Serious Games
als Lernbeschleuniger - worauf kommt es an?

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UNIVERSITÄT
WÜRZBURG

Games
Engineering

Faculty of
MATHEMATICS &
COMPUTER SCIENCE

Derzeitige Mitarbeiter/innen

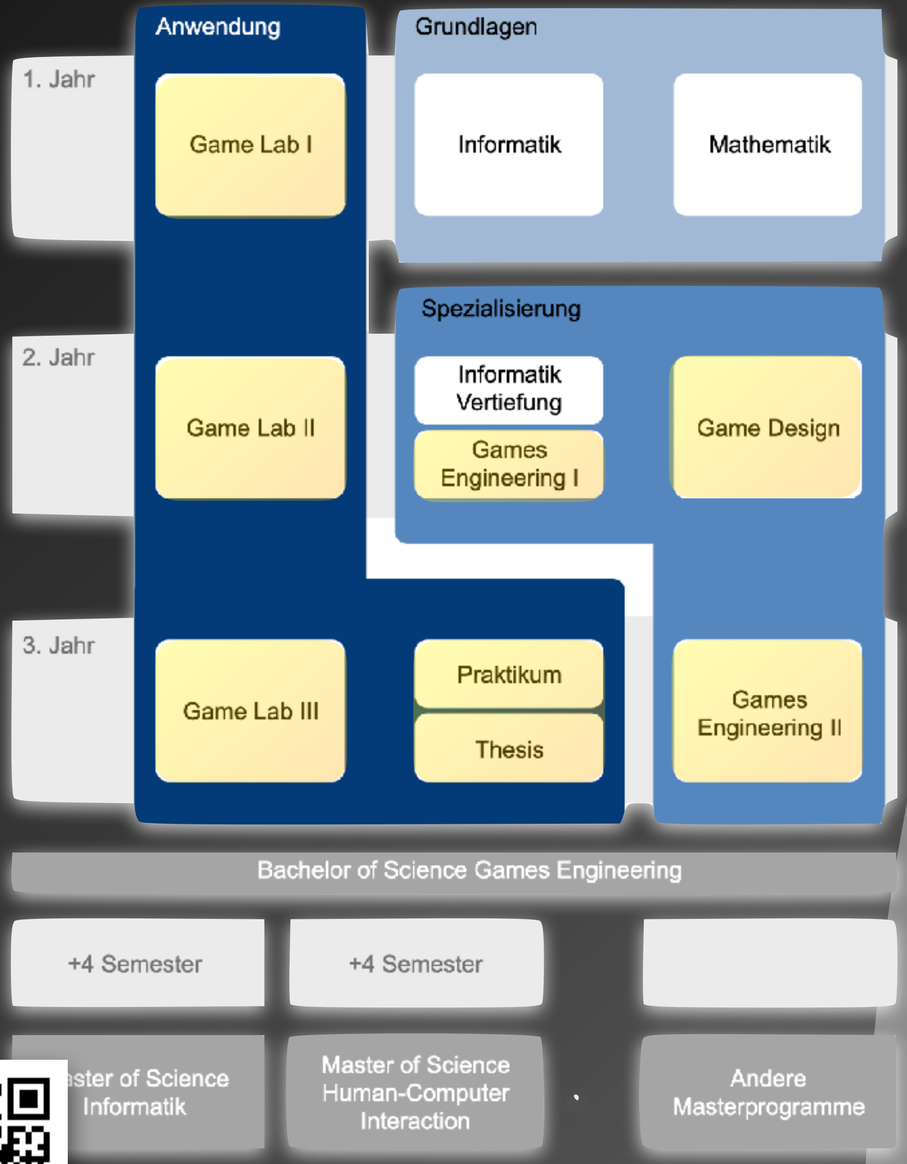
- Annika Fabricius, M.A.
  finanziert durch die Universitätsbibliothek
- Mounsif Chetitah, M.Sc.
- Sooraj K. Babu, M.Sc.
- Sarah Hofmann, B.Sc.
- Johannes Büttner, B.Sc.
- Samuel Truman, B.Sc.
- Damian Kutzias, M.Sc.
  with Fraunhofer IAO
- Andreas Müller, M.Sc.
  finanziert durch den Lehrstuhl Physikalische Chemie,
- Simon Seibt, M.Sc.
  an der TH Nürnberg
- Helge Olberding, M.Sc.
  an der FHWS

+ HiWis
+ Praktikanten/innen

Lehre/Betreuung

- **Games Engineering**, B.Sc.
- **Computer Science**, M.Sc
- **Human-Computer Systems**, B.Sc.
- **Human-Computer Interaction**, M.Sc.

Wissenschaftliche Schwerpunkte



Games Engineering, B.Sc.

- Game Labs 1, 2, 3 (je 15 bis 20 ECTS)
- Games Engineering Wahlfächer (5 bis 10 ECTS)
- Interaktive Künstliche Intelligenz (5 ECTS)
- Asset Development - Modellierung & Animation (5 ECTS)
- Seminar (5 ECTS)
- Praktikum (15 ECTS)
- Bachelorarbeit (15 ECTS)

https://games.uni-wuerzburg.de

Informatik, M.Sc. *

- Game Research Labs in den Bereichen: Theorie/Systeme/Gestaltung/Anwendung (je 10 ECTS)
- Seminar (5 ECTS)
- Wissenschaftliches Praktikum (10 ECTS)
- Masterarbeit (30 ECTS)

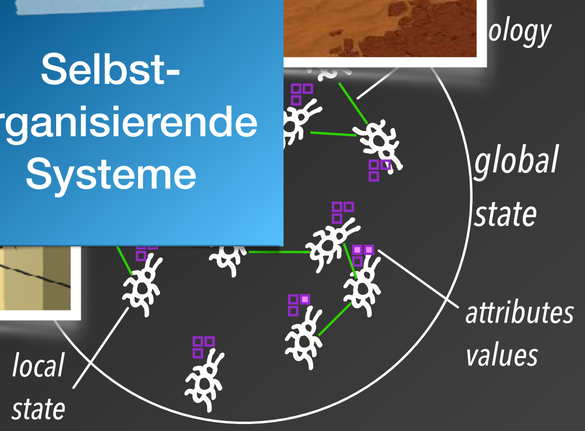
* **unsere Angebote im MSc-Programm münden in einem Studienschwerpunkt “Games Engineering”**

