Game Analysis and Research

(a.k.a The Science of Game Design)

Prof. Perttu Hämäläinen 2022

Course contents

- Week 1: Game design and research intro
- Week 2: Game design math, balancing, analytics
- Week 3: Psychology of game design: Behavioral game design, behavioral economics, monetization, free-to-play
- Week 4: Psychology of game design: Intrinsic motivation, emotion
- Week 5: Understanding the human body: Motor learning and performance for action game design, movement-based games
- Week 6: Excursion to Valo Motion or HopLop Pasila (not confirmed yet)

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

Passing the course

- Participate at least 80% of the time
- Final assignment (multiple options): learning diary, literature survey, Colab game analysis exercise, 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 of what is desired: 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

Books

Games & Animation

Making a successful video game is hard. Even games that are successful at launch may fail to engage and retain players in the long term due to issues with the user experience (UX). In a nutshell, game UX is about considering the gamer's brain: understanding human capabilities and limitations to anticipate how a game will be perceived, the emotions and motivation it will elicit, and how players will interact with it. This book is designed to help readers identify the ingredients for successful and engaging video games, empowering them to develop their own unique game recipe more efficiently.

Key Features:

- Provides a complete overview of how the brain works in a very accessible way.
- Provides a unique game UX framework, using numerous examples from released games.
- Covers design thinking, user research, analytics, and UX strategy.
- This book is a practical tool that any professional game developer or student can use right away and includes the most complete overview of UX in games existing today.

Author Bio:

Celia Hodent, Ph.D in psychology with over ten years of experience in the entertainment industry, is recognized as a leader in the application of user experience and psychology in video games, and in the development of UX strategy in game studios. Celia has worked at Ubisoft, LucasArts, and Epic Games on many projects across multiple platforms, including the *Tom Clancy's Rainbow Six* franchise, *Star Wars: 1313*, *Paragon*, *Fortnite*, and *Spyjinx*

Reviews:

"The beauty of this book is that it is two things at the same time:

1. *An amazingly complete introduction to psychology, using examples from video games to make the concepts clear and memorable.*
2. *An amazingly complete introduction to video game design, using psychology to help design more compelling games*

So whether you are a game designer, a player, or someone wishing to understand psychology, this is the book for you."

—**Don Norman**, Director, the Design Lab at the University of California, San Diego
author of *The Design of Everyday Things*

"By blending up-to-date brain science with game-relevant UX design principles, this book doesn't just give great tips about how to make better games, it gives designers the mental tools to get better at thinking about games. Read this, and suddenly you'll know what you're talking about."

—**Jesse Schell**, Game Designer, author of *A Theory of Fun for Game Design*

"This book is an invaluable asset for game developers, whether you work in game design, user experience, or programming. With a lucid overview of the current best knowledge from cognitive psychology, Hodent provides guidelines and approaches to improve the game experience for players that are based on actual science."

—**Raph Koster**, author of *A Theory of Fun for Game Design*

K29682

CRC Press
Taylor & Francis Group
an informa business
www.crcpress.com

6000 Broken Sound Parkway, NW
Suite 300, Boca Raton, FL 33487
711 Third Avenue
New York, NY 10017
2 Park Square, Milton Park
Abingdon, Oxon OX14 4RN, UK

ISBN-13: 978-1-4987-7550-2
90000
9 781498 775502

HODENT THE GAMER'S BRAIN CRC Press

The Gamer's Brain

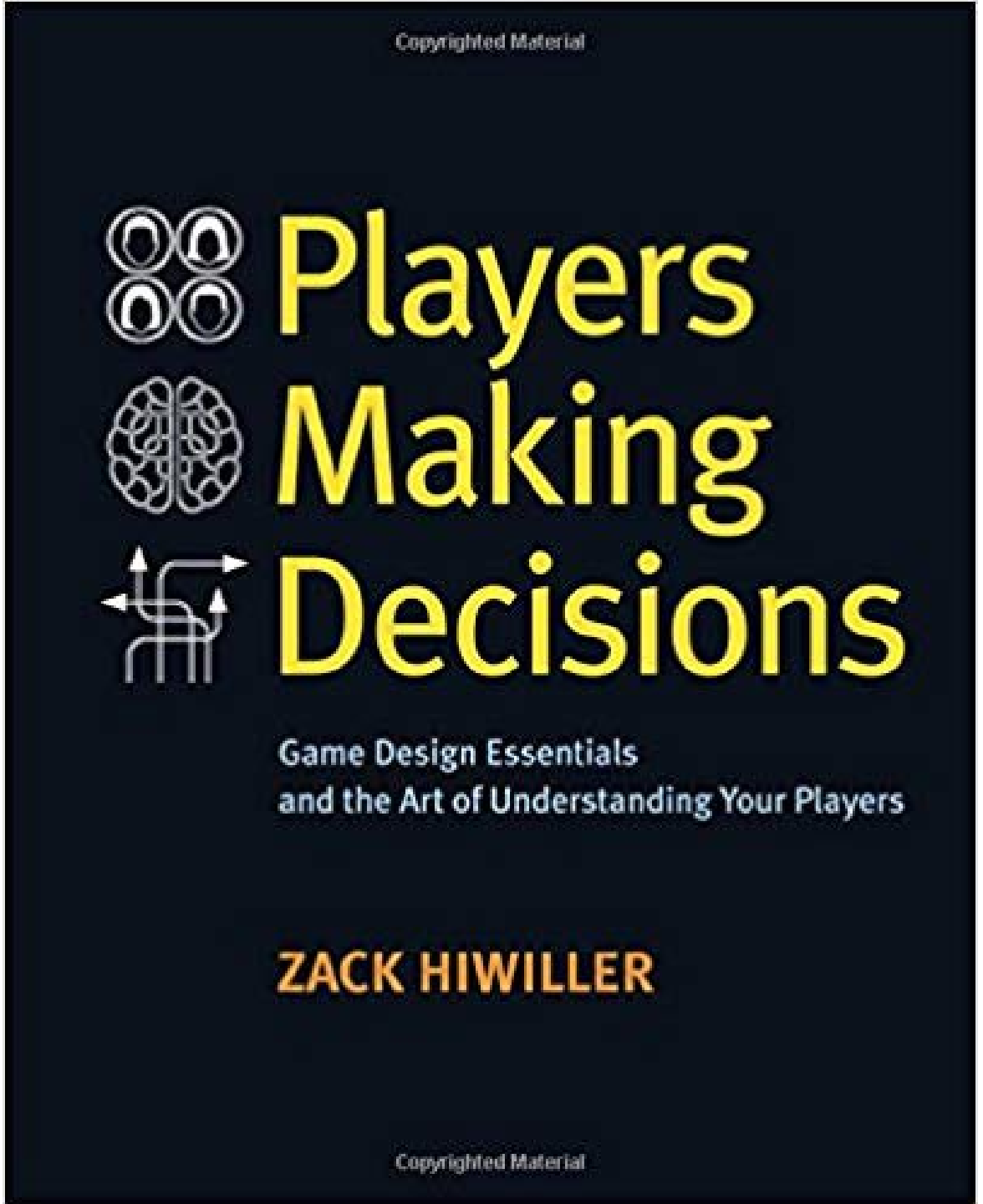
How Neuroscience and UX Can Impact Video Game Design

