DEPARTMENT OF INFORMATICS

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Bachelor's Thesis in Informatics Games Engineering

Dynamic Detection of Player Types and Adaption of Game Components for Optimal User Experience

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Dynamische Erkennung von Spielertypen und Anpassung von Spielkomponenten für optimale User Experience

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I confirm that this bachelor's thesis in informatics games engineering is my own work and I have documented all sources and material used.

Munich, 15.11.2020 Viktoria Kirchleitner

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Abstract

Goal of this bachelor thesis is to find ways of dynamically detecting player preferences during runtime and to suggest ways of adapting the game according to it.

To do so, it first investigates five different definitions of play and discusses them. It proceeds with a literature search of possible player type taxonomies and discuss them under the aspect of suitability for dynamic detection. The results of this discussion deem Bartle's player types to be the best fit for this task.

The thesis proceeds with outlining a short implementation of a player-type-detection algorithm in a prototype and highlighting possible ways of adapting the game to the players preferences.

Contents

1 Introduction

The video game industry has flourished in recent decades, turning the still young medium from a once niche form of entertainment to a mainstream success. A wide variety of new game genres and video games has attracted an even more diverse player base, each user with their own preferences in games and play style. Of course, as game developers and researchers, we are interested in creating the best experience for our users, therefore we need to ask ourselves the question: what exactly do people like to play? And what can we do with this kind of information?

Numerous studies and researchers, e.g. [4] [17] [6] [20], have looked at players motivation and play styles and came up with different answers for these questions. Furthermore, trying to adapt games to different types of players has been a part of the game design process for a while as well. But new and improved technology gives us the opportunity to not only design our game to fit different preferences but to also adapt our game during runtime individually for each player.

In this thesis, following questions will be discussed and answered:

Q1: What exactly is play?

Q2: What different models exist to categorize players and which is suited for adaptive gameplay?

Q3: How can we dynamically detect player types during runtime?

Q4: How can we adapt our game according to player types?

2 Related Work

2.1 Definitions of Play

To adapt gameplay according to player types, first, a definition for playing itself is needed. To do so, in 3 definitions of play out of various fields will be discussed. Seeing as 'Homo ludens' by Johan Huizinga [12], 'Man, Play and Games' by Roger Caillois [7] and 'Play' by Catherine Garvey [10] all use definitions based upon numerous, partly overlapping key characteristics while Salen et. al. in 'Rules of Play' [14] and Jesse Schell in 'The Art of Game Design' [16] use more abstract definitions for play, one will quickly come to realize that this seemingly trivial question is in fact anything but trivial and needs to be discussed before proceeding further.

2.2 Player Taxonomies

Numerous taxonomies for player types have been established. Richard Bartle [4] developed a well known and frequently used model of player types, grouping players into four different categories. His model served as a basis for numerous proceeding work such as Bart Stewart's Unified Model. In their paper 'Player Types: A Metasynthesis', J. Hamari et.al. [11] have had a look at numerous of these taxonomies and compared them especially in the aspect of which concepts were used to segment players. Their marketing theory segmentation approach gives an overview over segmentational aspects of each taxonomy. However, the paper only gives a summery of some of the most important models and does not discuss which taxonomy is best used to determine player types dynamically and to then adapt the game play, so in 4 different models will be discussed under these considerations.

2.3 Adaptive Gameplay

Adapting games to the preferences of players is a common practice in game design. Most big and successful role-playing games like e.g. *Skyrim* or the *Witcher* series give the player the opportunity to choose a class similar to their preferred style of play or quests of their liking.

The idea of changing a game dynamically is also nothing new. E.g. games such as *Resident Evil* use the praxis of *Dynamic Game Difficulty Balancing (DGDB)* which refers to the adaptation of a games difficulty during runtime. Fuentes Perez et.al. [9] propose a DGDB method using evolutionary fuzzy cognitive maps. But changing game mechanics according to a player type as is discussed in 6 has not yet been done.

3 Different Definitions of Play and Game...

Play is an important part of our life starting in our childhood. Every person seems to have a natural understanding of what 'playing' is supposed to mean but when trying to find exact words for it, one is struggling to come up with a definition that is neither too narrow nor too broad. But when thinking about creating a game and when trying to enhance user experience, it is essential to understand 'play' in itself. In this thesis, we will use Jesse Schell's definition of play as "manipulation that indulges curiosity" [16].

3.1 ...in cultural history

The Dutch historian Johan Huizinga defined a couple of key characteristics of play in his book 'Homo Ludens' which was published first in 1938. According to him, playing is a free and absorbing activity outside of life that is not serious or connected to any material interest. Furthermore, play has its own boundaries, its own set of rules and promotes the formation of social groupings who surround themselves with secrecy and who stress their difference from the common world by disguise or other means. [12]

Some characteristics instinctively make sense: play has to be free, meaning it has to happen voluntarily. If one is being forced to perform an action, this cannot be considered 'play'. The possibly fun afternoon activity all of a sudden becomes a duty and maybe even a burden which then can hardly be considered 'play'.

Furthermore, Huizinga stresses that playing is an activity which requires active involvement of the player. Watching a movie for example might also fulfil the other requirements but because of the lack of interaction most people would probably not consider this to be a form of play.

By defining play as 'outside of life' and 'not serious', he is not trying to belittle the importance of play. In fact, play is, according to him, promoting the well-being of a group. It is also important to notice that by 'not serious' Huizinga is not denying the seriousness someone can hold while participating in play. He simply separates play from the 'necessities of life' [12] referring to activities following material interests or satisfying biological needs.

Interesting about his definition is his focus on the social aspects of playing, especially video games promote the formation of fan bases who communicate through online

forums, who share their own inside-jokes that might be perceived as 'secrecy' by outsiders and who might partake in activities such as cosplaying. However, the formation of social groups is not mandatory for play. For example, a lot of people play mobile games on a regular basis without ever participating in conversations about the game, neither online nor in real life. These mobile games might try to add a social aspect to their game by integrating friend lists or high scores, but social interaction is not necessary to play.

Also, we would usually associate the absorbing aspects of play with the quality rather than play itself. A game might be quite challenging and absorbing to inexperienced players while being boring to others, however, even though the game might fail to absorb some players, they would most likely still consider their activity to be play and just move on to another game.

