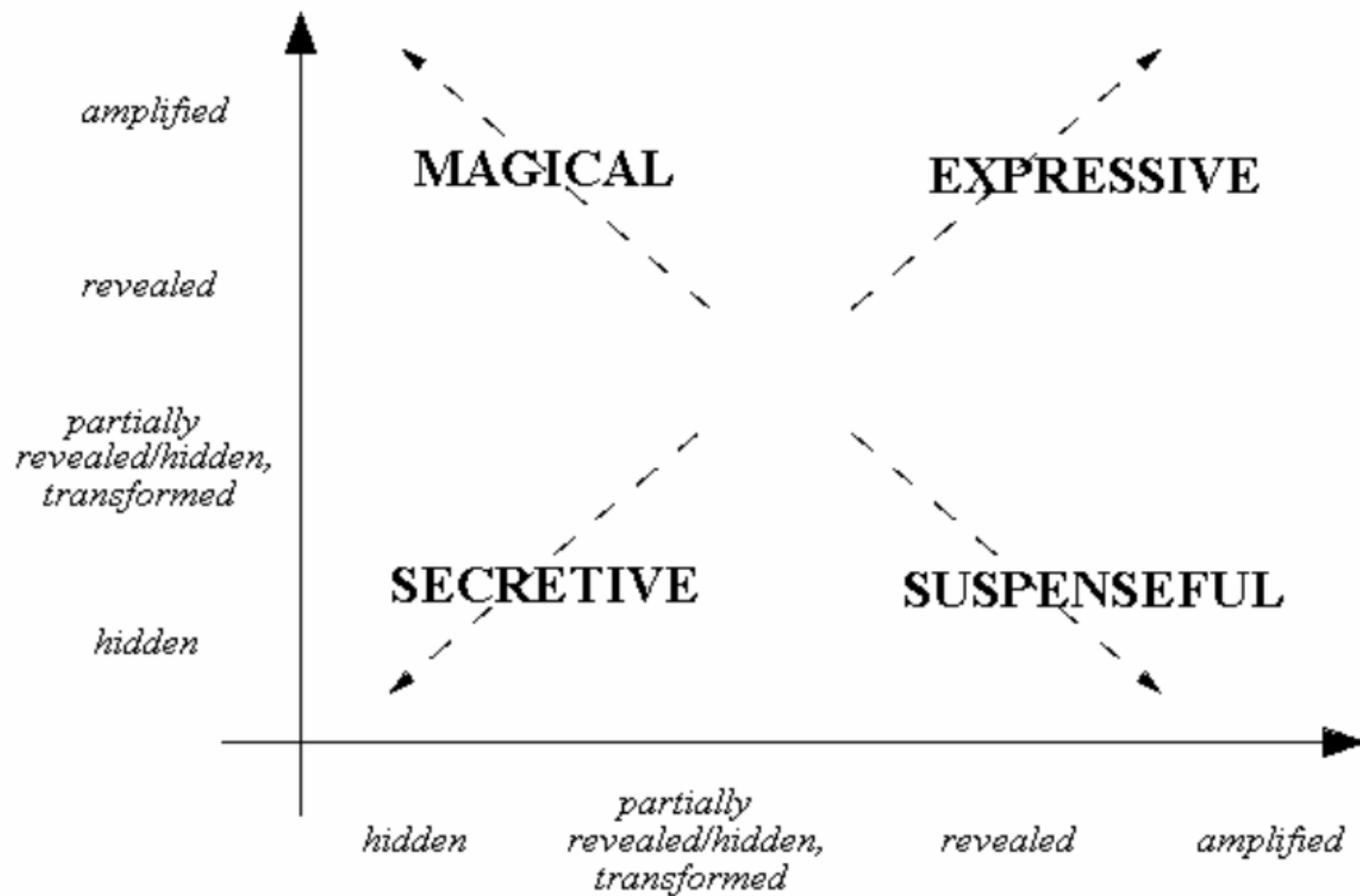
A Book of Lenses

Exercise: Schell's lenses

- Pick a game you have made or are making. If you don't have one, pick an existing game that you know well.
- Scrutinize your game using the following 5 lenses plus 3 others (hand-picked or randomly selected):
  - #1 (Essential experience)
  - #12 (Resonance)
  - #13 (Infinite Inspiration)
  - #17 (Toy)
  - #100 (Love)
- **Add a slide to a shared Google Slides (link in Teams): Which of the lenses was the most useful for you and why? What did you learn or what new ideas did you get?**
- If you don't have the book, download the Deck of Lenses app.