https://www.informatik.uni-wuerzburg.de

Rudolph et al., 2016

Büttner et al., 2020

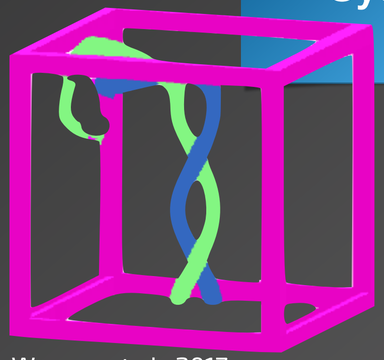
Selbst-organisierende Systeme



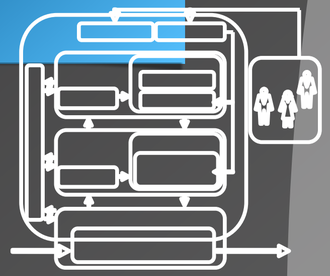
von Mammen, 2016

Künstliches Leben

Adaptive Systeme



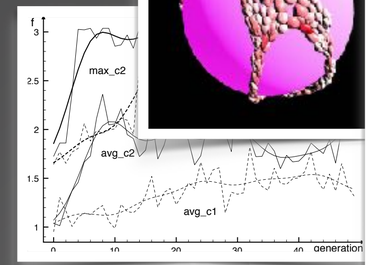
Wagner et al., 2017



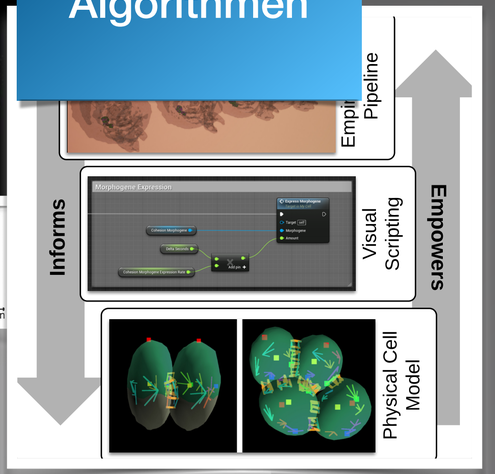
von Mammen, Tomforde et al., 2016

Däschinger et al., 2017

Evolutionäre Algorithmen

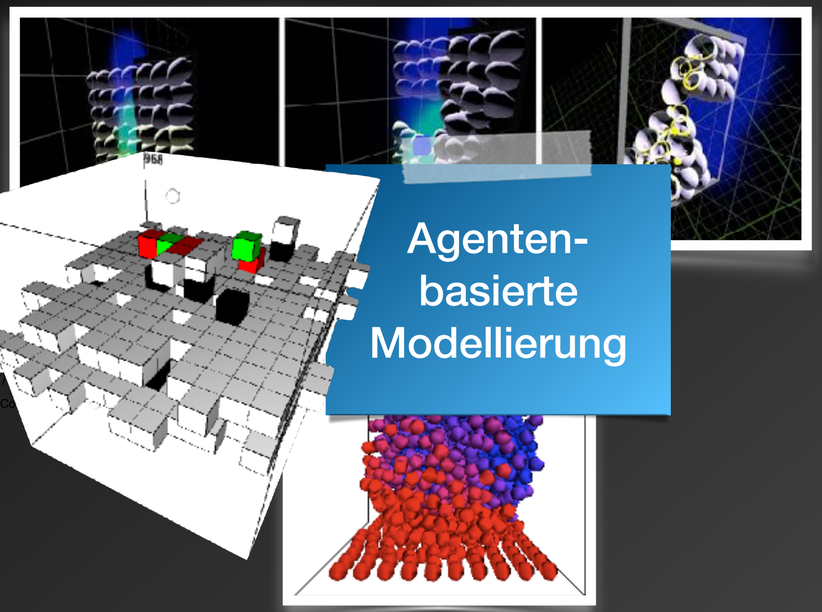


von Mammen & Jacob, 2008



Knote & von Mammen, 2017

Knote & von Mammen, 2019

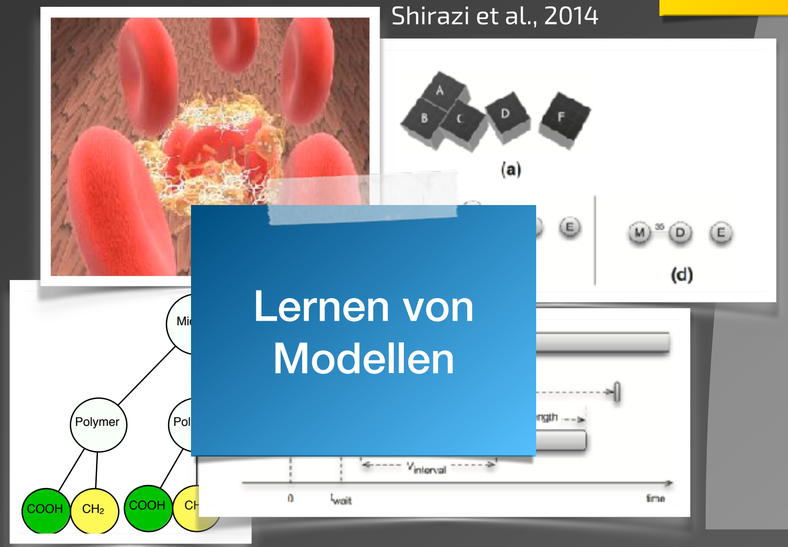


Agenten-basierte Modellierung

von Mammen et al., 2010

Künstliche Intelligenz

Shirazi et al., 2014

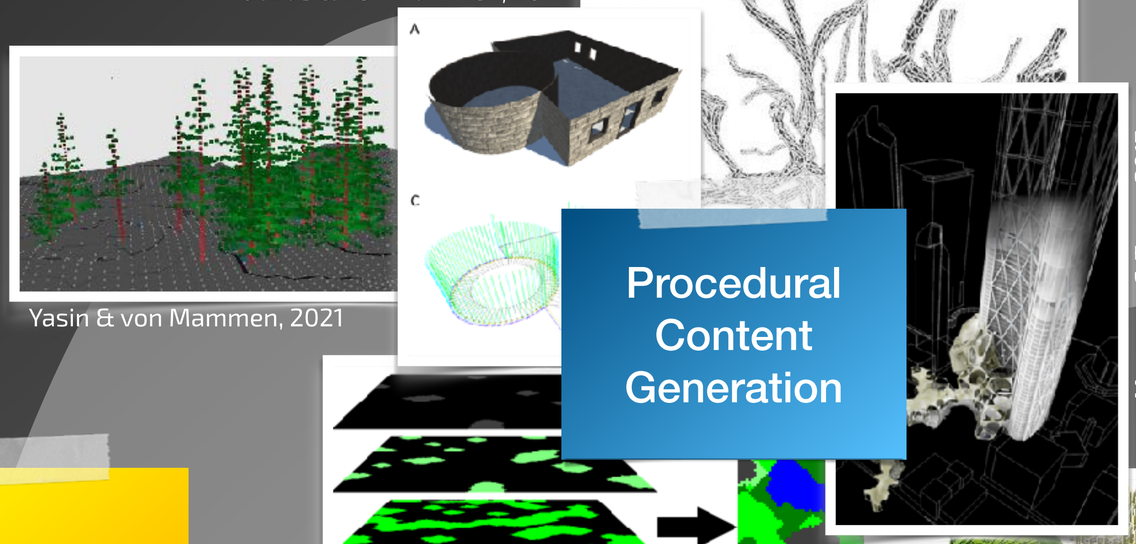


Lernen von Modellen

von Mammen & Stefhöfer, 2015

von Mammen, Wagner et al., 2017

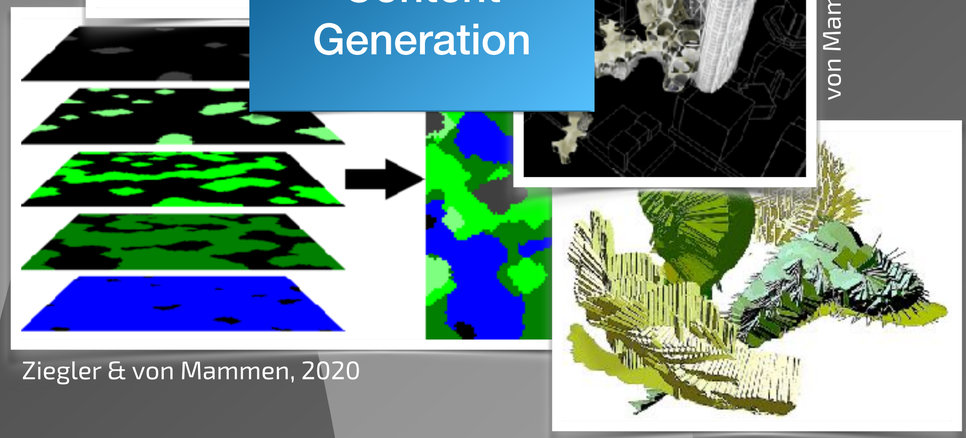
Kutzias & von Mammen, 2021



Yasin & von Mammen, 2021

Procedural Content Generation

von Mammen & Taron, 2017

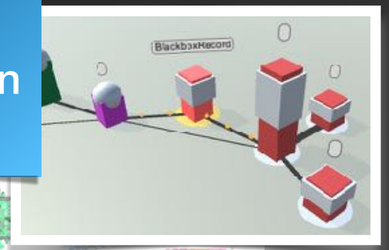


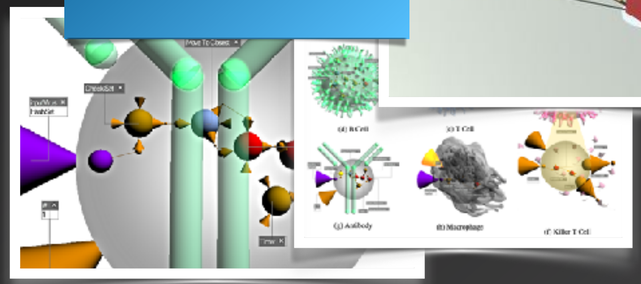
Ziegler & von Mammen, 2020

von Mammen & Jacob, 2008 [22]