It is interesting to notice that Huizinga does not differentiate between 'play' and a 'game' which also explains why he believes that play should have boundaries and rules. However, when we are thinking about e.g. children playing with each other 'make believe', making up rules and storylines on the spot and playing everywhere they can physically reach, it gets difficult to find set rules and boundaries of their play even though they are playing.

3.2 ...in sociology

The biggest issue about Huizinga's definition is pointed out by French sociologist Roger Caillois in his book 'Man, Play and Games' [7]: Huizinga explicitly defines play as "an activity connected with no material interest, and no profit can be gained by it" [7, p. 4]. This specifically excludes any type of game of chance.

Caillois picks up his definition and further specifies this criterium: play can be connected to material interest but no new wealth is created, only redistributed. During casino games such as Black Jack or Poker one can only win if another player is losing. The only real winner will be the casino itself. However, professional playing meaning playing directly connected with material gain, not only redistribution, like for example in sports is still excluded from this definition. In fact, Caillois states that "[...] it is clear that they are not players but workers. When they play, it is at some other game." [7, p. 6] But is this really the case?

A lot of professionals such as e.g. football players are trained from early childhood on with an intensity that makes it hard to believe that the players are always playing for fun rather than for a feeling of duty or financial interest. But in recent years, some professions popped up that involve professional gaming that is very well still playing.

Earning money by online streaming or recording videos of gameplay and uploading

them to the internet has become popular but most often, the fan bases are small and the money earned this way is not enough to make a living, so these professions are usually not the only source of income. In these cases, play is connected to material interest and creates wealth but it is possible that earning money is not the primary reason why they play since the wealth created this way is so small.

It is essential to look at the motivation of these streamers: if one is playing primarily to stay on upload-schedule, to keep the fan base entertained or to grow their profile on the respective platform to become a 'full-time streamer' in the future, playing is becoming a duty and is turning into work since play's characteristic as being a 'free activity' is violated. But if the main intention of the streamer is to play and enjoy the game, potential material gain is forgotten and work turns into play again. This motivation can obviously change meaning the question whether or not they are playing needs to be re-evaluated every time.

This applies to any type of professional player. There might be days where a football player participates in a match because they genuinely want to play instead of earning money. Nevertheless, Huizinga's and Caillois' point is important to distinguish between work and play even though it needs to be adapted slightly. So a definition of play should characterize play as an activity whose primary motivation is not connected to material interest. This means that one would most likely still perform or participate in this activity, even if they would not be paid.

Besides Caillois' claim that play does not produce any wealth which he called unproductivity of play, he used Huizinga's approach as a base for his own definition that is made up of five more characteristics. According to him, play is an activity that is

- free,
- separate,
- uncertain,
- unproductive,
- governed by rules and
- make believe. [7]

Most of these points, namely play as voluntary action that is separate from life, meaning it is limited in time and space by rules and that is unproductive, are familiar from before. But especially the uncertainty and make believe of play should be looked at more closely.

Caillois realized that an unknown outcome is essential to play. If the final result of a game is known in advance, play is stripped from any type of excitement and becomes

boring [7]. A player would probably refuse to play if it is known to them that they will lose, no matter how hard they try.

Furthermore, a lot of play is connected to imagination and the creation of fiction. A kid playing with dolls or toys usually does not follow any fixed rules. Instead, it is pretending: Pretending to be a mother, pretending to own a bakery, pretending to be a train driver, whatever the scenario is they come up with [7]. What Caillois describes as 'make-believe', Huizinga tried to explain with 'absorbing'. Play can create a new form of reality or self awareness outside of life. While playing, a player is inside of this newly created fiction with its own set of rules or own story. If someone is breaking this illusion, play ends [7].

The author himself suggests a connection between the existence of rules and play as make-believe. In fact, he states that play is either governed by rules or play-pretend [7].

Similar to Huizinga, he does not differentiate between 'play' and 'game' even though this very distinction might be the needed difference. However, it is important to notice that play or a game can be play-pretend and have rules, e.g. a lot of Pen-and-Paper role-playing games have detailed rule sets and components of role-playing as well.

3.3 ...in psychology

Caillois definition of 'make-believe' seems to be way more common during childhood than it is in adulthood. Nevertheless, both children and adults will most likely agree on a certain activity to be play even though a child might not want to play a game with a very difficult set of rules and a grown-up won't find much enjoyment in a play-pretend tea party.

Catherine Garvey's book 'Play' deals primarily with the play of children, however, some of her discoveries and theses might also apply to general play of both old and young. She defined play as follows:

"(1) Play is pleasurable, enjoyable. Even when not actually accompanied by signs of mirth, it is still positively valued by the player.

(2) Play has no extrinsic goals. Its motivations are intrinsic and serve no other objectives. In fact, it is more an enjoyment of means than an effort devoted to some particular end. In utilitarian terms, it is inherently unproductive.

(3) Play is spontaneous and voluntary. It is not obligatory but is freely chosen by the player.

(4) Play involves some active engagement on the part of the player."[10, p.4]

Again, a lot of this is familiar: play is pleasurable, the motivation is intrinsic and it is an activity that is performed by free will. However, there are some differences to prior definitions. Other than Huizinga and Caillois, she is talking about motivation as a whole and not only about material interest. We already established that motivation is crucial to identifying play but Garvey's definition is more narrow than the prior ones. While the other definitions allow e.g. serious games to be play since no money is earned, Garvey excludes any type of utilitarian gain a player could possibly have, meaning educational games cannot be considered play.

The point of play having to be 'spontaneous' seems inaccurate at first and easy to be proven wrong. A lot of play is planned e.g. sports tournaments. The play of children seems to be more spontaneous than adults playing, however, even children arrange meetings to meet up with their friends. It is obvious that play can of course be scheduled. What Garvey possibly tries to say is that, since play is voluntary, a player has to spontaneously commit to playing. If play is scheduled and at the beginning of the game a player does not decide to play out of a desire to do so but out of e.g. peer pressure, the activity is not voluntary anymore and becomes forced. Therefore, the player can no longer play.