Mechanics, Aesthetics, Dynamics (MDA)

- Mechanics (rules, verbs – what is designed and implemented)
- Dynamics (behavior patterns, strategies emerging from mechanics)
- Aesthetics (emotions & Player Experience emerging from dynamics)

Designers can only directly control the mechanics

Predicting player behavior becomes even more difficult with multiple players

MDA Aesthetics (≈ player experience)

- Sensation (Game as sense-pleasure)

- Fantasy (Game as make-believe)

- Narrative (Game as drama)

- Challenge (Game as obstacle course)

- Fellowship (Game as social framework)

- Discovery (Game as uncharted territory)

- Expression (Game as self-discovery)

- Submission (Game as pastime)

MDA Aesthetics

- Sensation (Game as sense-pleasure)
- Fantasy (Game as make-believe)
- Narrative (Game as drama)
- Challenge (Game as obstacle course)
- Fellowship (Game as social framework)
- **Discovery (Game as uncharted territory)**
- Expression (Game as self-discovery)
- Submission (Game as pastime)

Basic human psychological needs

- Need for competence
- **Need for autonomy**
- Need for social relatedness
- **Need for novelty (of sensations and experiences)**
- Need for self-esteem

Other game pleasures

Anticipation

Delight

Gift giving

Humor

Purification

Thrill

Wonder

…

MDA Example: Chess

- Mechanics: rules such as "A player cannot move his king into check"
- Dynamics: sacrificing lesser pieces to capture opponent's queen
- Aesthetics/experience: challenge, discovery, fellowship

MDA Example: Monopoly

- Mechanics: movement and transaction rules
- Dynamics: the rich get richer and the course of the game is set very early
- Aesthetics/experience: power fantasy, challenge, fellowship

MDA Example: Monopoly

- Mechanic: Auction (if player does not want to buy a property they land on, it is auctioned)

- Dynamic: All properties are bought early in the game

- Aesthetics/experience: Might feel "unfair", but fixes a problem of the game being too long without it

MDA Example: Knizia scoring

- Mechanic: Player counts for scoring only the resources of which he has the least

- Dynamic: Players collect all kinds of resources.

- Aesthetics/experience: Increased variety of gameplay (no motivation to keep hoarding just one resource that one happens to gain early in the game)

MDA Example: Drop item

- Mechanic: Player is able to slough of excess inventory by dropping items on the ground

- Dynamic: Trading, bartering

- Aesthetics/experience: Increased social connection with other players

MDA Example: Physics/dynamics simulation

- Mechanics: Newton's laws of motion

- Dynamics: Domino effects / chain reactions, shooting a target by bouncing a projectile, stability/instability of buildings…

- Aesthetics: Emergence, surprise, curiosity

MDA Example: What mechanics make this dynamic emerge?

- Dynamic: Turtling, camping

- Mechanics: predetermined spawn locations (camping where a valuable item is due to spawn)

- More generally: lower cost or higher rewards in passive than active play

MDA Example: What mechanics make this dynamic emerge?

- Dynamic: Button mashing
- Mechanics: Actions with no cost and no cooldown

Computational rationality: A converging paradigm for intelligence in brains, minds, and machines

Samuel J. Gershman,[1*] Eric J. Horvitz,[2*] Joshua B. Tenenbaum[3*]

After growing up together, and mostly growing apart in the second half of the 20th century, the fields of artificial intelligence (AI), cognitive science, and neuroscience are reconverging on a shared view of the computational foundations of intelligence that promotes valuable cross-disciplinary exchanges on questions, methods, and results. We chart advances over the past several decades that address challenges of perception and action under uncertainty through the lens of computation. Advances include the development of representations and inferential procedures for large-scale probabilistic inference and machinery for enabling reflection and decisions about tradeoffs in effort, precision, and timeliness of computations. These tools are deployed toward the goal of computational rationality: identifying decisions with highest expected utility, while taking into consideration the costs of computation in complex real-world problems in which most relevant calculations can only be approximated. We highlight key concepts with examples that show the potential for interchange between computer science, cognitive science, and neuroscience.