Celia Hodent

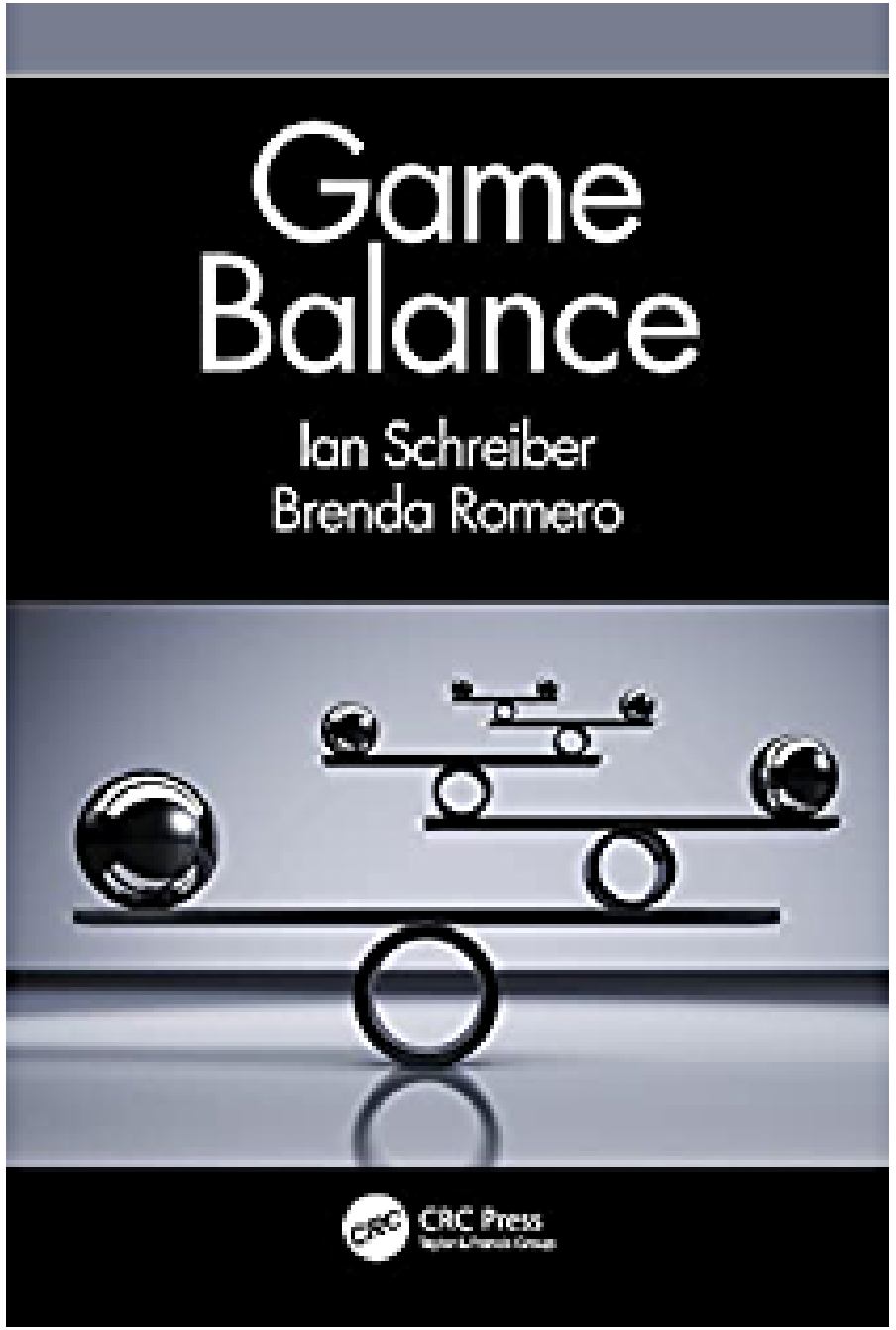
Foreword by **Brenda Romero**

CRC Press
Taylor & Francis Group

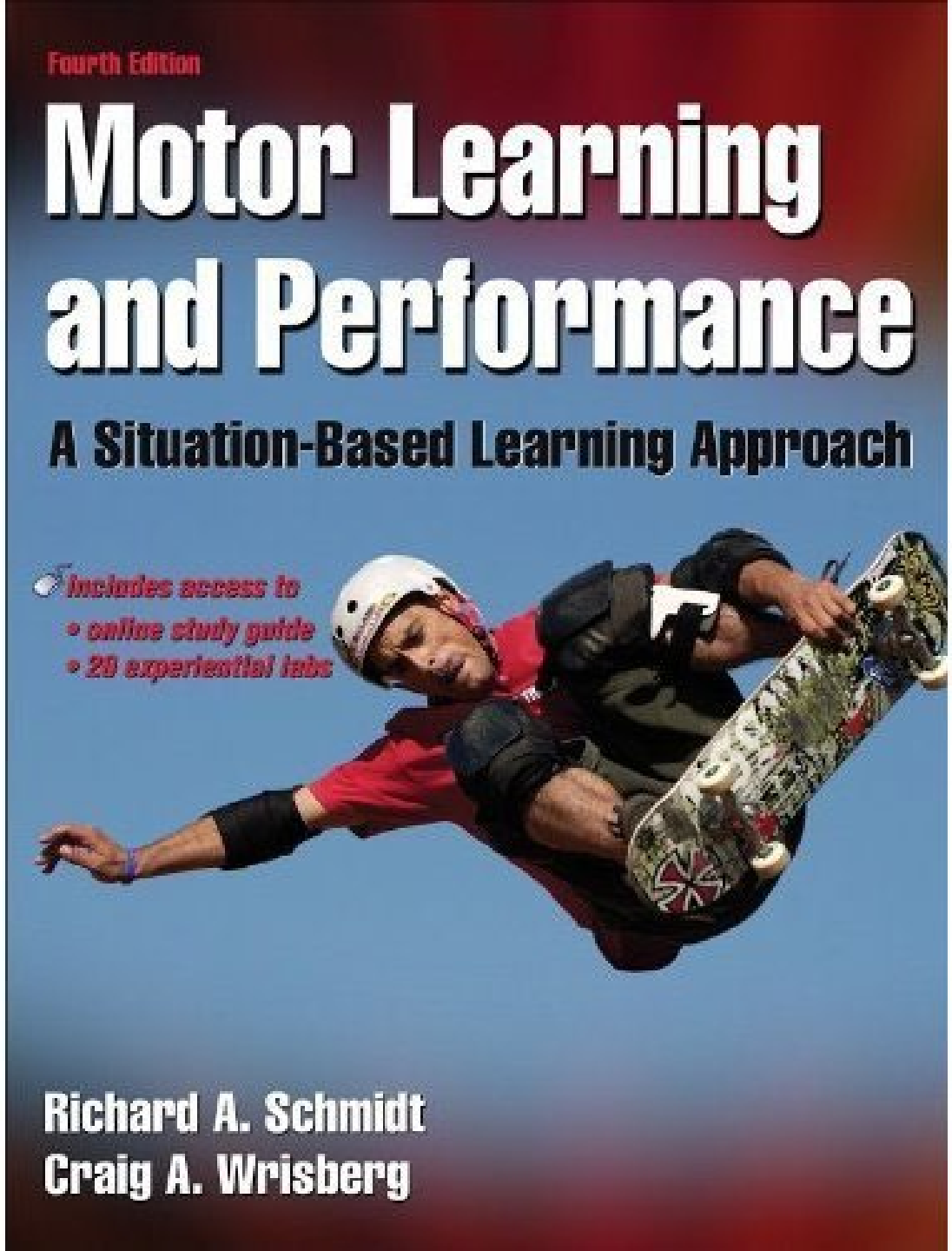
Books


Copyrighted Material
Players
Making
Decisions
Game Design Essentials
and the Art of Understanding Your Players
ZACK HIWILLER
Copyrighted Material

Books



Books


Fourth Edition
Motor Learning and Performance
A Situation-Based Learning Approach
Includes access to
• online study guide
• 20 experiential labs
Richard A. Schmidt
Craig A. Wrisberg

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
- GDC talks can be good, but they are not peer-reviewed before presenting, and the quality and reliability of what is said varies a lot

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/use games and interactive technology? 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

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."

View This Article

- FULL-TEXT (HTML)
- FULL-TEXT (PDF)
- IN DIGITAL EDITION
- COMMENTS

Reader Tools

PRINT
TEXT SIZE

SHARE

FEATURES

XXIII.3 May + June 2016
Page: 38
Digital Citation

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.

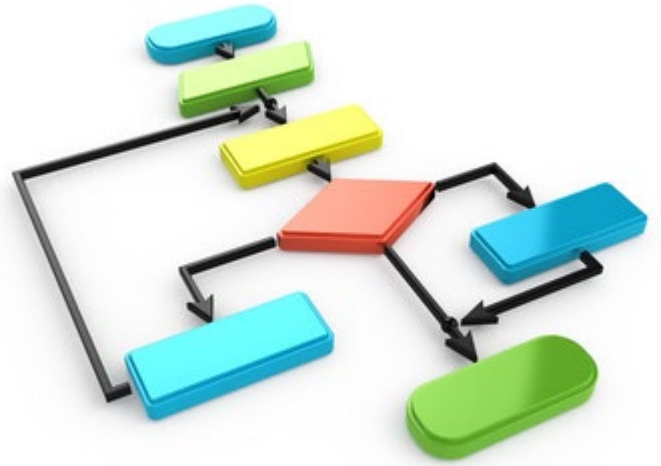
Daneels, Rowan, et al. "The 'eudaimonic experience': A scoping review of the concept in digital games research." *Media and Communication* 9.2 (2021): 178-190.