It is interesting to notice that in 'Play' we find the first distinction between playing and a game. Garvey talks about the division of play of psychologist Jean Piaget who focused his work on child development. Piaget cuts play into three different types depending on the state of cognitive development:

- *Sensorymotor play* happens during the first two years where a baby is gradually gaining control over its motions.
- *Symbolic or representational play* is predominantly playing between two and six. This is what we formerly described with 'play-pretend' or 'make-believe' where e.g. a doll hat with marbles can be symbolic for a birds nest.
- Playing after the year of six is usually games with a fixed set of rules and boundaries. [10]

Garvey deviates from Piaget's formulation in a way that she is focusing on the social aspect of play instead of the relation between child development and play but the distinction between play and game as essentially a game with rules remains.[10]

3.4 ...in game development

Seeing as Huizinga was a cultural historian, Caillois a sociologist and Garvey a professor of psychology, the three definitions came from a humanistic and social science

perspective. But of course, some game developers and game designers whose main job is to create an enjoyable experience for their players, defined playing as well.

The game designers Katie Salen and Eric Zimmerman defined play as follows: 'Play is free movement with a more rigid structure' [14]. This is a very broad definition. However, the aspect of free will and the motivation to play is not considered at all and a lot of activities are included that are definitely not play. E.g. if one is locked up in a house but can move freely within its boundaries, it is technically covered by this definition, however most people would probably agree that this is indeed not playing.

The game designer Jesse Schell also criticized Salen and Zimmermann's definition as too broad. Another negative example brought up by him, is a child that has to scrub the floor. It is free to move the brush anywhere on the floor but the child itself would probably refuse to call this activity play [16].

He himself suggests play to be "manipulation that indulges curiosity" [16]. This is certainly a rather unconventional definition. Manipulating can only be done by an activity and something you are curious about is probably a task you perform willingly.

Furthermore, this definition includes a field of games that stayed in a grey zone before: serious games. Educational games e.g. are played to learn something, therefore it would be wrong to deem them completely unproductive but they definitely indulge curiosity. However, this definition includes some activities that are at least questionable to categorize as play, e.g. research or cooking. Some might argue that these tasks can be play with the right mindset but its not the conventional definition of play.

Still, this definition solves a lot of the issues from before: both make-believe and play with rules are included, it focuses on the players mindset and motivation which makes it possible for serious gaming, professional gaming and games of chance to be play and it is narrow enough to only include activities that are at least arguably playful.

Since we are aiming at improving the user experience of video games, a broader perspective on play might inspire new and interesting gameplay elements that excite players. Therefore, Schell's definition *"manipulation that indulges curiosity"*[16] will be used.

4 Player Types

Similar to board games or sports, video games can be divided into multiple subcategories or genres with characteristic gameplay elements. Seeing this wide range of different games and more importantly the varying opinions about them, it is logical that every person too has different preferences in video games.

Since our ultimate goal as game developers should be to create the optimal user experience for as many of our players as possible, it is important to take a deeper look into the differences of players, their playing styles and their preferences. With these informations, it is possible to group users into different player types that can be appealed by varying game components.

In marketing literature, four main approaches for segmentations are frequently used which are suitable for a segmentation of players as well. [11]

In *geographic* segmentation, residents of a certain area like e.g. a country or a city, are sorted into one group. [11] In game design context, this can mean e.g. following local trends, integrating different cultural aspects or changing your game according to local laws. One example for this is the version of *Wolfenstein:3D* with censored swastikas that was changed specifically for Germany where a depiction of swastikas is prohibited.

In *demographic* segmentations, people are divided into groups according to factors such as gender, race, age or social background. [11] Taking a demographic approach in video game design can be helpful with e.g. representation of minorities or popularizing the medium in other demographic groups, e.g. female players who are still a minority and might need specific design choices to be appealed to.

A more complex approach is the *psychographic* segmentation in which people are grouped according to their attitudes, interests, values and lifestyles. [11] Getting to know the preferences of one's players is essential for good game design. With knowledge about the audience's interests, it allows developers to adapt the game accordingly.

Behavioural segmentation tries to find and analyse patterns in users' behaviour with or towards a product. [11] In some video games, e.g. the *Resident Evil 2* remake, this approach is used in analysing the performance of its players and adapting the difficulty of the game accordingly. [15] But player behaviour can also give an insight on preferences.

Numerous models of player types were established, each with different focus. But

not all of them are suitable for dynamic player type detection.

4.1 Bartle's Taxonomy of Players

One of the first characterizations of players was developed by author and game designer Richard Bartle who asked players of a popular MUD (Multi-User-Dungeon) in an online forum about their motivation to play. During the discussion which went on from November 1989 to May 1990, Bartle made out that most players agree to most game features to be enjoyable, however, he distinguished four major player types that share common interests in playing a MUD. [4]

From 1999 to 2000, Erwin Andreasen and Brandon Downey developed a personality test based on Bartle's taxonomy known as the 'Bartle Test of Gamer Psychology' [2] which is no longer online, however, other implementations of this questionnaire [18] can still be found on the internet.

Bartle's taxonomy categorizes players according to their preferences in a game, making it a behavioural segmentation: do they like to *act* or *interact* and do they like to do it to the *world* or other *players*. [4] The Bartle Test results in the Bartle Quotient which assigns a percentage to each of the four possible characters, all summing up to 200% and no category exceeding 100%. [13]

Figure 4.1: Bartle's player type axes [11]

Later on, Bartle added a third dimension to his model: *implicit* vs. *explicit* actions. [3] This results in eight possible player types, however, most papers focus primarily on the initial four types as so will we in our discussion and implementation.