Visuelles Programmieren

Ciolkowski et al., 2017

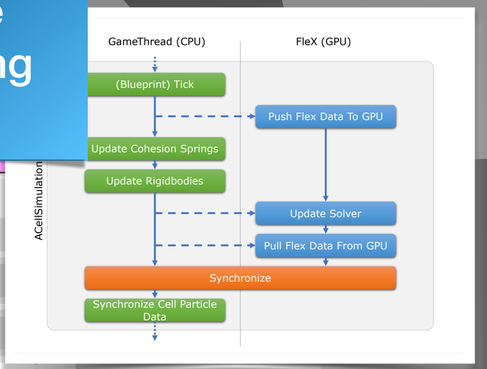


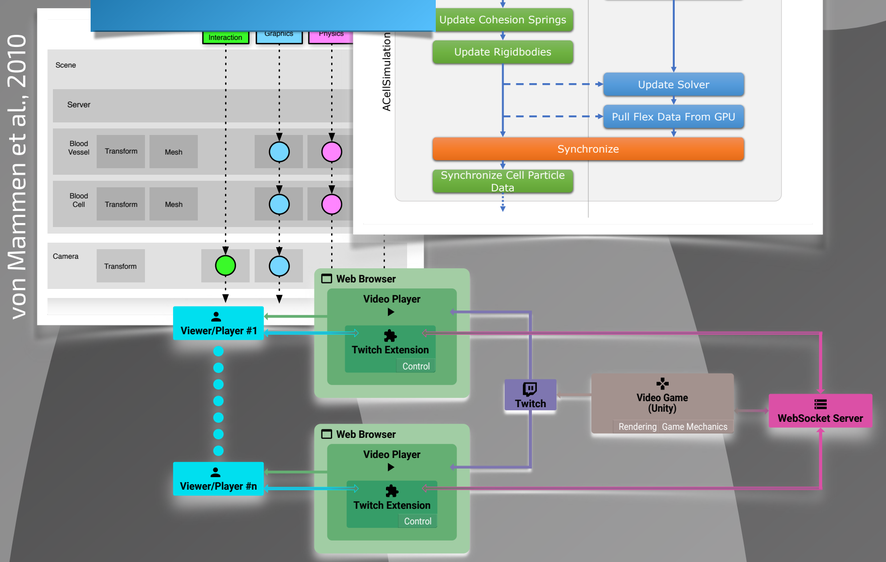


von Mammen, Schellmoser et al., 2016

Software Engineering

Knote & von Mammen, 2018





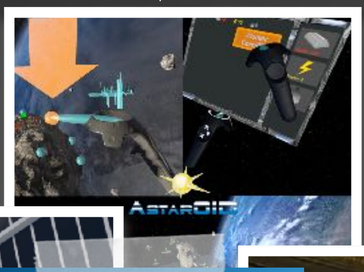
von Mammen et al., 2010

Wodarczyk & von Mammen, 2020

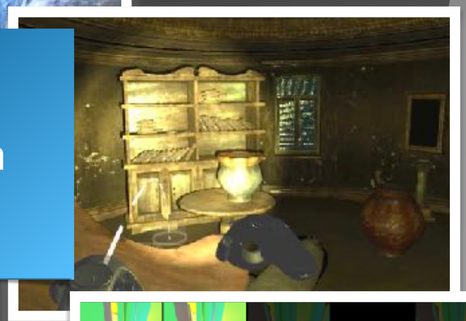
Echtzeitfähige Interaktive Systeme

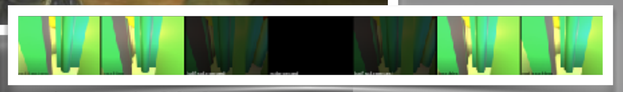
Immersion

Truman et al., 2018



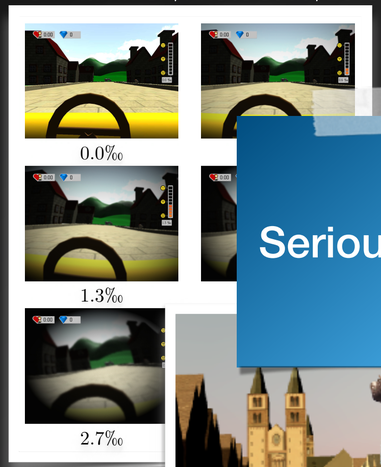
Truman & von Mammen, 2020



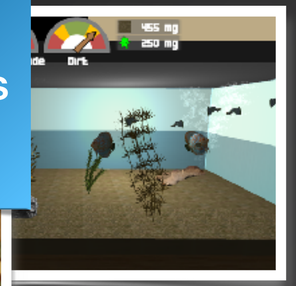


Ziegler et al., 2018

von Mammen, Knote et al., 2016



Serious Games

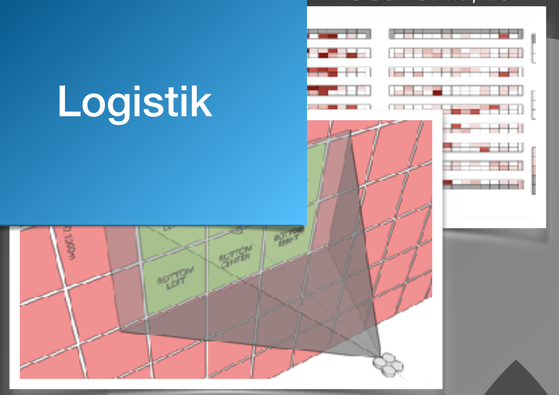


Schikarski et al., 2015

von Mammen & Schmidt, 2019

Logistik

Meisch et al., 2017



von Mammen, Lehner et al., 2015

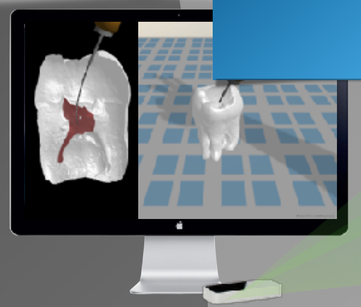
Interaktive Simulation

Knote, Fischer et al., 2019

Jacob et al., 2012

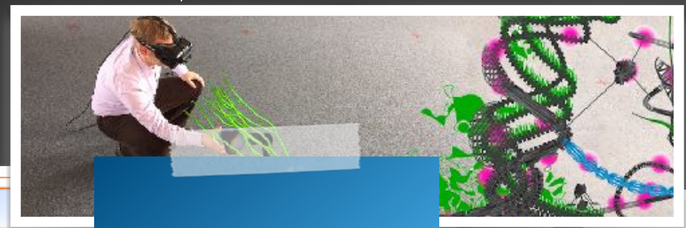
von Mammen, Müller et al., 2019

Medizin/ Gesundheit



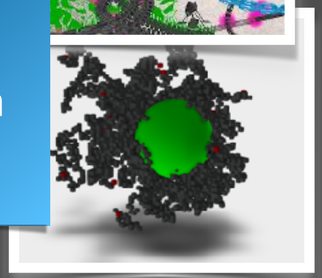
von Mammen, Weber et al., 2015

Heinrich et al., 2019



Konstruktion

Niebling et al., 2020



Edenhofer et al., 2016

Serious Games

Serious Games

Definition

“unterhalten einen erziehungswissenschaft-lichen oder Lernaspekt und sind nicht nur für Unterhaltung bestimmt”

De Freitas & Liarokapis 2011

haben “ein Ziel jenseits der Unterhaltung”

Dajouti et al. 2011

Serious Games

Kurze Geschichte

- von Plato bis Piaget: **Spielen heißt Lernen**
- die ersten **Serious Games** waren Simulationen, wie bspw. das Limonadenstand-Spiel von 1973

LEMONADE WEEK NUMBER 3

YOU HAVE:

$ 39.37
2 KG. SUGAR
8 L. CONC.
456 CUPS

WEATHER:

TEMPERATURE: 98
WET BULB : 94

YOU COULD HAVE GROSSED $ 23.36 TODAY,
IF YOU HAD CHARGED 16 CENTS.

HELP - PRESS H <RETURN>

Game Engines

Definition

Code Module

- die ein Spiel antreiben
- unabhängig von den konkreten Inhalten

Gregory 2019

Game Engines

Google Books Ngram Viewer, 2019

Serious Games

Kurze Geschichte

- von Plato bis Piaget: **Spielen heißt Lernen**
- die ersten **Serious Games** waren Simulationen, wie bspw. das Limonadenstand-Spiel von 1973
- erste Gestaltungsrichtlinien in den 80er Jahren (bspw. Melone, 1981)
- America’s Army und Serious Games-Initiative 2002

Wilkinson 2016


Burst
12
NEC
MultiSync FE700+
MultiSync

Serious Games

Ziele

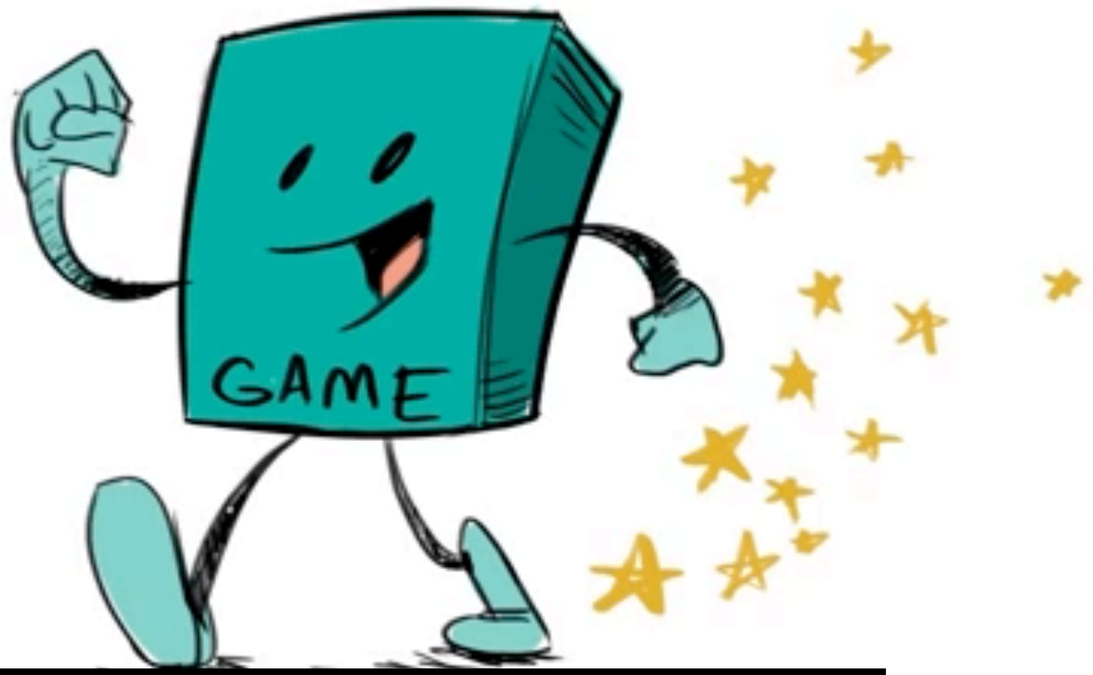
- **Lobbyismus**: Werbespiele, Ecogames, News Games,…
- **Lernen**: Spatiotemporal, logisch, Fakten,… über alle Disziplinen hinweg
- **Training**: Sensorimotor, kognitiv
- **Therapie**: Physiologisch, psychologisch
- **“Welt Retten”**: Puzzle lösen, Big Data,…

Gamification

Definition

“die Verwendung von Spielelementen in nicht-spielerischem Kontext“

Deterding et al. 2011



Aber wie erreicht man diese Ziele?

https://www.youtube.com/watch?v=1d

Lassen Sie uns drei Beispiele ansehen…

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

Spielemechaniken

“Methoden, die von Agenten aufgerufen werden, um eine Interaktion mit dem Spielzustand zu ermöglichen”