Understanding how people think & feel

- Psychology & Cognitive science: How do people make decisions? What motivates us? What are emotions and how they affect behavior and experience?
- Sport & exercise psychology: What motivates people to move? What factors affect motor learning and performance?
- Relevant to:
  - Predicting and understanding player behavior and experience
  - Understanding and optimizing designer creativity, design decisions,and design thinking

Two types of thinking

SYSTEM 2: EXPLICIT/CONSCIOUS:
SLOW, ALGORITHMIC, EFFORTFUL



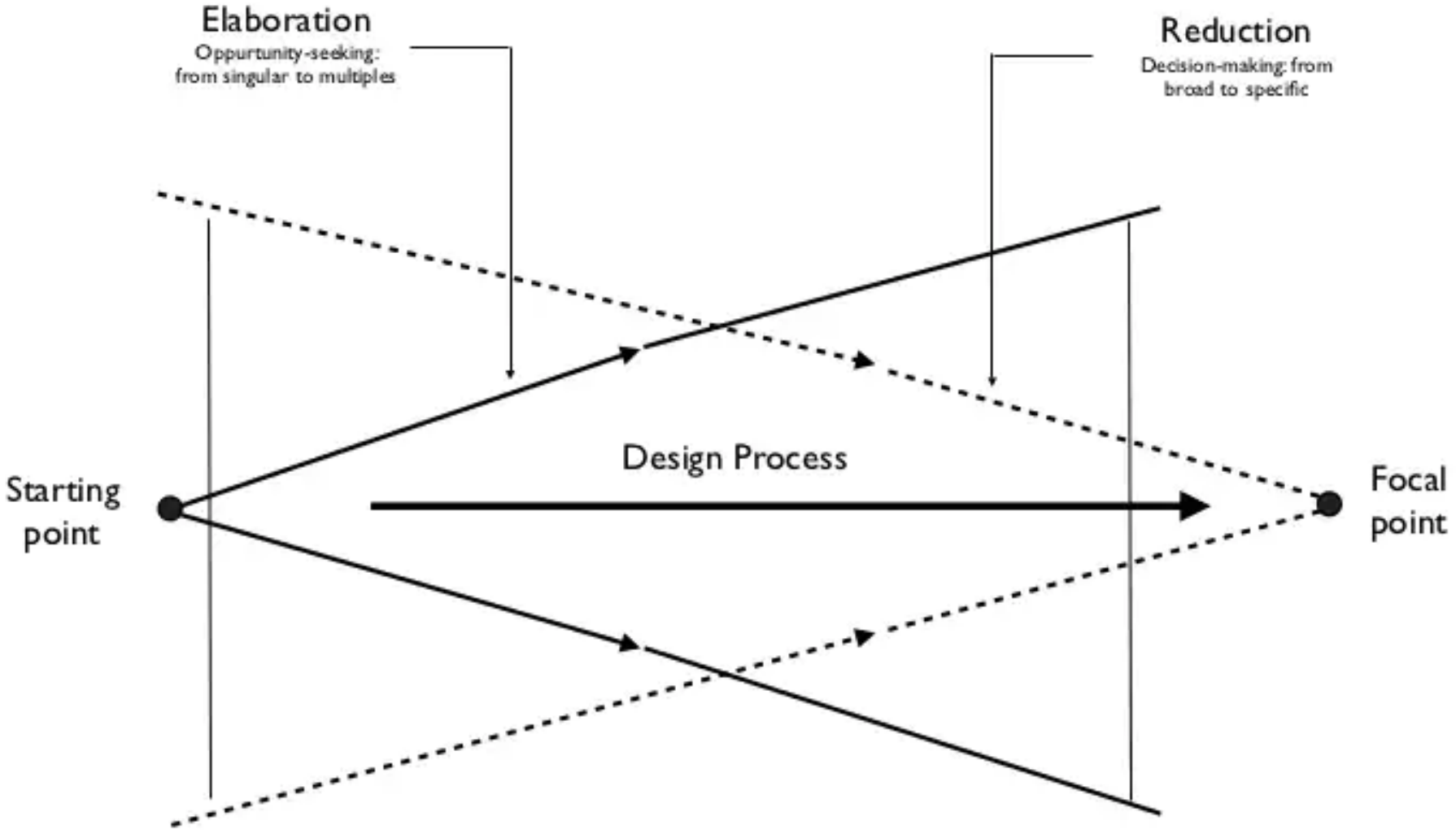
ATTENTION,
PRIMING,
INHIBITION

IDEAS,
ASSOCIATIONS,
IMPULSES
(AUTOMATION)

SYSTEM 1: IMPLICIT/UNCONSCIOUS:
FAST, ASSOCIATIVE, EFFORTLESS,
INTUITIVE

ASSOCIATION

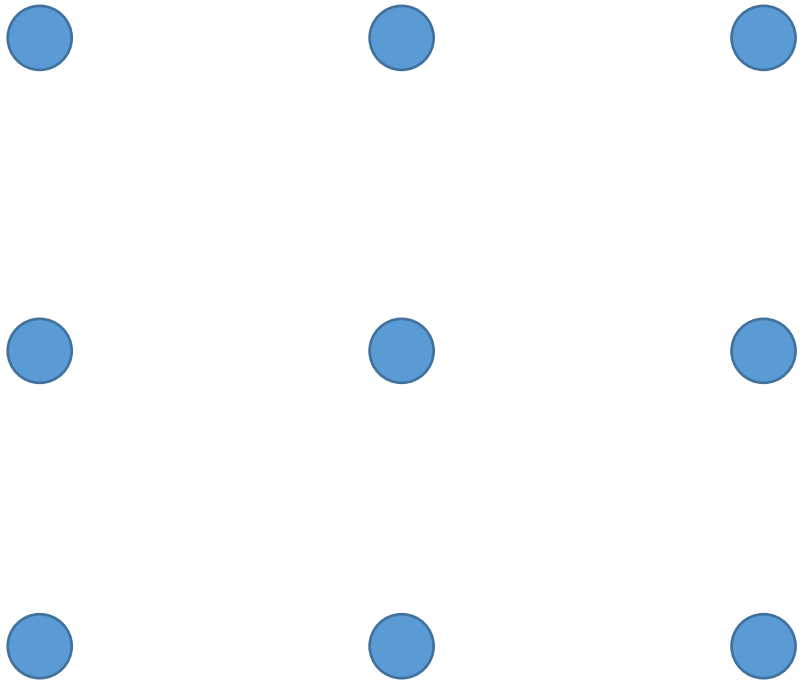
Generating ideas: Asking the right questions



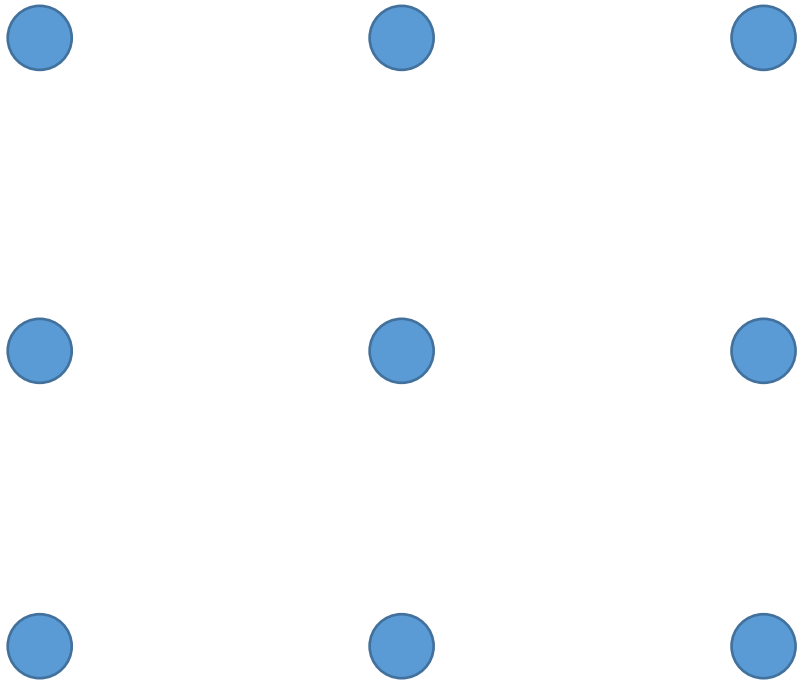
System 1 System 2

Bill Buxton 2007, Sketching User Experiences; Paul Laseau 1980, Graphic Thinking for Architects and Designers