4.1.1 Achiever

Achievers have an interest in *acting* on the *world*. They usually thrive towards completion of a game, meaning hunting for collectibles and achievements and following the build-

in rank or level system. Other tasks are only a tool for the purpose of discovering more secrets, e.g. exploration is necessary to find all secrets, killing other players is a good and quick way of gaining experience and socializing might give the player information about new undiscovered treasure.[4]

Planners (explicit Achievers) usually like to set goals and achieve them while *Opportunists* (implicit Achievers) go after things they stumble over. [5]

4.1.2 Explorer

Explorers like to *interact* with the *world*. Their main goal is to travel through the virtual world and discover as much land as possible. They usually also enjoy finding out smaller secrets about the game like a shortcut between two locations or bugs. Levelling up via killing other players or completing tasks is necessary to reach new, higher level areas while talking to other players might give them new ideas to try.[4]

Scientists are *explicit Explorers* who collect knowledge in a methodical way, other than the *implicit Hackers* who have an intuitive understanding of the game world. [5]

4.1.3 Socialiser

Socialisers main motivation to play a game is to *interact* with its *players*. They are interested in talking, sharing the newest gossip and hanging out with their friends in taverns or on adventures. Exploration might give them new material to talk about with their friends while they might enjoy the social status that comes with a higher level. Killing can be a form of revenge to avenge a dear friend. [4]

Networkers (*explicit*) like to make new friends in a game and they are usually looking for people while *Friends* (*implicit*) mainly interact with players that they already know and like. [5]

4.1.4 Killer

The *Killers* like to *act* upon other *players*. They are interested in competition with other people. This usually means to compete in combat and to kill other players' online personas. Leveling up is necessary to become stronger and more powerful, exploring is needed to find new prey and socialising can be useful to gain information about an opponent.[4]

Implicit Killers, the so called *Griefers* like to indulge in combat and gain a bad reputation in the game. The *explicit Politicians* on the other hand, act with forethought and foresight. They manipulate people and like to gain power by getting a good reputation. [5]

4.2 Demographic Game Design Model 1 (DGD1)

In 2005, Bateman and Boon presented a model with four types of play styles based upon findings in a data set collected through online surveys and case studies conducted between 2002 and 2004. This model used the popular Myers-Briggs typology as a psychometric basis for player types. [6]

4.2.1 Conqueror

The *Conqueror* play style is associated with challenge and a desire to experience triumph and finish the game. Furthermore, *Conquerors* are usually highly tolerant of frustration and have a proficiency with logistical optimisation and strategic thinking. [8]

4.2.2 Manager

The *Manager* likes to master a game, not necessarily finish it. This play style is usually good at dealing with multiple factors in parallel. Strategic thinking and tactical competence are typical for *Managers*.

4.2.3 Wanderer

Wanderers are driven by a sense of wonder: they like to experience a game and discover something new. They don't necessarily dislike a challenge but their primary goal are things such as involving in the story or enjoying a beautiful game world. Tactical competence and abstract thinking characterise this play style. [8]

4.2.4 Participant

The play style of *Participants* is connected to emotions and involvement. They like to play with other players, but they also enjoy play which is rooted in emotion such as a game with well written characters with which the player can bond. However, direct competition is usually not liked by these players. They're typically good at logistical optimization. [8]

4.2.5 Hardcore Gamers

The study was initially driven by the hypothesis of the likely personality preferences of so called *hardcore gamers*. *Hardcore gamers* in opposite to *casual gamers* are usually gamers who invest a lot of time into playing video games meaning a lot and longer

game sessions. However, this hypothesis could not be entertained since both *hardcore* and *casual gamers* could be found in all four player types. [6]

Furthermore, Bateman et. al. suggest a new definition for *hardcore* gaming. Instead of measuring e.g. time spend gaming, they suggest to look at a players capacity for imaginative play. These new 'hardcore gamers', the so called *game hobbyists*, play a wide range of different games, know about the trends and implicit rules of video games.[6]

4.3 Stewart's Unified Model

Bart Stewart looked at different theories of player types, personality types and types of motivation and combined them into one behavioural and psychographic, unified model. Models he included were Bartle's player taxonomy, David Keirsey's four temperaments (Idealist, Artisian, Rational, Guardian) which he asserted to be supersets of Bartle's player types, and Bateman's DGD1 Mode. He adopted Bartle's axes to place the different player types in a coordinate system but he renamed the axes from *Player-World* to *Change-Structure* and from *Interacting-Acting* to *Internals-Externals* [17].

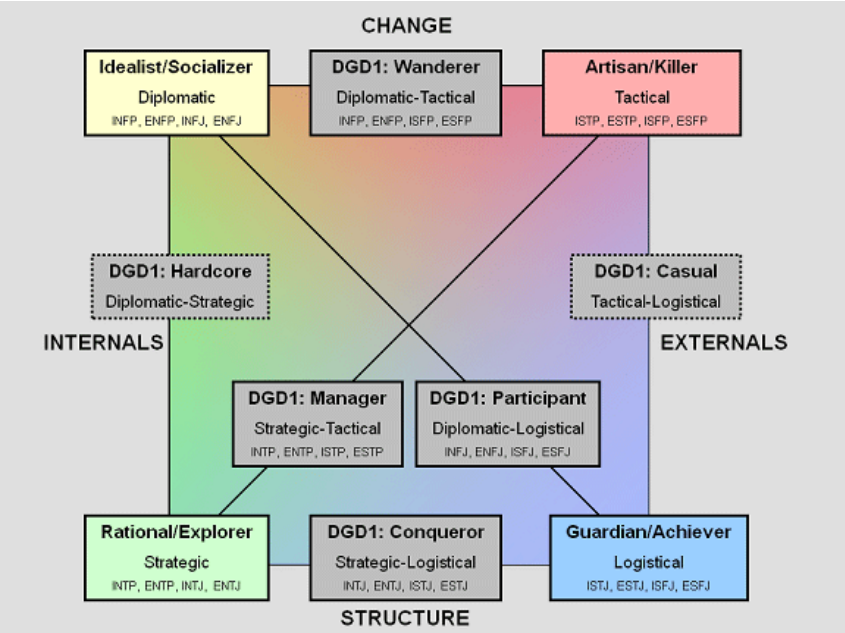

Figure 4.2: Stewart's Unified Model [17]

He claimed that the types from Bateman's DGD1 model filled the gaps between the Bartle/Keirsey types, effectively adding to the model and refining it. [17]

Stewart picked up on Bateman's reflections on hardcore vs. casual gaming. He defined hardcore gaming as a significant level of immersion in the game world. This is particularly interesting because a lot of behaviour we would usually label as *hardcore* such as excessive playing of First-person shooters would then be labelled *casual* since FPS are usually very poor in immersive story and can be left at any point in time. On the other hand, story based adventure and puzzle games are preferred by these newly defined *hardcore* gamers. [17][11]

4.4 University of Turku

Researchers from the University of Turku took a different approach in identifying player types. Instead of looking at player motivation or player behaviour, they took a more general approach and looked at preferences for game dynamics. During their investigation, they made out 5 different types of game dynamics and 7 player types in total.