Sicart 2008

- **Bewegung** (room-scale und Teleportation zu vordefinierten Zielpunkten)
- **Manuelle Interaktion** (Hebel, Knöpfe, Münzen, Eicheln, Türklinken,…)

… **steigern die Immersion in den historischen Kontext und das Narrativ.**


1:30
0
3
0.0 ‰

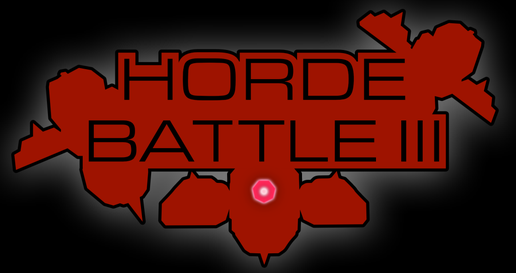
DRINK+DRIVE

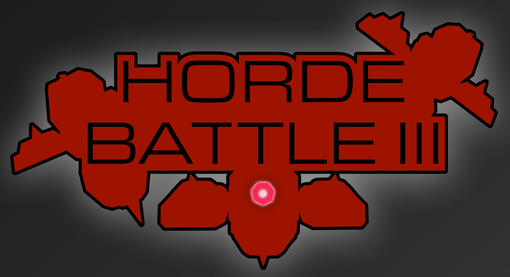
Spielemechaniken

- Bekannte cart-Mechaniken
- **Begrenzte Rundenzeit** (fordert sensorimotorische Spielleistung)
- **Blutalkohol** (reduziert sensorimotorische Spielleistung)
- **Highscore** (objektiviert und normiert die Spielleistung)

… lehren den negativen Einfluss von Alkohol auf sensorimotorische Leistungsfähigkeit.

https://www.youtube.com/watch?v=XQ9isXgUKaQ

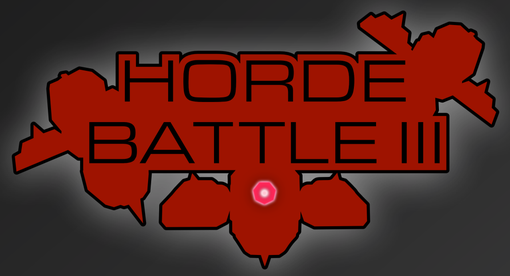




Spielmechaniken

- Bekannte First-Person-Shooter-Mechaniken

… werden direkt angewandt, um effizientes Zerlegen von Netzwerken zu trainieren.



Lernziele

Mechaniken

Netzwerkzerlegung

Performanzverlust wg. Blutalkohol

Historische Umgebung und Narrativ

Stärkere Beziehung zw. Zielen und Mechaniken

Zielen und Schießen, Gesundheitsstatus,

Fahrkontrolle

Navigation und manuelle Interaktion

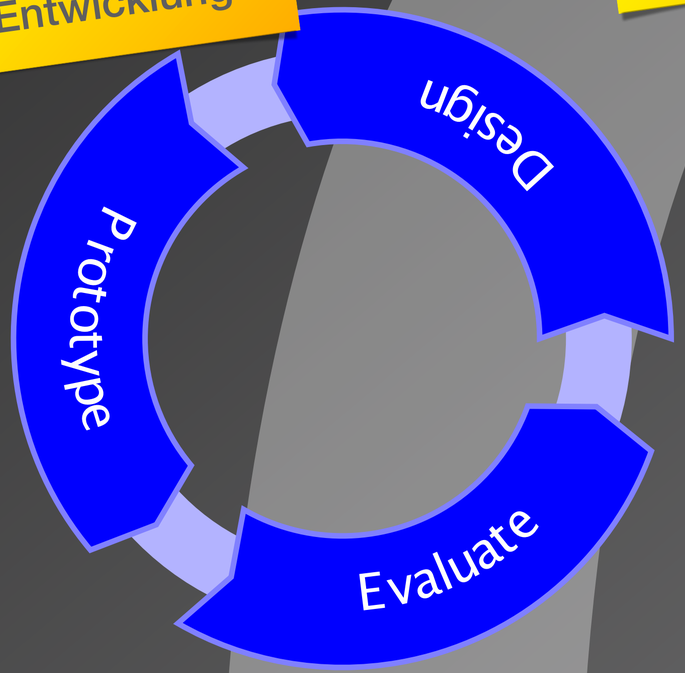
Welche Gestaltung setzt die Ziele um?