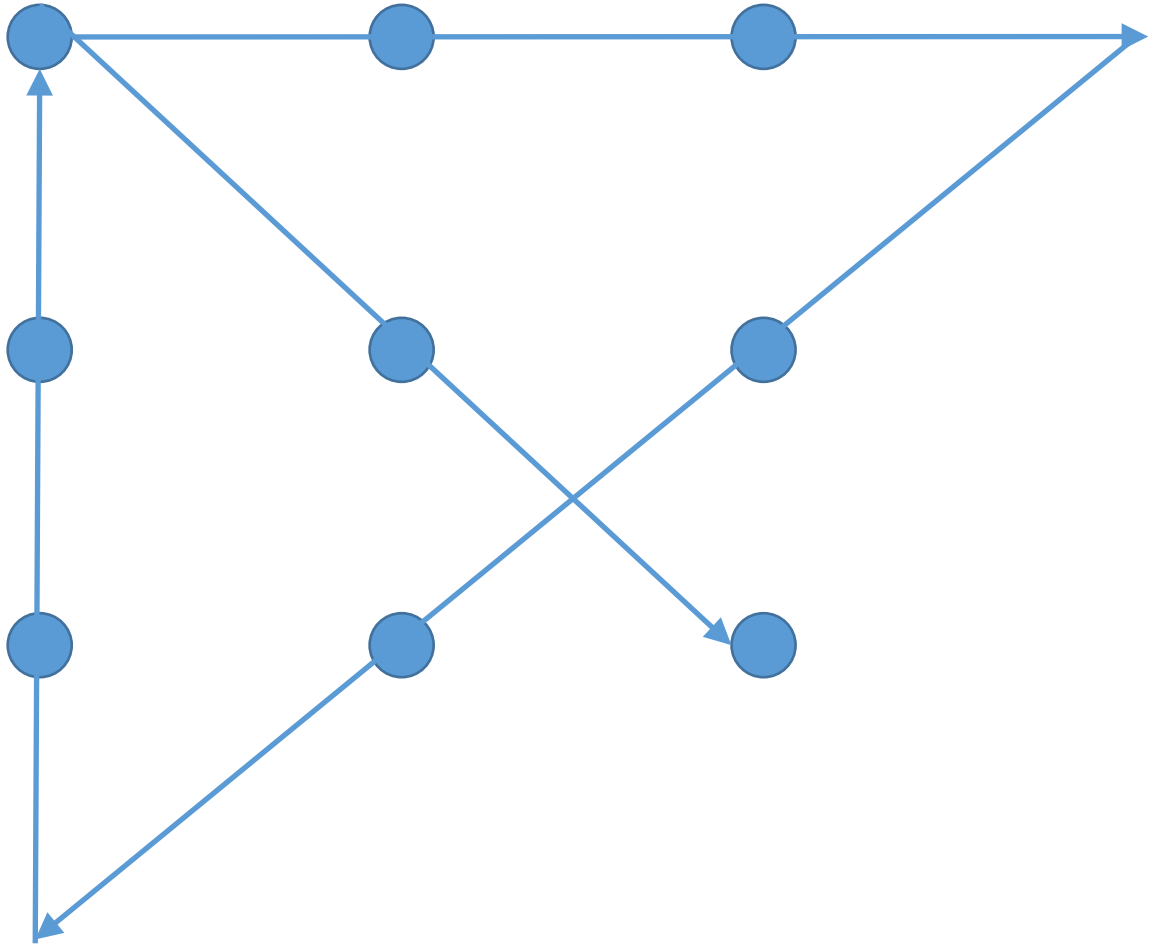
Asking the right questions: connect the dots with four connected straight lines



Can you think **outside the box**?

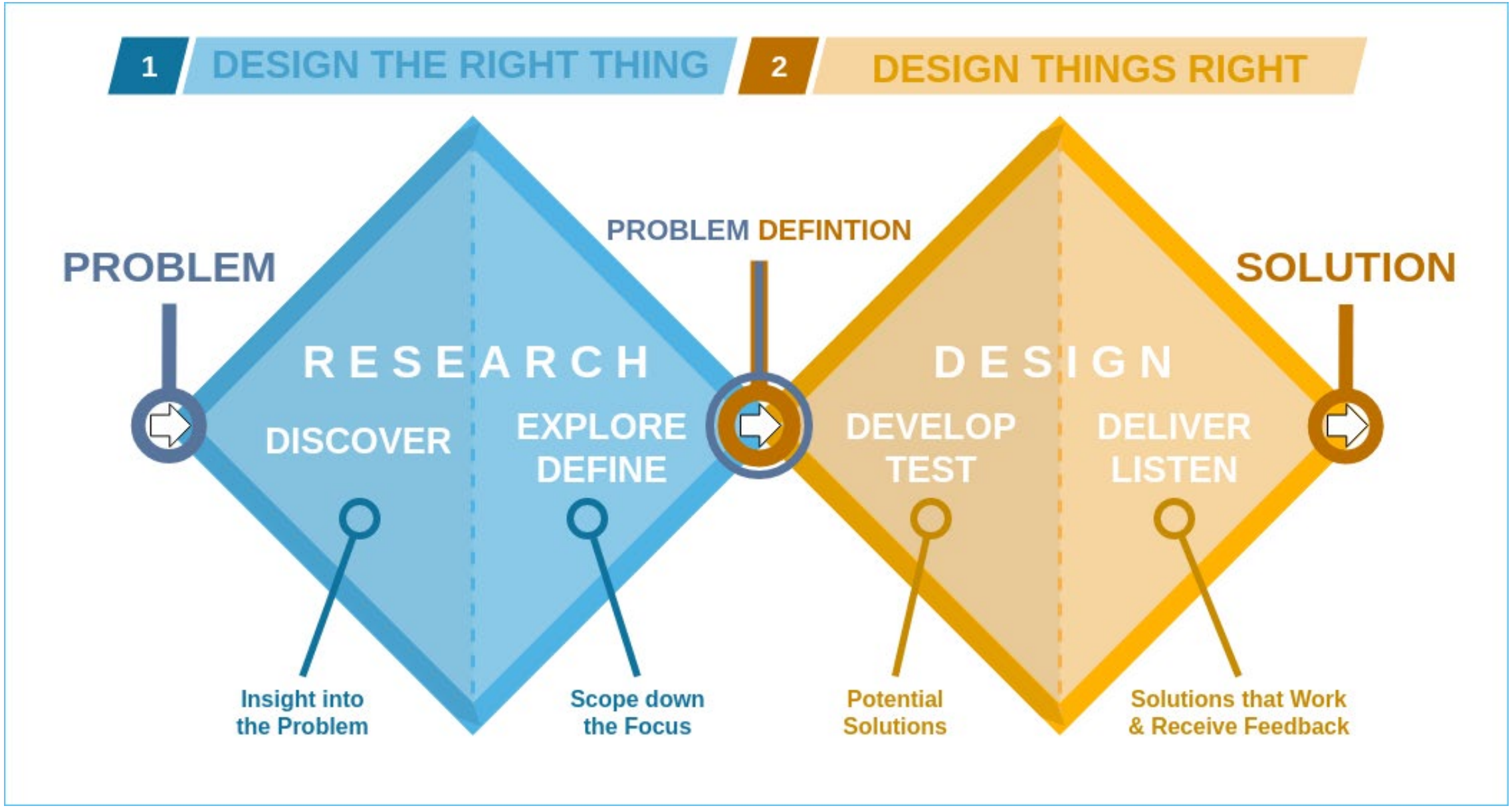


Can you think **outside the box**?