4.4.1 Game Dynamics

A game is usually made up of multiple actions a player can take via input. These actions trigger so called *game mechanics* which should not be confused with *game rules* rather be seen as in-game methods and behaviours possible within the boundaries of the game. [20]

A *game dynamic* on the other hand is possible through a collection of game mechanics performed together. E.g. in *Forza 6*, a racing game by *Microsoft Studios*, some of the game mechanics would be *steering, accelerating, braking* or *gear-changing*. The combination of these makes up the game dynamic *driving*. A total of 33 core game dynamics were initially established and participants of the survey needed to rank them according to their preferences. These informations were then used to group game dynamics into five different categories. [20]

The first field, described as *Assault*, contains game dynamics usually connected to combat like e.g. killing, shooting enemies and destroying but also conquering or running for one's life.

The second category, named *Manage*, involves tasks such as acquiring food, developing and expanding a city or a base, upgrading equipment, defending their home base or planning a strategy and choosing resources to implement them. [20]

Players, who like game dynamics from the third field called *Journey* prefer exploring the game world and uncovering its secrets e.g. by acting as the protagonist, befriending in-game characters, collecting rare items and developing skills and abilities of a self-created playable character. [20]

The field of *Care* involves game dynamics like flirting, kissing, hugging, making love or training and taking care of pets

The last category is made up of game dynamics like matching tiles together, jumping from platform to platform, avoiding obstacles or staying in rhythm while dancing, singing and playing instruments. This field was called *Coordinate*. [20]

The researchers used these 5 categories to determine 7 types of players according to their like and dislike for specific game dynamics.

4.4.2 Mercenary

The *Mercenary* player type showed the highest preference in Assault game dynamics like shooting but also in acting as the main character and developing skills. They also showed very low interest in Care like rhythm-based games and pet training. [20]

4.4.3 Companion

The *Companion* on the other hand has a strong dislike for Assault like killing and exploding, a moderate like for Care and a slight preference for Journey and Manage. Specifically they enjoy e.g. befriending in-game characters, developing skills, creating a character and developing a city. [20]

4.4.4 Commander

Players of the type *Commander* usually favour Manage over all other fields, especially Care. They like strategizing, defending and managing their city or base while disliking Care dynamics but also e.g. stealing and running for their life. [20]

4.4.5 Adventurer

A high preference in Journey dynamics, a slight liking in Assault and a low preference in Care and Manage are characteristic of the *Adventurer* player type. They typically like creating their own character and developing its skills, playing as the protagonist, befriending in-game characters and exploring the game world. They don't have an interest in racing, sports, playing an instrument, matching tiles or pet care. [20]

4.4.6 Explorer

Not to be confused with Bartle's player type of the same name, the *Explorer* prefers Journey and Coordinate game dynamics such as collecting rare items, exploring the

game world and developing skills of their character. They don't like Assault or Care such as stealing, exploding and running for their life. [20]

4.4.7 Daredevil

The player type with the second most interest in Assault, some interest in Coordinate, the strongest dislike in Journey and a clear disapproval in Care was labelled *Daredevil*. They also showed the biggest interest in racing in comparison to the other types. Furthermore, they enjoy exploding, sneaking and shooting. Interestingly, they showed no strong dislike for any of the 33 game dynamics. [20]

4.4.8 Patterner

Finally, the *Patterner* has the highest interest in Coordinate game mechanics compared to the other player types, but other than that relatively low preferences in all other dynamics types. They showed the highest interest in matching tiles and moderate preference in jumping between platforms and collecting rare items, however, they showed strong dislike in many other game dynamics like e.g. killing, stealing, destroying or waging war. [20]

4.5 Discussion

This overview over different player segmentations is by no means complete. There are many more models and approaches to player taxonomies. E.g. we only considered behavioural and psycho-graphic segmentations, but of course it is possible to form groups according to demographic and geographic criteria as well. However, these aspects should usually be considered during the game design phase of a game and not during runtime.

The approach of the researchers from the University of Turku is very interesting: they don't look at a player base that is already narrowed down by the selection of a certain game or a specific genre, they try to look at players of all genres and their preferences. With their study, they managed to create a seemingly solid base for a general player taxonomy that groups players according to their preferences in video games.

Of course, this model has the same issue as any possible player taxonomy: it is limited to the current game market and player base. As we defined earlier, play is manipulation that indulges curiosity. It is possible that the future will bring new technologies and innovative ways of manipulation which might open ways for additional genres and bring in new players. Furthermore, future games might include already existing and unconventional ways of playing (e.g. *Pokemon Go* which effectively gamified the activity

of *going for a walk*), that way creating new possible preferences and new types. But for the current market and the momentary gamer base, this model seems useful.

Especially for research and during the game design process, this approach might be of use, however, for the use case of detecting player types during runtime, it is not suited since we already narrow down the player base with the choice of a specific game.

In his Unified Model, Stewart made a couple of assumptions about the Bartle and DGD1 types. E.g. he stated that the two models are disjunct so a combination of those two would result in a more refined taxonomy. When looking at the definitions of the taxonomies, this seems to be correct. There are certain similarities between types from the two models but none of them are completely aligning in their definitions, e.g. the *Conqueror* from DGD1 likes challenge and triumph which is similar to Bartle's *Killer* but they also like to finish a game which is atypical for the latter.

However, some of Stewart's choices are debatable. First of all, he is mixing together taxonomies that are built upon very different foundations and with different contexts. Bartle developed his taxonomy specifically for player behaviour in MUD's while DGD1 uses the Myers-Briggs personalities as a foundation. The before mentioned difference between the *Conqueror* and the *Killer* is therefore not surprising since in Bartle's taxonomy the aspect of 'finishing the game' is not considered since you simply can not finish an MUD or MMORPG. Nevertheless, in a single-player adventure game, something between an *Achiever* and the *Explorer* might be most likely to strive for completion of a game which aligns with Stewart's placement of the *Conqueror* in his model.