Spiele-entwicklung

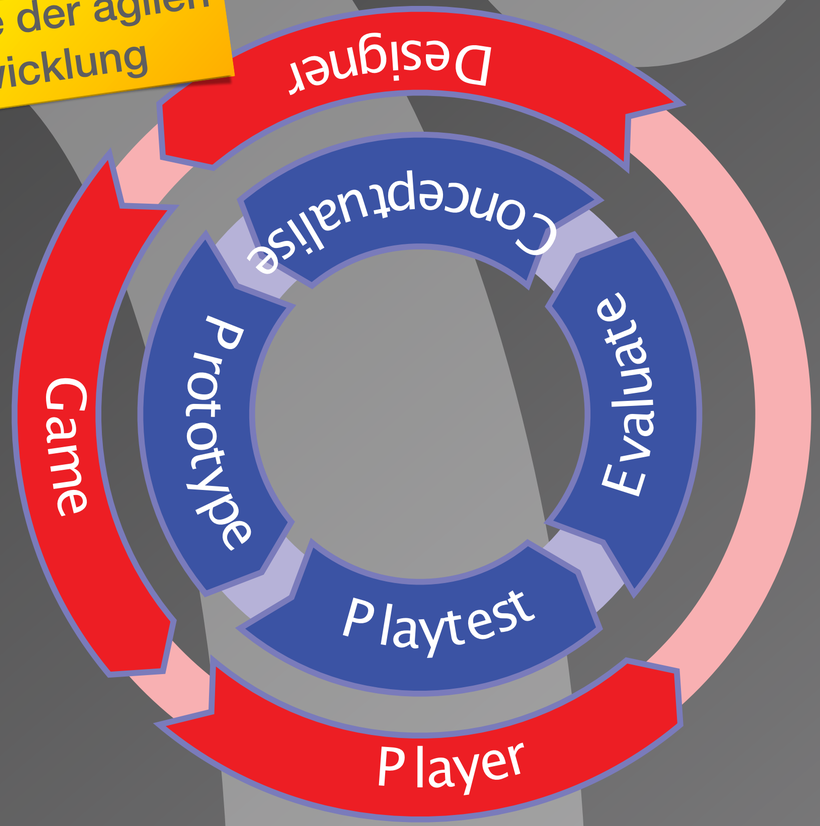
Phasen

1. Konzept
2. Pre-Produktion
3. Prototyp
4. Produktion
5. Alpha
6. Beta
7. Gold
8. Post-Produktion

Agile Entwicklung



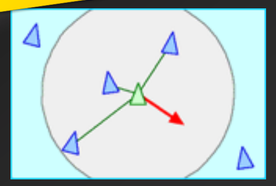
2. Ebene der agilen Entwicklung

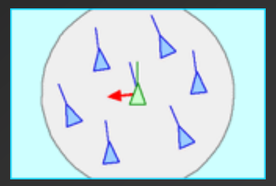


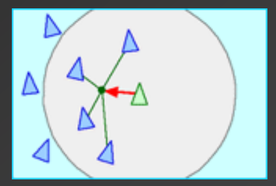
Macklin and Sharp, 2016

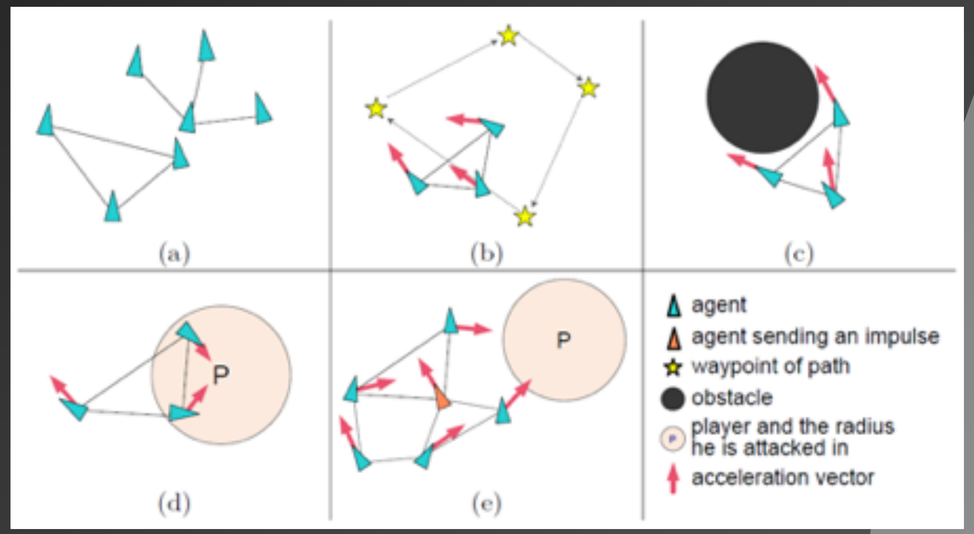
HORDE BATTLE

Domänenmodell

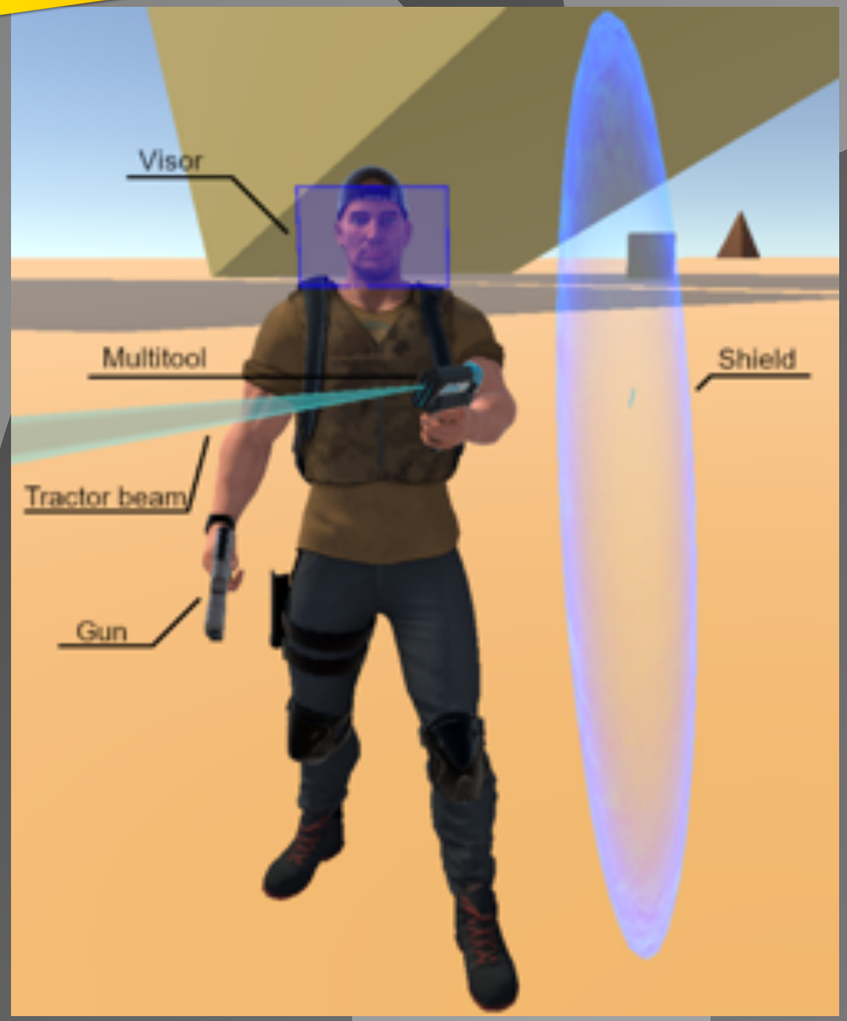






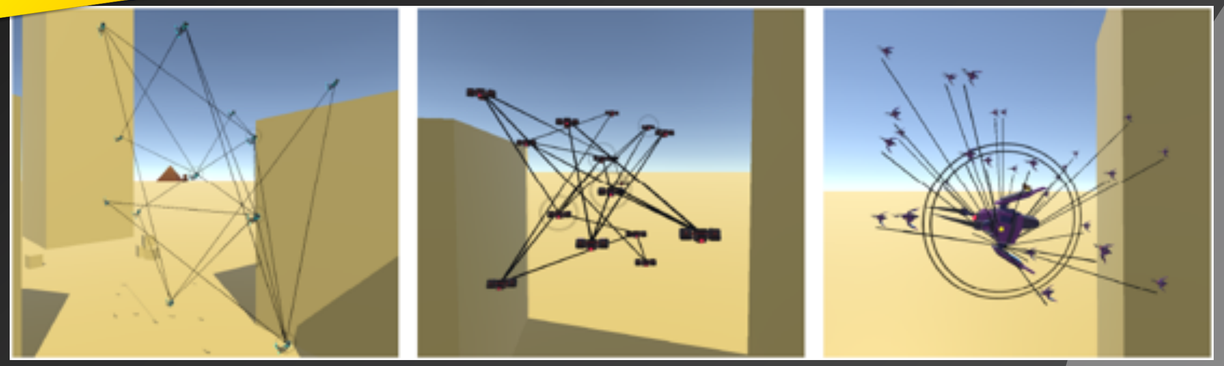


Nutzerinteraktion



HORDE BATTLE III

Level Design



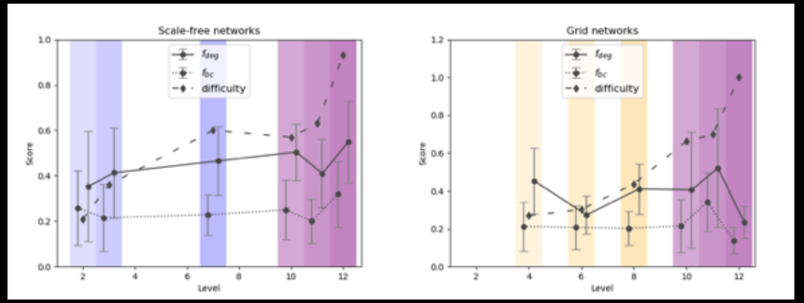
Level	1	2	3	4	5	6	7	8	9	10	11	12
Lootboxes	-	-	-	-	1	2	5	-	-	2	-	6
Enemies	3	7	12	16	2	14	15	16	31	8, 9	12, 9	11, 14
Tutorials	Shield	Pistol	Grenade Launcher	Submachine Gun	Lootboxes			Visor				

Evaluation

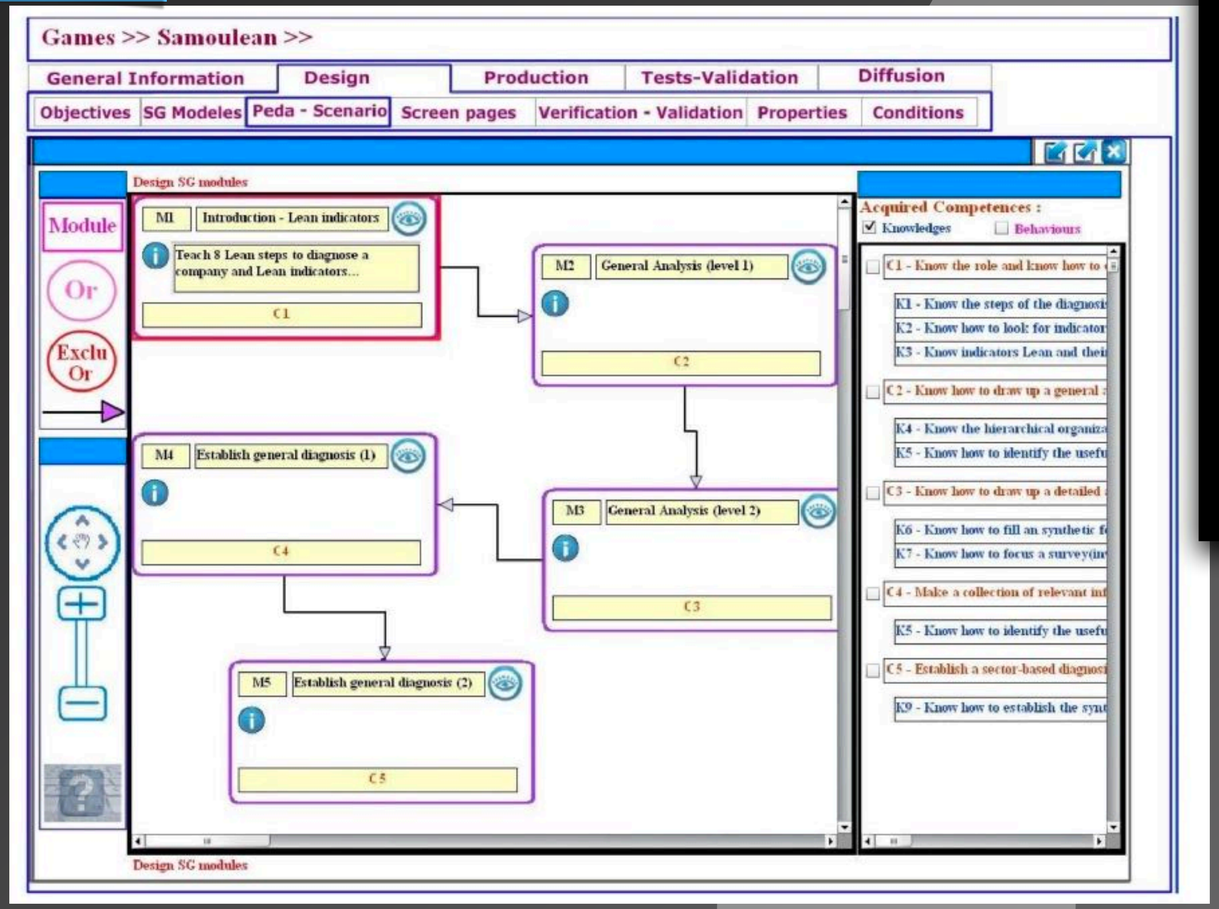
- Demographische Daten
- Wiederholbares Experiment
- Standardisierte Fragebögen
- Aufgabenspezifische Performanzmessung

$$f_{bc} = \frac{\sum_{h=1}^{||hits||} g(n_{max}) - g(n_h)}{||hits||} \qquad f_{deg} = \frac{\sum_{h=1}^{||hits||} \hat{d}(n_{max}) - \hat{d}(n_h)}{||hits||}$$