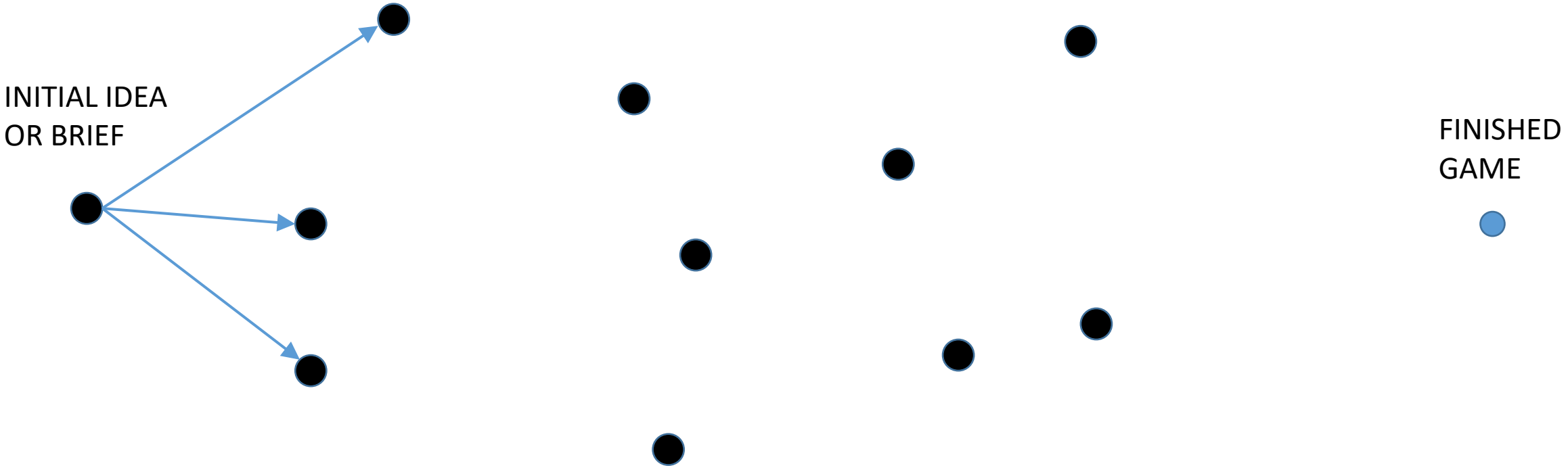


Criticizing and pruning ideas

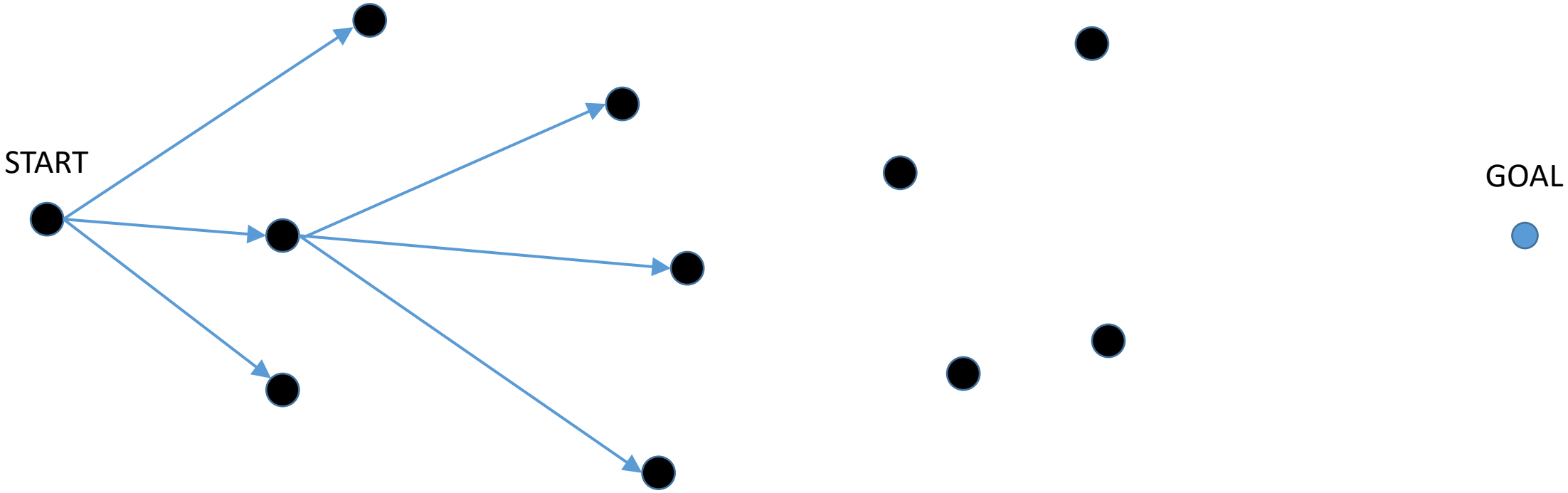
The Double Diamond Method



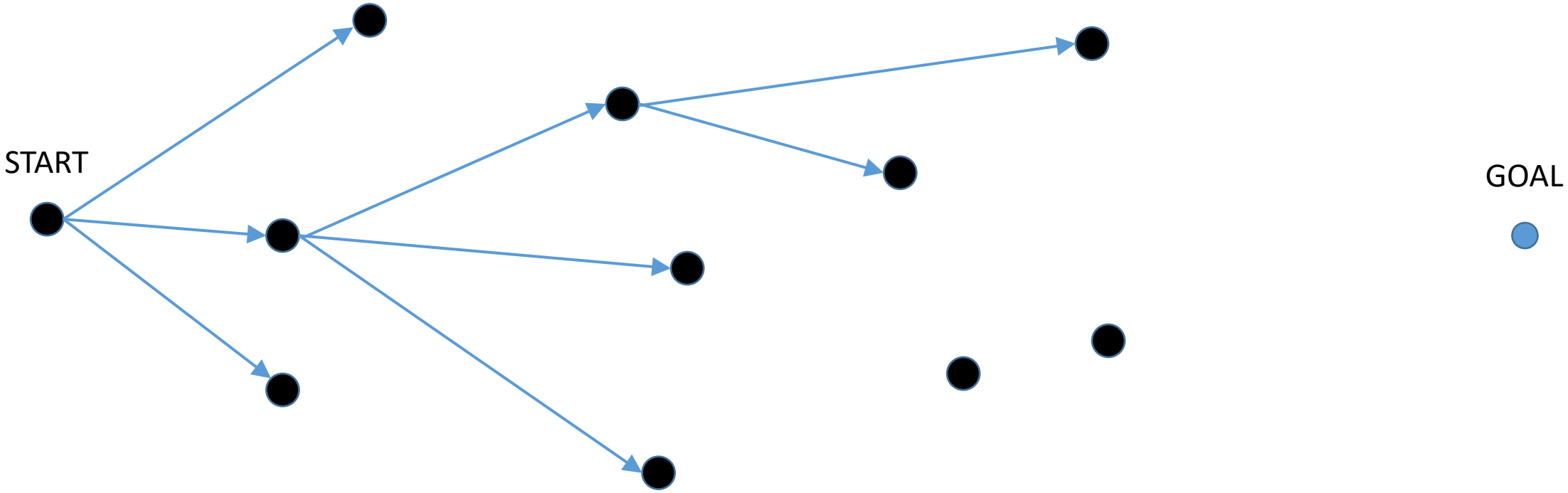
Game design as tree search



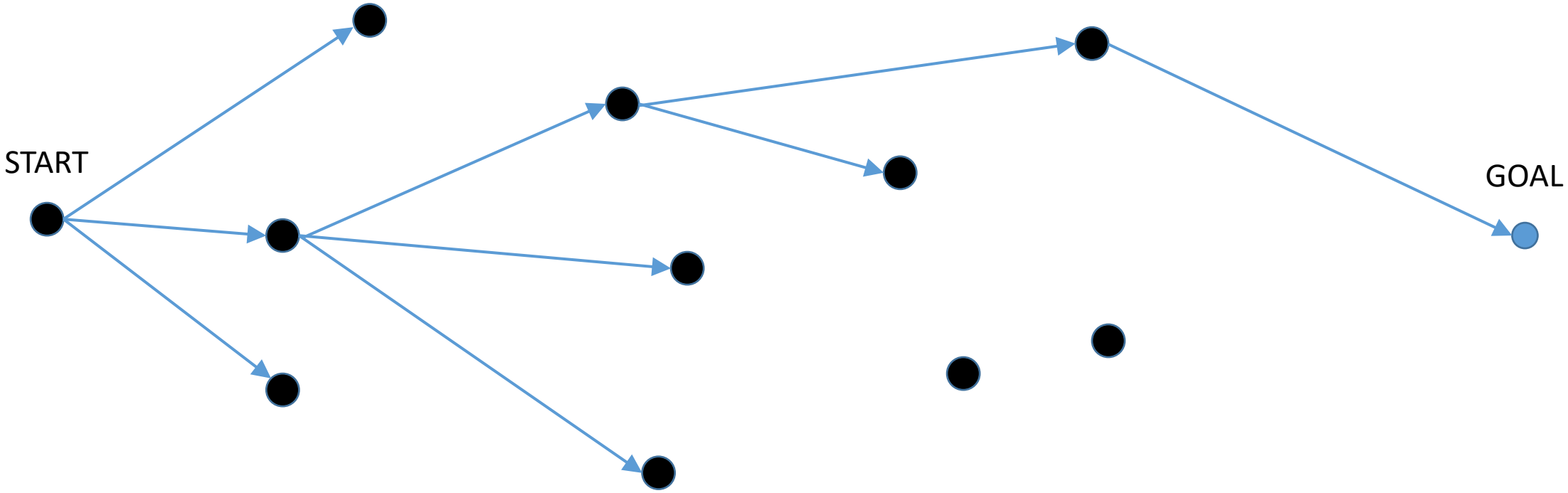
Game design as tree search



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?