Some other placements on the other hand, are at least questionable. DGD1's *Participant* is interested in playing with other players and indulging in emotional play, e.g. by following emotional storylines. This sounds like a type in between the *Socializer* and the *Explorer*. But Stewart places them next to the *Achiever* in the *Externals-Structure* field (which is equivalent to Bartle's *Acting-World* field). The *Participant* seems to be enjoying both *Structure* and *Change*, but a play style that is "associated with emotion and involvement" [8] is only possible with *interacting* (or in Stewart's case: *Internals*). This furthermore suggests a placement of this type in between *Structure* and *Change* on the left with *Internals*. Right where Stewart put DGD1's *Hardcore Gamers* or *Game Hobbyists*.

Both Stewart's Unified Model and Bateman and Boon's DGD1 model are based on Myers-Briggs personalities. This suggests that one can make assumptions about a person's play style depending on their character. While personality is definitely a factor, it must not be the only one. In fact, behaviour in games depends on multiple factors such as skill level, mood, general preferences and of course the opportunities offered by the game in question. To map personality types onto player types one on one is at least debatable.

Bartle's taxonomy has been a staple in game design processes ever since his paper was published in 1996. While it was initially designed for a MUD setting, it still holds truth in other games and even single-player contexts. Nevertheless, his model has received some criticism, especially for its type-based nature. The play behaviour of a person changes over time and depends on multiple factors such as mood or progression of the game. A player can therefore never be only one type of player. [11] Furthermore, people typically have multiple motivations to play across all types and therefore sorting them into one specific type could be too strict. However, when looking at Bartle's paper and especially the framework which consists of scales instead of nominal categories, it becomes clear that he himself never suggested clear-cut types. [11] Neither does the Bartle's test since it results in the Barte Quotient which totals in 200% across all categories and never exceeding 100% in one. This suggests that a lot of the criticism is not actually about the taxonomy itself but about how people used it. [11]

Nevertheless, the Bartle taxonomy can be a useful tool for us in the game design process and for our use case of adapting the gameplay during runtime depending on the players behaviour, the Bartle types are currently our best option under the condition that we mind the nature of the Bartle Quotient.

5 Detecting Bartle's Player Types during Runtime

To maximize user experience, we want to find ways to adapt our game during runtime depending on who plays. Therefore, we previously looked at different player taxonomies and decided Bartle's player types to be the best fit for this use case. Now we need to find methods suitable for determining a player's type while playing the game.

5.1 Questionnaires

One possible option is the integration of the Bartle Test into the game itself. The test was criticised for being too dichotomous [21], however, since we already decided to take Bartle's taxonomy as our base, we can overlook this.

A simple questionnaire similar to the available online tests could be added in the beginning of the game. This would enable us to determine the player type and adapt our game to the players preferences before the game even started, which could also benefit performance since we don't need to re-evaluate and change our game during a game session. But since we already discussed the weaknesses of Bartle's model, it is important to keep them in mind when looking for a suitable implementation: player types can change over time and a player is more than just one type. Therefore, we would need multiple questionnaires during a game session resulting in the Bartle Quotient.

A simple set of questions comes with some advantages: the evaluation of the test results is easy and cheap performance-wise since evaluation only needs to be done at distinct points in time and not continuously. However, filling out a questionnaire in the middle of a game session is not very immersive and can be damaging to user experience. Nevertheless, there are some examples of cleverly used surveys in video games. *Until Dawn* is a survival-horror game developed by the British studio *Supermassive Games*. In between each chapter, a short intermission cutscene is played in which a psychologist asks the player directly about their fears. The player's answers to this hidden questionnaire influence e.g. the look of the monsters later in the game. [19] These intermissions add an interesting element to the game and don't break immersion,

therefore, embedding questions in the game e.g. in the form of dialogues with NPC's is an option.

The choice of questions is of course crucial for the success of this method. They can either aim at finding a specific preference for a certain play style or an alignment on one of the axes. This needs to be considered when evaluating the test results since an alignment with an axis always shows a preference for two types while an indication for one specific type also means an alignment on two axes. The Bartle's Test was designed for entertainment purposes and for a MMORPG context. Therefore it might be of interest to design a new test, possibly in collaboration with psychologists with more neutral questions. For our implementation, we will get inspired by Bartle's test but change some questions to fit into our context and into the environment of the game itself.

5.2 Choice of Reward

A lot of games are based upon a reward system. These systems could be adapted to give information about what the player wants. Therefore, we need to give the player 4 different options of possible rewards after a completed task, each reward typical for a specific player type. Of course, each game has different possible rewards with different implications for the gameplay, so therefore, these affiliations need to be specified for each game. Possible choices of play-type-specific rewards would be:

(1) *Achiever*: experience points, collectible items without effect on gameplay (e.g. artwork, trophy, achievements), hints for the completion of achievements

(2) *Explorer*: a secret, a key to a locked room, a piece of a map, a hint leading to a secret location

(3) *Socialiser*: emoticons usable in in-game or forum chats, customizables for player accounts (e.g. frames for a players Steam profile), clothing signalizing affiliation with a guild, advancement in the relationship with an NPC, a companion

(4) *Killer*: a powerful weapon, an item boosting the by the wearer inflicted damage, a compass showing possible enemies, titles connected to achievements in combat

The *Achiever* is interested in completing the game and reaching goals in the game's context, so rewards helping the player rising in the game's level- or rank-system more quickly and collectibles that otherwise dont influence the character's abilities, might be of interest for this type. Other rewards like e.g. a special sword might also be chosen by an *Achiever* if their collection progresses the game's completion, however, other types

such as the *Killer* might be interested in these rewards as well which needs to be kept in mind when designing an algorithm for type-detection.

Secret locations or information about them are of specific interest for the *Explorer* since it gives them the opportunity to find out more about the game. An *Achiever* might also choose this option if they're expecting great treasures or a *Socializer* looking for a new interesting topic to talk about.