- Analyse: Performanz vs. Schwierigkeitsstufe



Werkzeuge



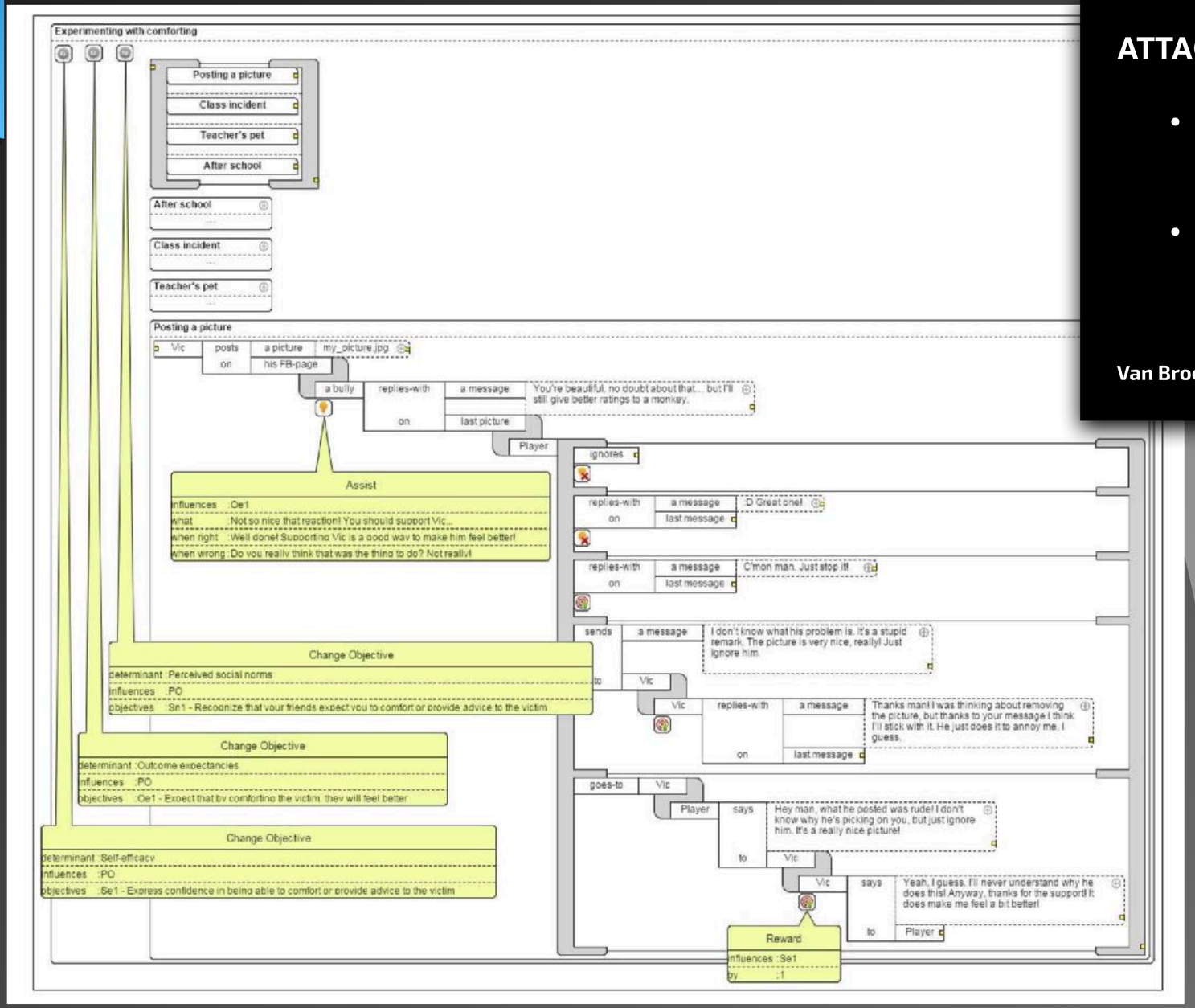
Gestaltungsumgebung für Serious Games

Entwicklung eines strukturierten Szenarios mithilfe dreier Modellierungsschritte:

- Pädagogische Zielsetzung
- Interaktions-basiertes pädagogisches Szenario
- Unterhaltungselemente

Tran et al. 2010

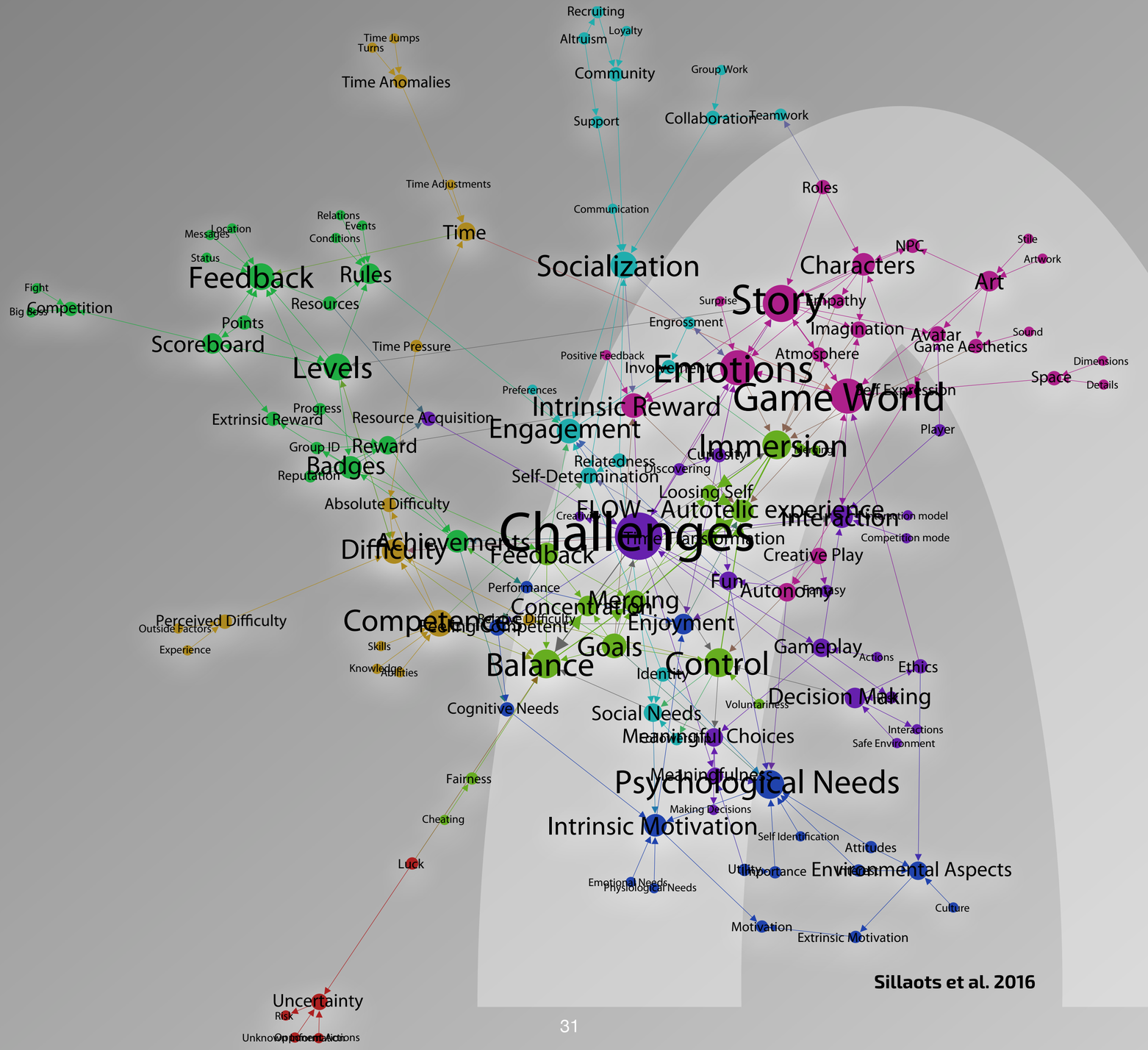
Werkzeuge



ATTAC-L

- Domänen-spezifische Modellierungssprache
- Zwischen pädagogischer Gestaltung & narrativeer Modellierung

Van Broeckhoven et al. 2015


Recruiting
Altruism
Loyalty
Community
Group Work
Collaboration
Teamwork
Support
Time Jumps
Turns
Time Anomalies
Time Adjustments
Time
Communication
Roles
Relations
Events
Conditions
Messages
Location
Status
Feedback
Rules
Resources
Socialization
Characters
NPC
Stile
Artwork
Art
Fight
Competition
Big Boss
Points
Scoreboard
Levels
Time Pressure
Surprise
Story
Empathy
Engrossment
Imagination
Avatar
Sound
Game Aesthetics
Positive Feedback
Involvement
Atmosphere
Emotions
Game World
Dimensions
Space
Details
Preferences
Intrinsic Reward
Self Expression
Progress
Extrinsic Reward
Resource Acquisition
Engagement
Immersion
Player
Group ID
Reward
Badges
Reputation
Relatedness
Curiosity
Discovering
Self-Determination
Loosing Self
Absolute Difficulty
FLOW
Autotelic experience
Interaction
Challenges
Difficulty
Achievements
Feedback
Creative Play
Fun
Performance
Autonomy
Fantasy
Concentration
Merging
Perceived Difficulty
Outside Factors
Experience
Competence
Enjoyment
Goals
Gameplay
Skills
Knowledge
Balance
Control
Actions
Ethics
Identity
Decision Making
Cognitive Needs
Social Needs
Voluntariness
Meaningful Choices
Interactions
Safe Environment
Fairness
Meaningfulness
Psychological Needs
Cheating
Making Decisions
Intrinsic Motivation
Self Identification
Attitudes
Luck
Utility
Importance
Environmental Aspects
Emotional Needs
Physiological Needs
Culture
Motivation
Extrinsic Motivation
Uncertainty
Risk
Sillaots et al. 2016