Break

Game definitions

Costikyan 2002

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

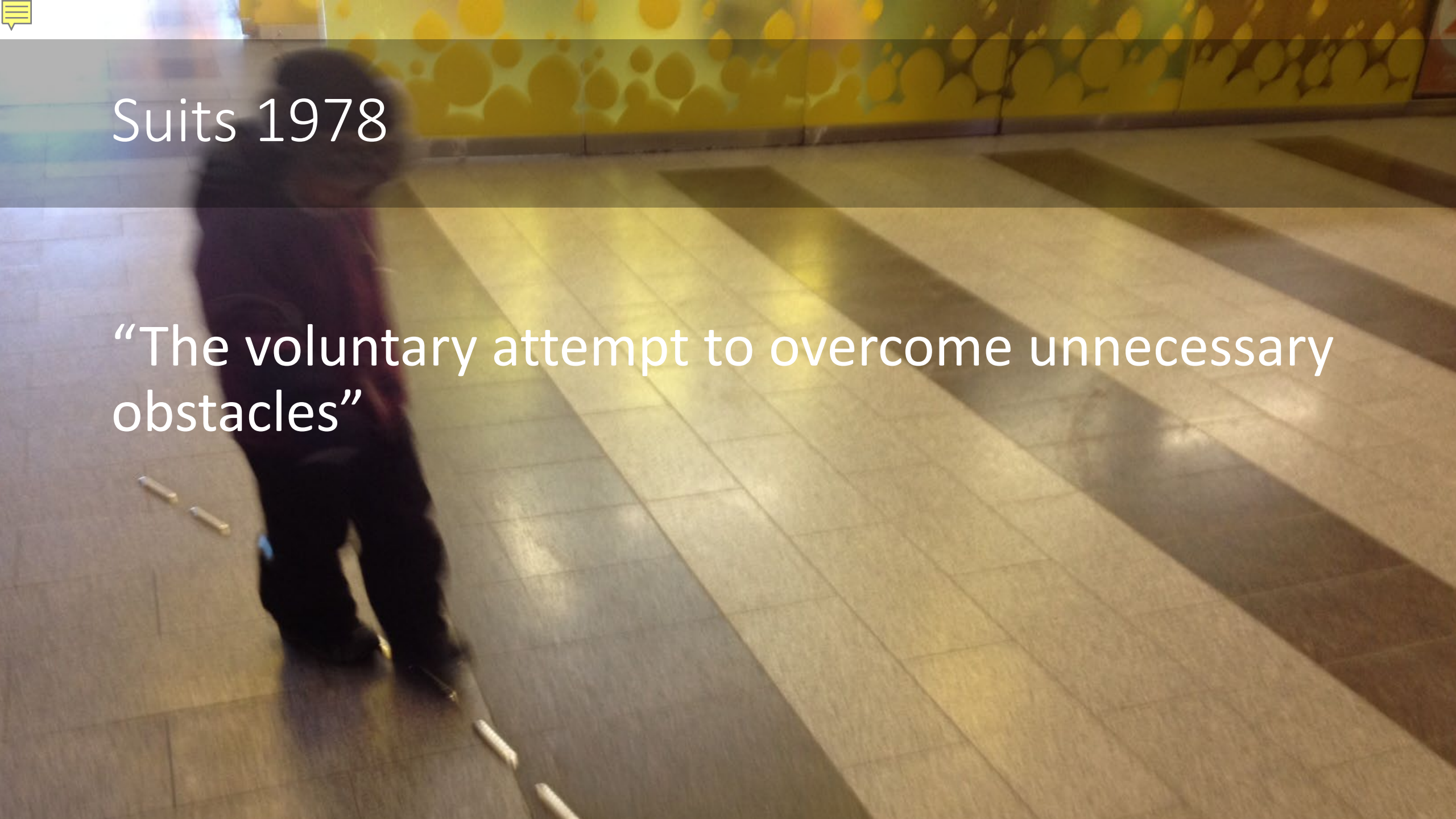
Caillois 1961

”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

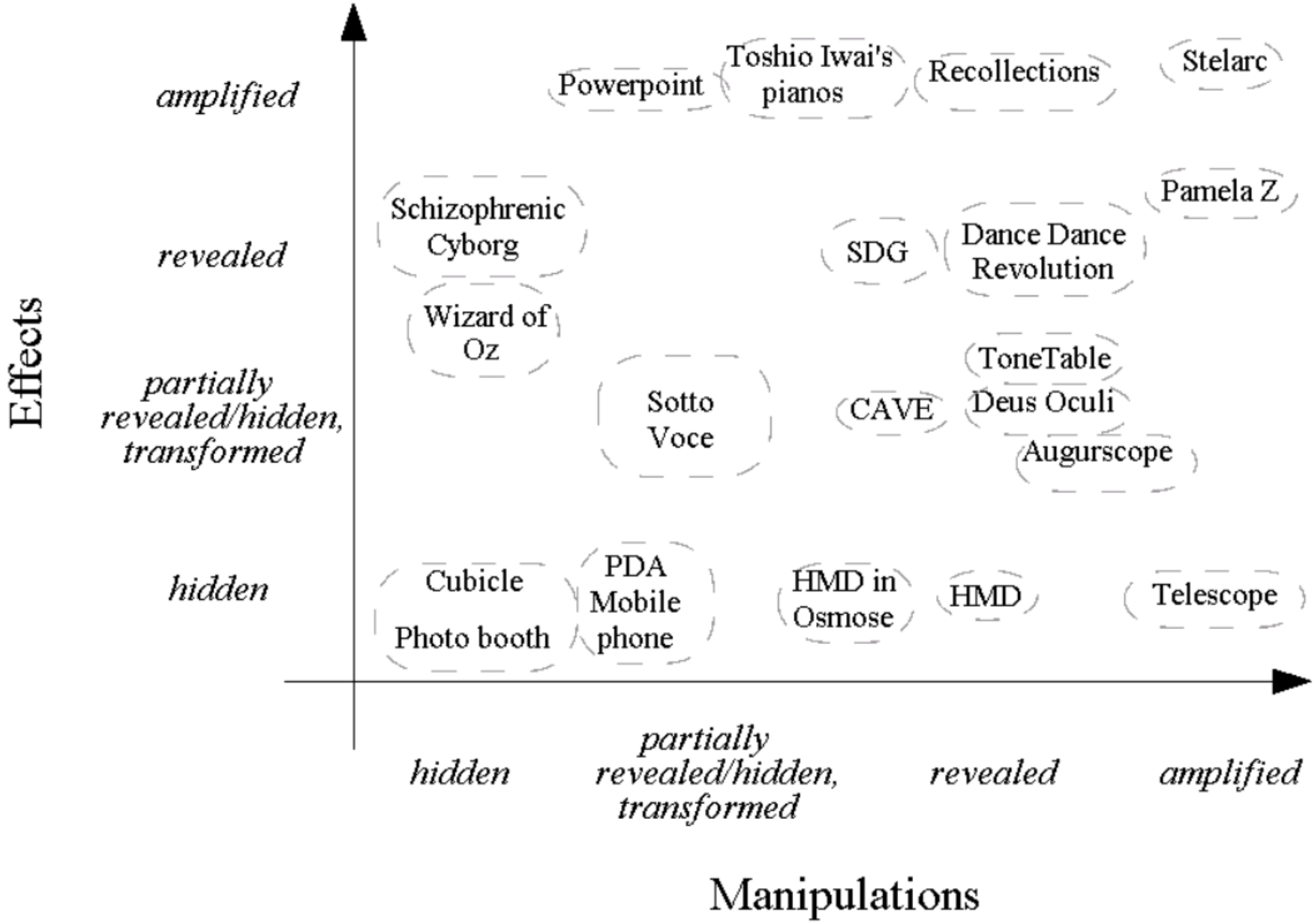
Pacing - The perception of how often game events occur.	**Scope -** The size of the possibility space afforded by a game.
Complexity - The measure, or sense, of the number of parts in a system and how they are interrelated.	**Demands -** The requirements imposed upon the player by the gameplay
Cognitive 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.