MDA in the real world

- Mechanics: The plough

- Dynamics: Specialization, trade, rulers and ruled, social inequality, misogyny, tyranny, malnutrition, dense population, disease, war
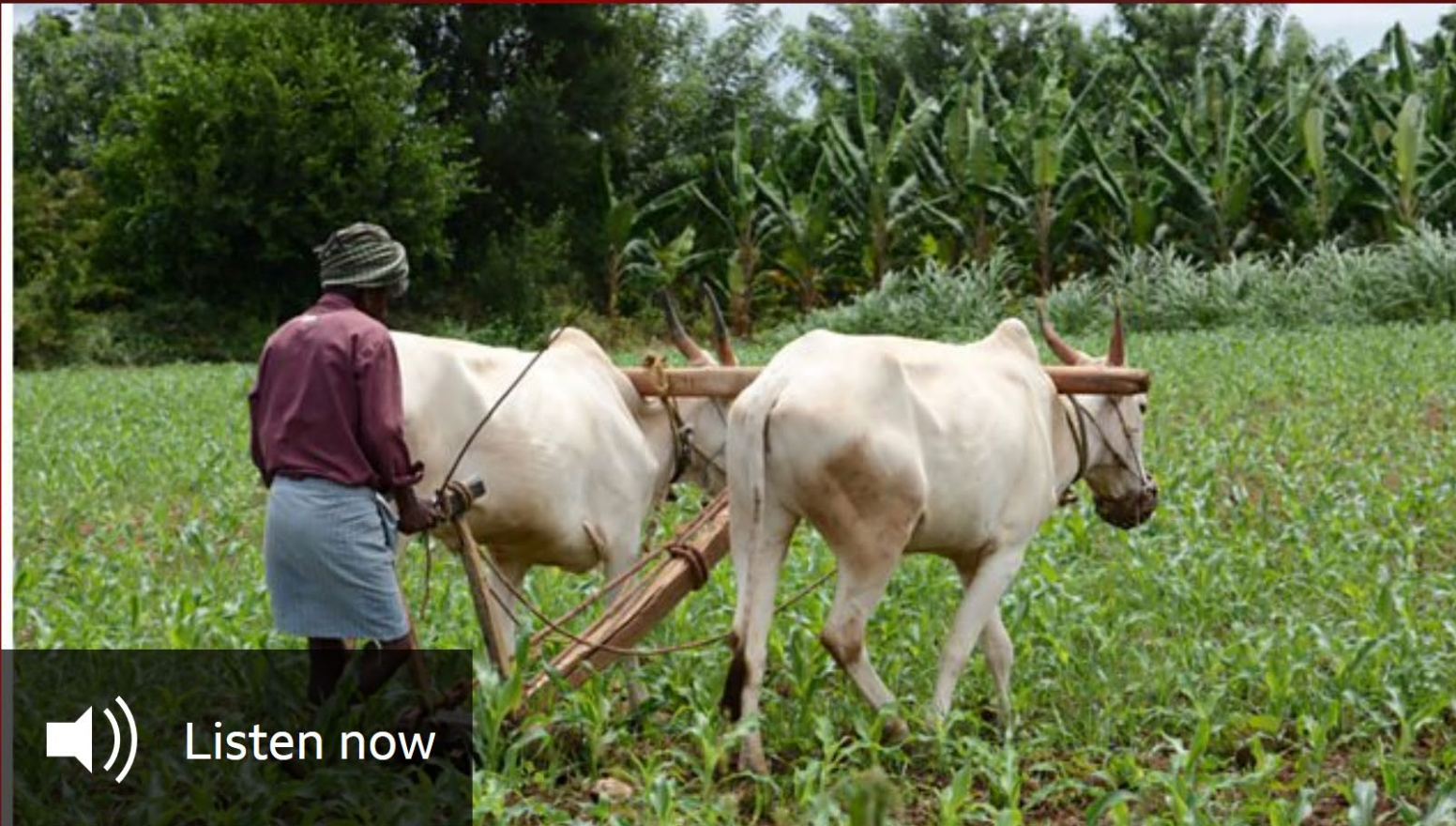
- Aesthetics: Cultivation, Ownership, Safety, Fear