Finding game related rewards for *Socializers* especially in a single-player game can be difficult since they are interested in conversation and connection with other players. Possible rewards could be added in-game features like emoticons for chat systems and customizables showing affiliation with a group or out-game content for more social platforms (e.g. Steam or game forums) like a frame for profile pictures or a trophy to show specific milestones reached in the game. For single-player games, it should be possible to form a connection and have interesting conversations with NPC's as well. Titles or trophies showing off certain reached goals might also be of interest for *Achievers* and *Killers*.

The most straight forward rewards can be found for the *Killer* type. They are interested in combat and imposing themselves onto other players, so any kind of item helping them in combat such as special weapons and spells boosting their attack is of interest to them. But since one of their goals is to have a reputation, special titles could also be of interest to them. If the collection of weapons is also necessary for certain achievements, the *Achiever* might also choose them.

5.3 Analysis of Player Behaviour

The most straightforward approach is to look at a players behaviour during a game session and analyse it. This could potentially have an impact on performance, however, this obviously depends on the exact implementation. Different measurables require different methods for analyzing, e.g. counting finished quests associated with a specific play type vs. examining whether a player behaved offensive or defensive during a fighting sequence.

When trying to find possible assignments for different measurables or gameplay elements, we are faced with a question rather simple but difficult to answer: What is the right assignment? For some measurables, assignments seem logical: long distances walked are typical for an *Explorer*, a *Killer* will most likely finish a huge amount of combat missions, an *Achiever* will hunt for achievements while a *Socializer* will talk to players or NPC's. However, what about gameplay elements that aren't typical for an MMORPG? How would a *Killer* behave in a game like *Animal Crossing* or *Silent Hill*? What would a *Socializer* like about *Uncharted*? How can you differentiate player types in

a party game like *Jack Box* or *Fall Guys*? Even though Bartle's taxonomy was developed for an MMORPG context, it is not far-fetched to assume that these player types remain, even when changing the game genre. We only need to find the connections between measurables in our games and Bartle's player types.

One possible way of finding these connections would be with the help of neural networks. Neural networks are a structure of so called neurons often arranged in different layers which can be trained in various ways to predict an outcome from a specific input. [1] We could use this to assign effects on type calculations to our various measurables. However, this would go beyond the scope of this thesis, therefore we will manually assign measurables to different player types. This will bring some inaccuracy to our determination but for our short prototype this is acceptable. Possible assignments would be:

(1) *Achiever*: number of unlocked achievements, levels gained, items picked up, collectable chests, high reward missions

(2) *Explorer*: distance walked, areas explored, lookouts visited, secrets found, travel missions

(3) *Socialiser*: number of conversations with NPCs or other players, relationship levels with NPCs gained, messages send, time spend in in-game hangouts (e.g. tavern), dialogue options explored, optional missions in the form of favours for NPCs

(4) *Killer*: enemies killed, damage inflicted, number of combat encounters with NPCs or players, assassination missions, combat missions

Since *Achievers* are interested in reaching in-game goals and milestones, they will most likely try to level up quickly or collect as many achievements as possible. Collecting items tends to be tedious: they are often spread out around the entire map or even hidden so finding all of them can take some time. If, additionally to this, the reward for finding all of them is of limited relevance for gameplay (e.g. a weapon skin, an achievement), most player types stay away from completing these tasks, which makes them a usefull indicator for *Achievers*.

It comes as no surprise that exploring is a key interest of *Explorers*. Therefore, measurables like distance walked, areas explored or secrets unlocked are good measurements for them, for as long as these tasks are not connected to other aspects that are of interest for other types like e.g. achievements or enemies for combat. Missions connected to a lot of travelling might be boring to other types while exciting for *Explorers*.

Socializers are interested in connecting with other players or NPCs, so measuring how many conversations a player is having with them or how many dialogue options

are explored is useful for determining *Socializer* types. Optional missions that give the player an advancement in a relationship with an NPC could be of interest for this type.

Again, measurables for the *Killer* type seem to be the most straight-forward: since they are actively looking for combat, counting combat encounters, killed enemies or inflicted damage could be a suitable method to determine *Killers*. While other types might shy away from combat or assassination missions, *Killers* will actively choose them, therefore choices for these missions can be a strong indication for *Killer* types.

5.4 Implementation

Now that we have discussed a couple of possible methods for determining player types during runtime, we want to implement a couple of these methods in a simple demo. For the implementation, we will use *Unreal Engine* as our game engine. Our demo will be a short 3D, third-person RPG-like game since this gives us a lot of freedom for possible game mechanics and elements.

For the calculation of the types, we will use two values ranging from -1 to 1, one for the position on the x-axis (-1 indicating *Players*, 1 indicating *World*) and one for the position on the y-axis (-1 indicating *Interacting*, 1 indicating *Acting*). To get these, we will need to store our findings in two more variables for each axis, one storing the effect of each action and one counting the absolute value of effects on one axis used for normalization.

For the calculation of the Bartle's Quotient, we will use following formulas:

$x_{absEffect}$: the absolute effects on the x-axis
$y_{absEffect}$: the absolute effects on the y-axis
x_{pos} : the position on the x-axis
y_{pos} : the position on the y-axis

$$x_{normPos} = x_{pos} / x_{absEffect}$$
$$y_{normPos} = y_{pos} / y_{absEffect}$$
$$p_{worldPercent} = [(x_{normPos} + 1)/2] * 50$$
$$p_{actingPercent} = [(y_{normPos} + 1)/2] * 50$$
$$p_{playerPercent} = 50 - p_{worldPercent}$$
$$p_{interactingPercent} = 50 - p_{actingPercent}$$

$$q_{Achiever} = p_{worldPercent} + p_{actingPercent}$$
$$q_{Explorer} = p_{worldPercent} + p_{interactingPercent}$$
$$q_{Socialiser} = p_{playerPercent} + p_{interactingPercent}$$
$$q_{Killer} = p_{playerPercent} + p_{actingPercent}$$

Each of the two axes can add up to 50% to the two corresponding types. Since one axis ranges from -1 to 1, we first need to map the value on a scale from 0 to 1 before then multiplying the result with the maximum achievable percentage 50. The percentage relevant for the other side of the axis (meaning *Acting* vs *Interacting* and *World* vs *Player*) is therefore the difference of 50 and the already calculated percentage from this side of the axis.