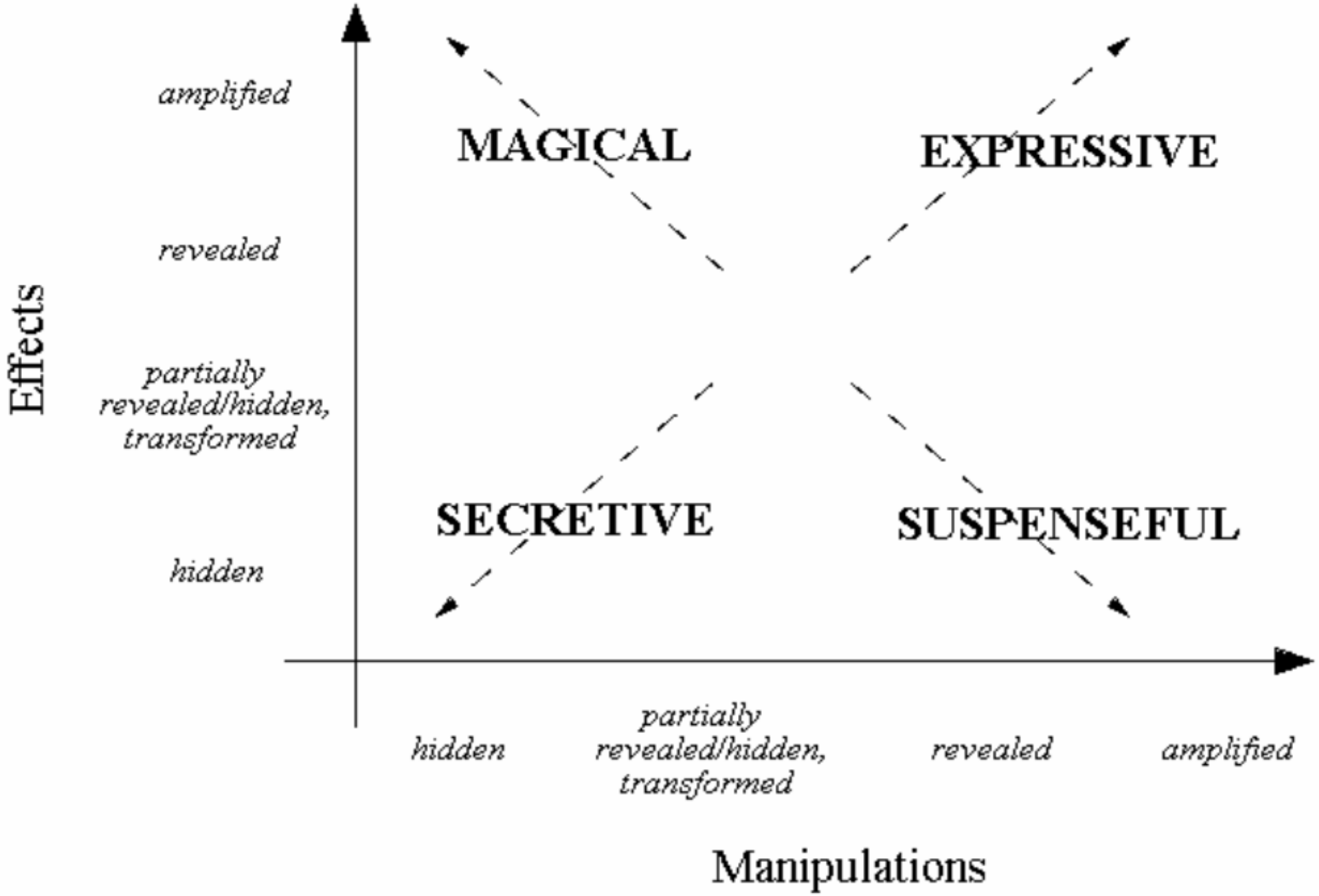
Describing the interface and controls

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


Effects
amplified
revealed
partially revealed/hidden, transformed
hidden
Powerpoint
Toshio Iwai's pianos
Recollections
Stelarc
Schizophrenic Cyborg
SDG
Dance Dance Revolution
Pamela Z
Wizard of Oz
Sotto Voce
CAVE
ToneTable
Deus Oculi
Augurscope
Cubicle
Photo booth
PDA Mobile phone
HMD in Osmose
HMD
Telescope
hidden
partially revealed/hidden, transformed
revealed
amplified
Manipulations


MAGICAL
EXPRESSIVE
SECRETIVE
SUSPENSEFUL
Effects
amplified
revealed
partially revealed/hidden, transformed
hidden
hidden
partially revealed/hidden, transformed
revealed
amplified
Manipulations


SCORE 0000028816
HI 0000161636

https://www.youtube.com/watch?v=TN2hodL8Mfk

Schell's 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 1 or 2 of the lenses. Before selecting which lense to use, check at least the following:
  - #1 (Essential experience)
  - #12 (Resonance)
  - #13 (Infinite Inspiration)
  - #17 (Toy)
  - #100 (Love)
- **Add a slide to a shared Google Slides: 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.

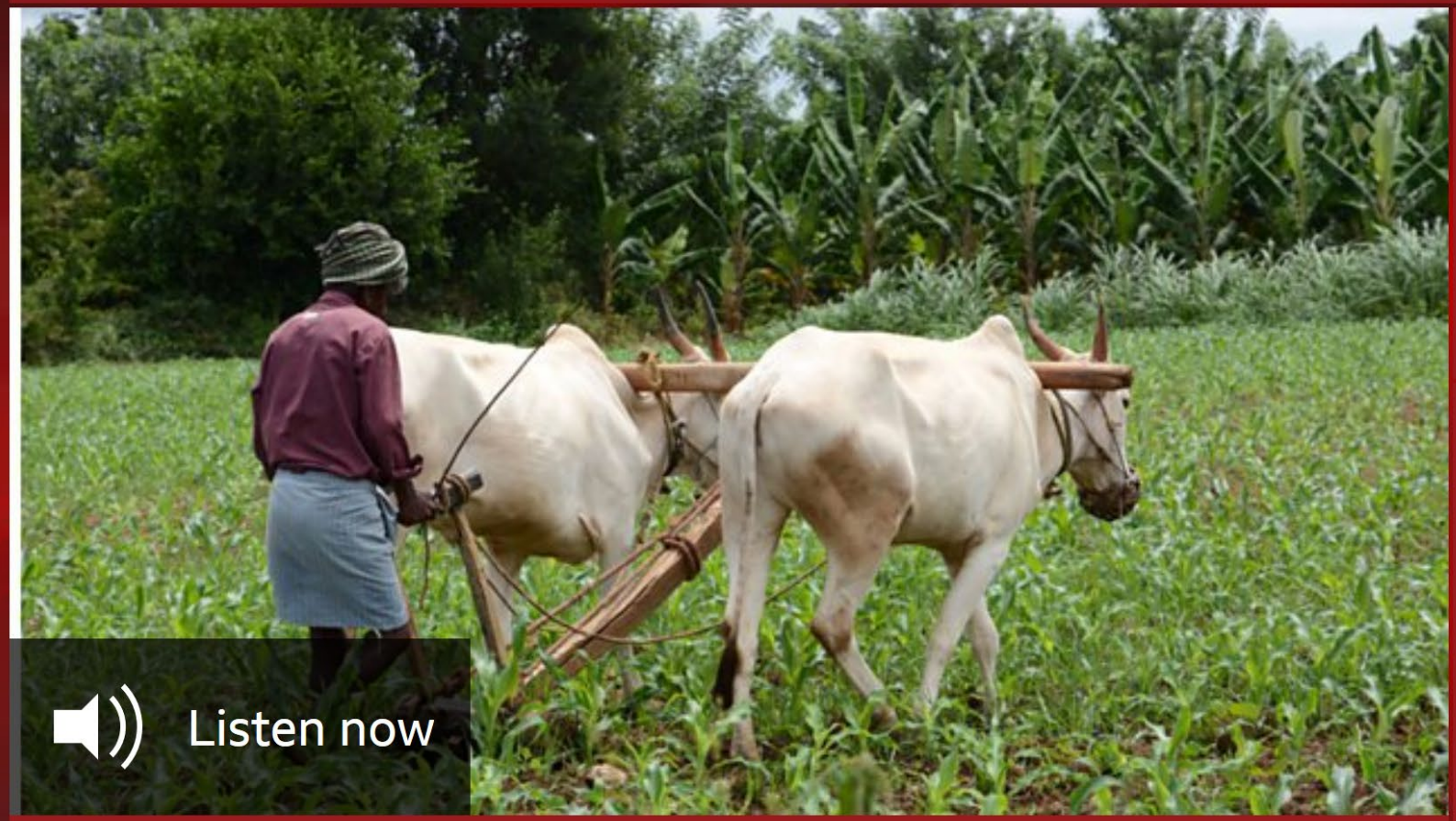
Gershman, Samuel J., Eric J. Horvitz, and Joshua B. Tenenbaum. "Computational rationality: A converging paradigm for intelligence in brains, minds, and machines." *Science* 349.6245 (2015): 273-278.