http://sciencenordic.com/how-heavy-plough-changed-world

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PREVIOUS
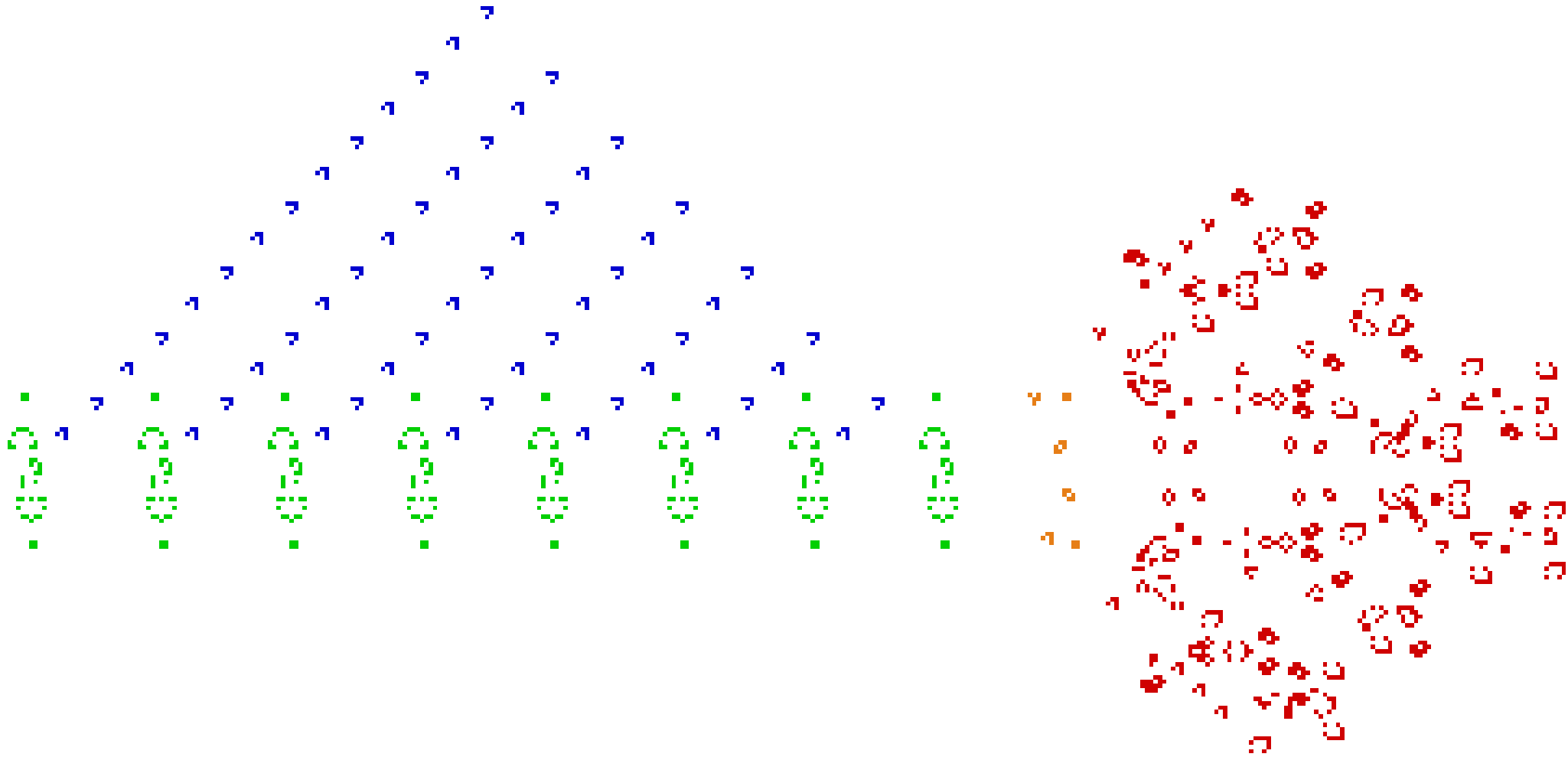**Cold Chain**

NEXT
Number 51

Designing for Emergence: PlusMinus

Successful student game (CHI PLAY game design competition winner, showcased at Experimental Gameplay Workshop 2019)
Juuso Toikka's master's theses about the core mechanics: https://aaltodoc.aalto.fi/handle/123456789/39850

# Designing for Emergence: Conway's Game of Life

Game of Life rules

- Any live cell with fewer than two live neighbours dies, as if by underpopulation.

- Any live cell with two or three live neighbours lives on to the next generation.

- Any live cell with more than three live neighbours dies, as if by overpopulation.

- Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.
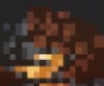
MDA and information visualization

In our version, effect of keys is predicted and time only advances when the player holds down space

MDA and explorable explanations exercise

- Play these "explorable explanations", together with a pair:
  - Parable of Polygons (https://ncase.me/polygons/)
  - Evolution of Trust (https://ncase.me/trust/)
- What are the mechanics, dynamics & aesthetics?

MDA & explorable explanations debriefing

- What did you learn?
- Was there anything surprising?

Preparation for the rest of the week

For Tuesday:

- Play Clash Royale (reach 1-2 new arenas after the training ground)

- Watch this GDC talk on balancing Clash Royale:
https://www.youtube.com/watch?v=bHLQQh8Ctu4

For Wednesday:

- Play Walking Dead No Man's Land (Complete 1-2 chapters)

Other games discussed, play if you have time: Journey, Thomas Was Alone, Gone Home