Systematische Gestaltung

Lerntheorien

- Behaviorismus
- Kognitivismus
- Konstruktionismus
- …

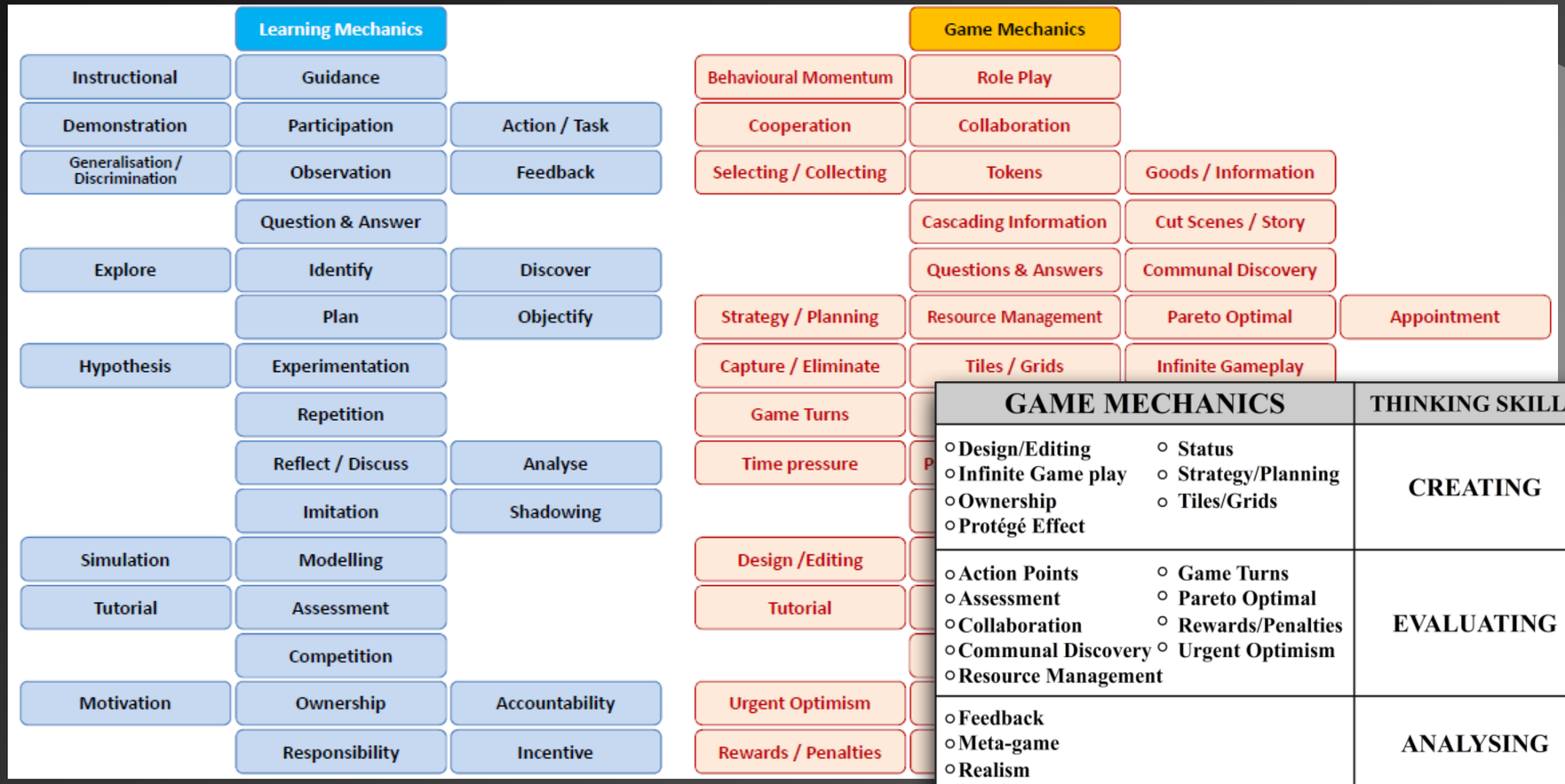
Ertmer & Newby 1993

Rahmenwerke für das Lernen

- (Revised) Bloom's taxonomy
- Gardner's multiple intelligences
- …

Mosely et al. 2005

Spiel-elemente



GAME MECHANICS	THINKING SKILLS	LEARNING MECHANICS
○ Design/Editing ○ Infinite Game play ○ Ownership ○ Protégé Effect ○ Status ○ Strategy/Planning ○ Tiles/Grids	CREATING	○ Accountability ○ Ownership ○ Planning ○ Responsibility
○ Action Points ○ Assessment ○ Collaboration ○ Communal Discovery ○ Resource Management ○ Game Turns ○ Pareto Optimal ○ Rewards/Penalties ○ Urgent Optimism	EVALUATING	○ Assessment ○ Collaboration ○ Hypothesis ○ Incentive ○ Motivation ○ Reflect/Discuss
○ Feedback ○ Meta-game ○ Realism	ANALYSING	○ Analyse ○ Experimentation ○ Feedback ○ Identify ○ Observation ○ Shadowing
○ Capture/Elimination ○ Competition ○ Cooperation ○ Movement ○ Progression ○ Selecting/Collecting ○ Simulate/Response ○ Time Pressure	APPLYING	○ Action/Task ○ Competition ○ Cooperation ○ Demonstration ○ Imitation ○ Simulation
○ Appointment ○ Cascading Information ○ Questions And Answers ○ Role-play ○ Tutorial	UNDERSTANDING	○ Objectify ○ Participation ○ Question And Answers ○ Tutorial
○ Cut scenes/Story ○ Tokens ○ Virality ○ Behavioural Momentum ○ Pavlovian Interactions ○ Goods/Information	RETENTION	○ Discover ○ Explore ○ Generalisation ○ Guidance ○ Instruction ○ Repetition

LOTS to HOTS

LM-GM Framework

Lim et al. 2015

Systematische Gestaltung

Lerntheorien

- Behaviorismus
- Kognitivismus
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- …

Ertmer & Newby 1993

Rahmenwerke für das Lernen

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Mosely et al. 2005

Spiel-elemente

E.g. **De Lope & Medina-Medina 2017**

Ontologie

Definition

“eine Menge an Konzepten und Kategorien einer Domäne, die ihre Eigenschaften und Beziehungen zum Ausdruck bringt”

Oxford Dictionary 2020

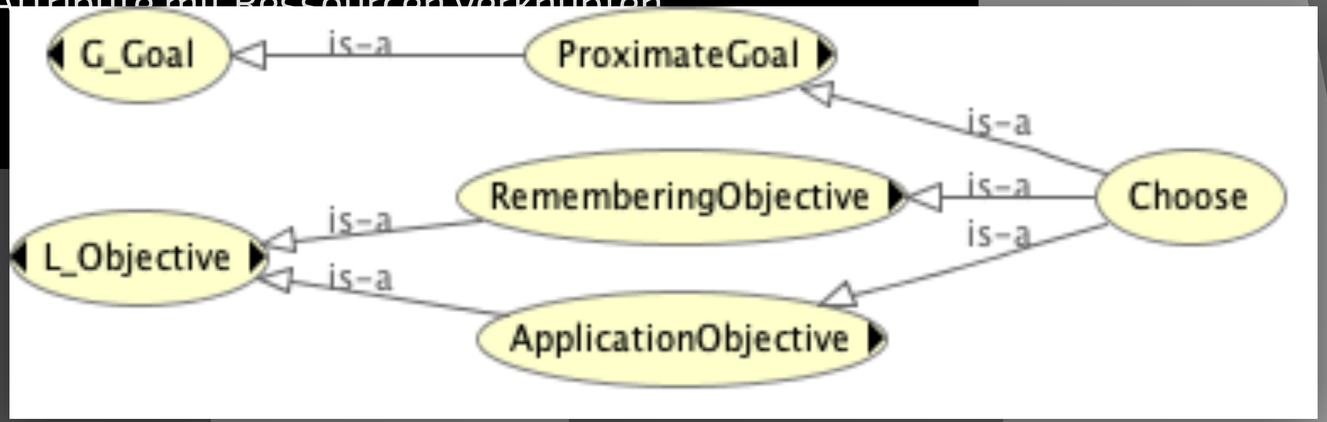
Resource Description Framework (RDF)

Idee

“Daten über Daten” ➤ “Daten, die Web-Ressourcen beschreiben”