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

50 Things That Made the Modern Economy



The Plough

Last on

BBC WORLD SERVICE

Mon 23 Oct 2017

06:50

Local time

BBC WORLD SERVICE ONLINE & UK DAB/FREEVIEW ONLY

More episodes

PREVIOUS

Cold Chain

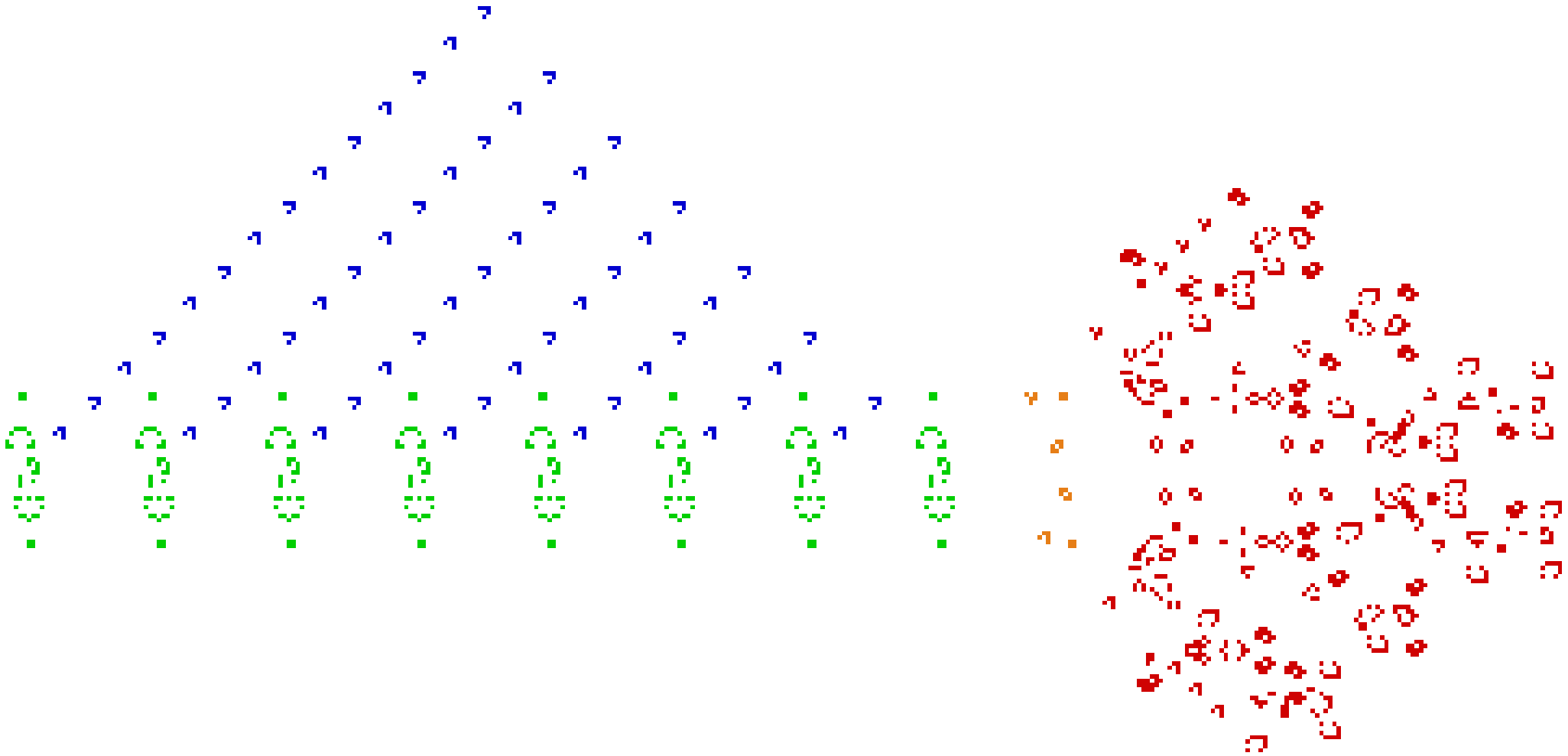
NEXT

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

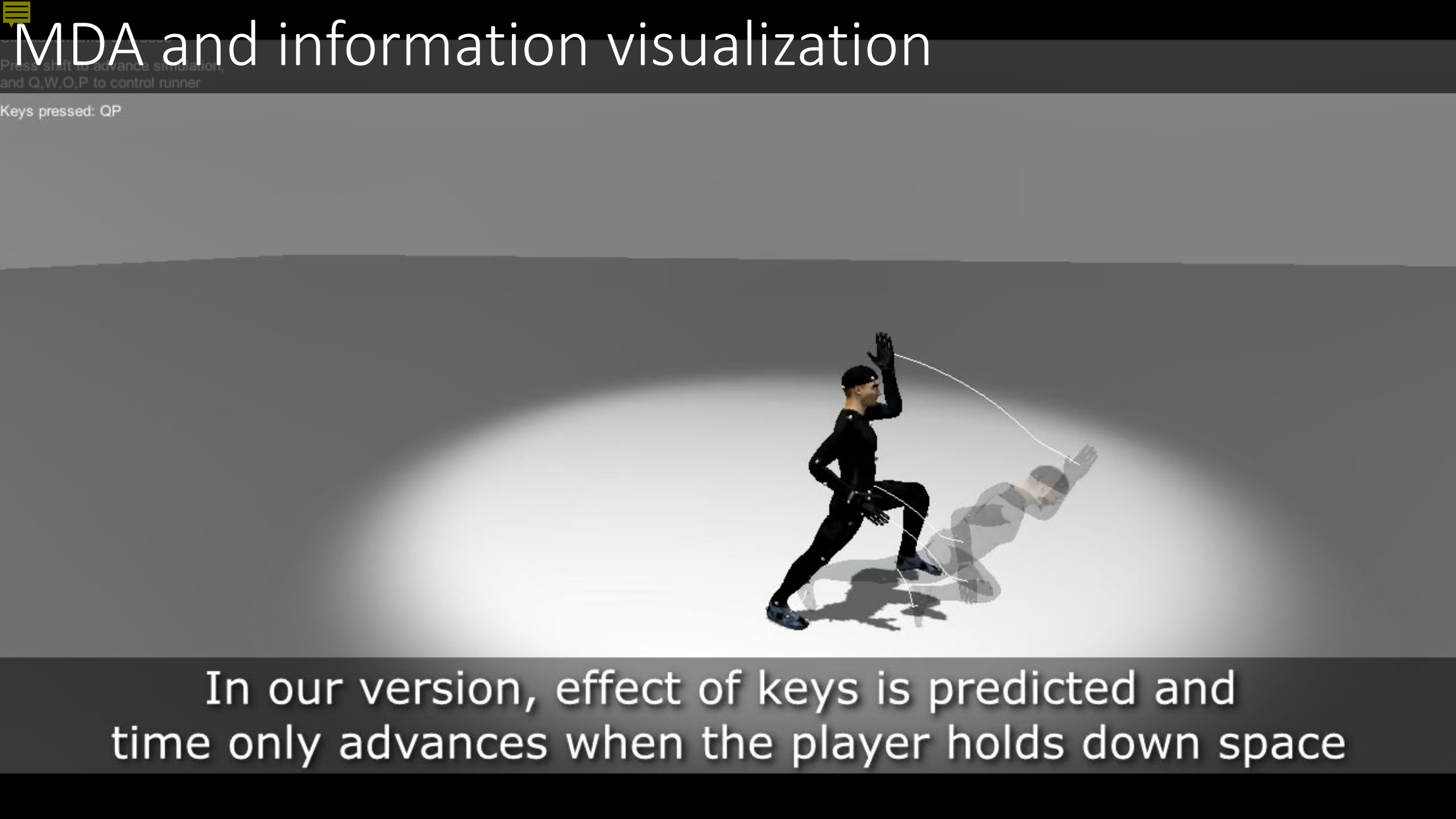


Game of Life rules

- 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.


Noita

MDA and information visualization



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 and dynamics? What did you learn? What do you find most interesting about the mechanics, dynamics & aesthetics, and why? Try to consider these both as a player and as a game designer.

MDA & explorable explanations debriefing

- What are the mechanics and dynamics?
- What did you learn?
- Was there anything surprising?

Preparation for the rest of the course

For week 2:

- 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 week 3:

- 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