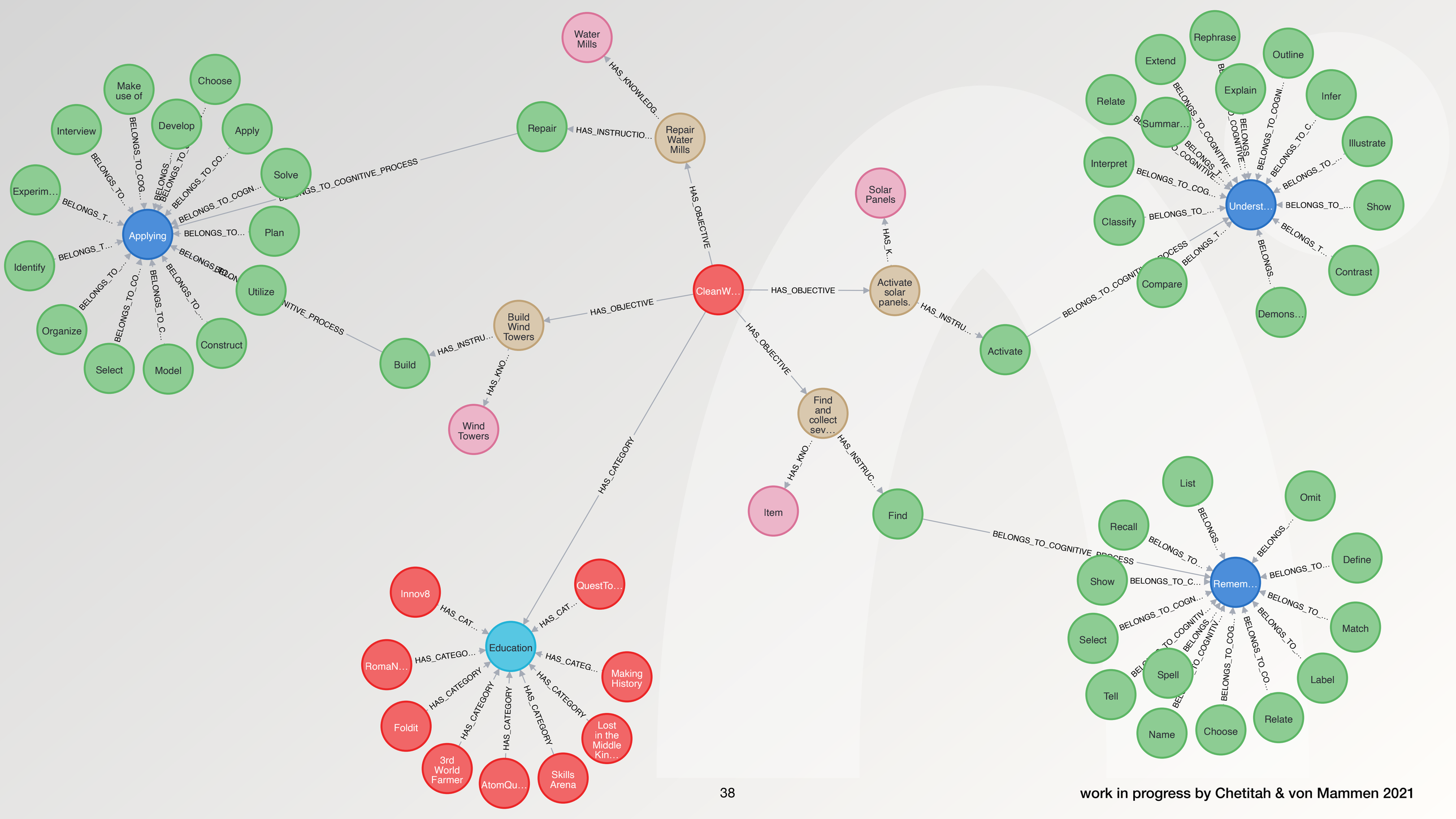
wobei
- “Ressoucen” beliebige Objekte sein können und
- “Aussagen” Attribute mit Ressourcen verknüpfen

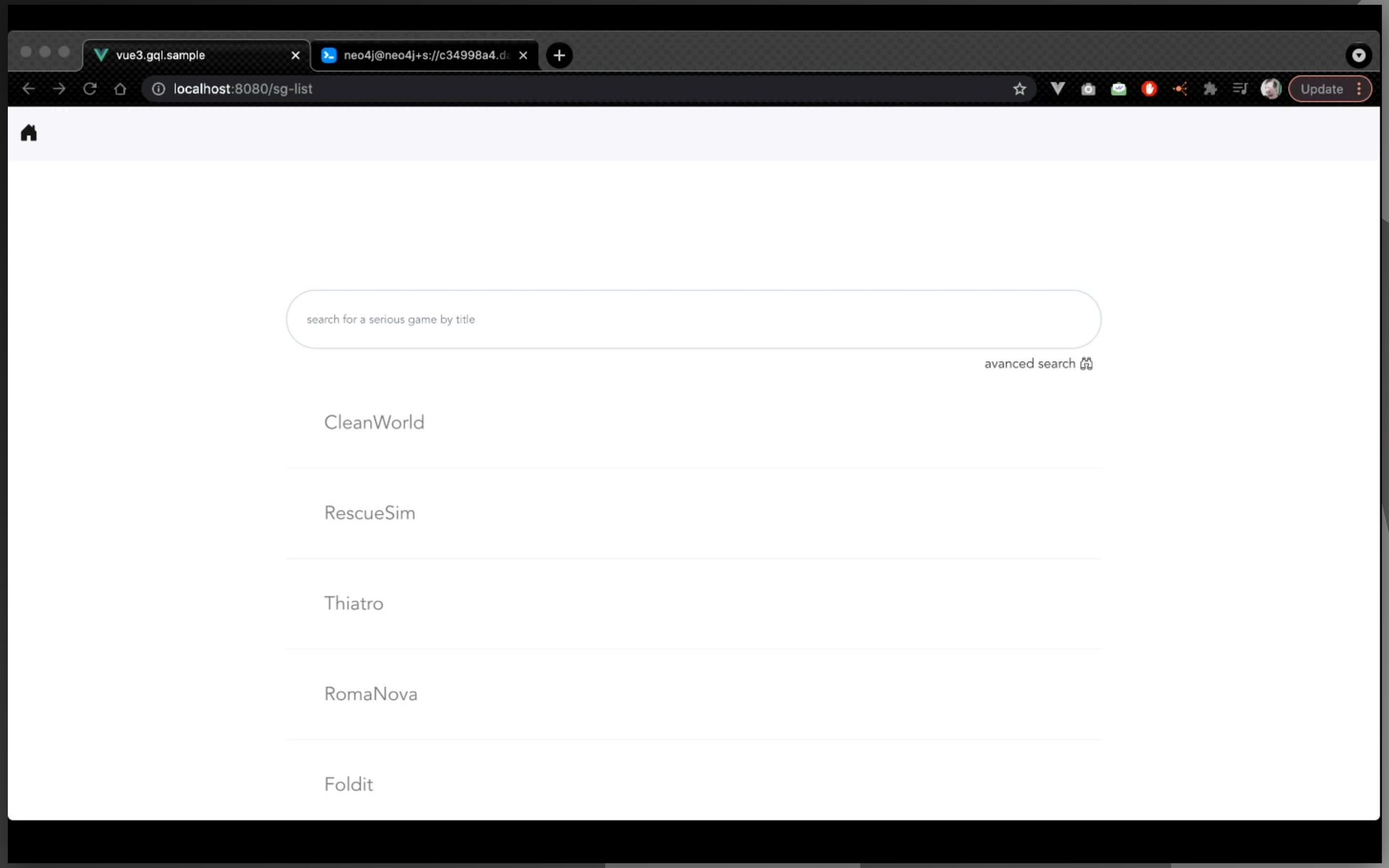
Lassila et al. 1998



CleanWorld

Barbosa et al. 2014


CleanW…
HAS_OBJECTIVE
Water Mills
HAS_KNOWLEDG…
Repair Water Mills
HAS_INSTRUCTIO…
Repair
BELONGS_TO_COGNITIVE_PROCESS
Applying
BELONGS_TO…
Make use of
Choose
Interview
Develop
Apply
Solve
Experim…
Plan
Identify
Utilize
Organize
Construct
Select
Model
Build
HAS_INSTRU…
Build Wind Towers
HAS_KNO…
Wind Towers
HAS_OBJECTIVE
Solar Panels
HAS_K…
Activate solar panels.
HAS_INSTRU…
Activate
BELONGS_TO_COGNITIVE_PROCESS
Understa…
Rephrase
Extend
Outline
Explain
Relate
Summar…
Infer
Illustrate
Interpret
Classify
Show
Compare
Contrast
Demons…
HAS_OBJECTIVE
Find and collect sev…
HAS_KNO…
Item
HAS_INSTRUC…
Find
BELONGS_TO_COGNITIVE_PROCESS
Remem…
List
Omit
Recall
Define
Show
Match
Select
Spell
Label
Tell
Name
Choose
Relate
HAS_CATEGORY
Education
Innov8
QuestTo…
RomaN…
Making History
Foldit
Lost in the Middle Kin…
3rd World Farmer
AtomQu…
Skills Arena


vue3.gql.sample
neo4j@neo4j+s://c34998a4.d
localhost:8080/sg-list
Update
search for a serious game by title
avanced search
CleanWorld
RescueSim
Thiatro
RomaNova
Foldit

Zusammen-
fassung

Serious Games
- Definition
- Kurze Geschichte

Beispiele
- Barlock, Drink & Drive, Hord Battle III
- Spielemechaniken

Herausforderung: Gestaltung
- Agile Spieleentwicklung
- Details zu Hord Battle III
- Werkzeuge (EDoS, ATTAC-L)
- Spielelemente

Systematische Gestaltung
- Lerntheorien, Rahmenwerke, LM-GM framework
- Ontologie, RDF, OWL
- Ontologische Ableitung kognitiver Prozesse von Serious Games, Bspe: Clean World, AtomQuest

Nächster Schritt
- Ableiten von Spielelementen um (Lern-)Ziele optimal zu unterstützen

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