As mentioned before, an implementation of a neural network calculating the effects on the axes positions for each action would go beyond the scope of this thesis. Therefore, we will use fixed effects for predefined actions. The exact mapping can be seen in 5.1.

Measurable	Effect on x-axis (from -1 *Player* to +1 *World*)	Effect on y-axis (from -1 *Interacting* to +1 *Acting*)
Killing a weak enemy	-1	+1
Killing a strong enemy	-2	+2
Collecting flowers	+1	+1
Reading a book	+1	-1
Visiting a new location	+1	-1
Visiting a new secret location	+2	-2
Talking to random NPC's	-1	-1
Choosing NPC centric dialogue options	-0.5	-0.5
Choosing a location quest	+5	-5
Choosing a conversation quest	-5	-5
Choosing a combat quest	-5	+5
Choosing a collection quest	+5	+5
Finishing an exploration objective	+2	-2
Finishing an combat objective	-2	+2
Finishing an collection objective	+2	+2
Finishing an conversation objective	-2	-2
Choosing reward: sword	-5	+5
Choosing reward: artefact	+5	+5
Choosing reward: key	+5	-5
Choosing reward: dog	-5	-5
Choosing interaction based answers	0	-2
Choosing action based answers	0	+2
Choosing world based answers	+2	0
Choosing player based answers	-2	0

Table 5.1: Effects of predefines actions on axes

Most mappings result from considerations that were already explained in 5.1, 5.2 and 5.3.

Combat missions such as killing enemies are typical for *Killers*. In an actual RPG game, it is to be expected that the game itself is designed around a combat system so every type of player will need to kill enemies from time to time. However, *Killers* will actively look for opponents and will also not shy away from more difficult fights, so killing a stronger enemy is also a stronger indicator for a *Killer* type.

Achievers like *acting* on the *world* so classical collection tasks can be appealing to

them.

Exploring the area and finding new places is of interest for the *Explorer* type, therefore visiting new undiscovered places indicates this play style, but it is to be expected that also other types will explore new places from time to time since a lot of quests usually involve some extend of exploration for either reaching the quest giver or the position of the objective. Therefore, more hidden locations with a low number of quests connected to them receive a higher effect than other, more common and centric places. Furthermore, *interacting* with the *world* by e.g. reading descriptions of books also indicates this play style.

Interacting with the *people* of the game world indicates *Socializers*, so e.g. talking to random, non-quest-relevant NPC's effects the type detection accordingly. Also, exploring dialogue options that resemble an actual, human centric conversation (e.g. "Where does the name Dorax come from?", "Tell me something about the innkeeper.") can be interesting for *Socializers*, however, once a dialogue has been started by players, a lot of them will probably go through all dialogue options if allowed, looking for a potential quest or secret information, so, to take this into account, the effect for this action is lower than most measurables.

As described in 5.1, we implemented a short questionnaire through different dialogue options. This way, we can get to know the players preferences of the axes without breaking immersion.

The most important part of play type detection is the player's choice itself. Every other type of measurable can be achieved for other reasons than being a specific type. E.g. players of every type might read a sign if it is placed prominently, pick up collectables when stumbling over them, talk to NPC's hoping for a quest or get in a fight if the reward seems promising. And of course, as mentioned before, no person is only one type so occasional actions of another type can occur. Therefore, the most reliable way of finding a players preference is by simply making them choose. For this reason, in this implementation, choice of quest type or reward has the biggest impact on type determination.

6 Discussion and Outlook on Future Research

We have shown that a detection of player types during runtime is possible. However, our short demo game is far from perfect and needs improvement if the concept is to be used in an actual game.

6.1 Change of Bartle's Player Type over Time

As mentioned before, Bartle's player types depend on multiple factors such as mood or the game progress itself and can therefore change over time. Especially a change of game sessions should be considered in type calculations since events in between sessions could have an influence on types. In our prototype, we simply add the effects onto each other and normalize them with the total amount of effects applied, meaning that the longer the game session, the less impact new changes have onto the determination of the player type.

Ideally, we are only interested in the changes applied to the Bartle's quotient in the last n minutes or alternatively the last n changes. To implement this, we would need to store information about the applied effects either in a list with the help of timestamps (for the time-based approach) or in a ring buffer (for the amount-based approach). However, these approaches come with certain problems: The time-based approach is potentially very storage heavy while in the amount-based approach, a single mission that involves a lot of measurables (e.g. a combat mission with a lot of enemies) can have a huge impact on type calculation.

The most accurate calculation of player types would probably involve a time-based approach, however, since the Bartle's taxonomy itself is vague at times and since we are working in a video game context, a certain level of inaccuracy is acceptable. A possible implementation that represents a suitable compromise between accuracy and low memory computability is an application with two alternating type computations.

Each computation contains two alternating phases:

(1) The *Computation-Phase*: Effects are added to the axes-positions, values of the axes are not used

(2) The *Usage-Phase*: Axes-positions are fixed and can be used for type determination

While one calculation process T_1 is in the *Calculation-Phase*, the second calculation process T_2 is in the *Usage-Phase* and vice-versa, which can be seen in Figure 6.1. This ensures that new player behaviour still has a valuable impact on play type determination while at the same time ensuring that the impact of measurable-heavy missions stays balanced. To further ensure that older actions still have a moderate impact on the type determination, we can initialize the axes positions and absolute effects like the following:

w : weight

$x^0_{absEffect1}$: absolute effects on the x-axis of T_1 at the beginning of the *Calculation-Phase*

$y^0_{absEffect1}$: absolute effects on the y-axis of T_1 at the beginning of the *Calculation-Phase*

x^0_{pos1} : the position on the x-axis of T_1 at the beginning of the *Calculation-Phase*

y^0_{pos1} : the position on the y-axis of T_1 at the beginning of the *Calculation-Phase*

$x_{normPos2}$: the normalized position of the x-axis of T_2

$y_{normPos2}$: the normalized position of the y-axis of T_2

$$x^0_{absEffect1} = w$$
$$y^0_{absEffect1} = w$$
$$x^0_{pos} = x_{normPos2} * w$$
$$y^0_{pos} = y_{normPos2} * w$$

The weight w should be adapted to the specific game depending on the duration of a *Calculation-Usage* cycle and the average amount of measurables.

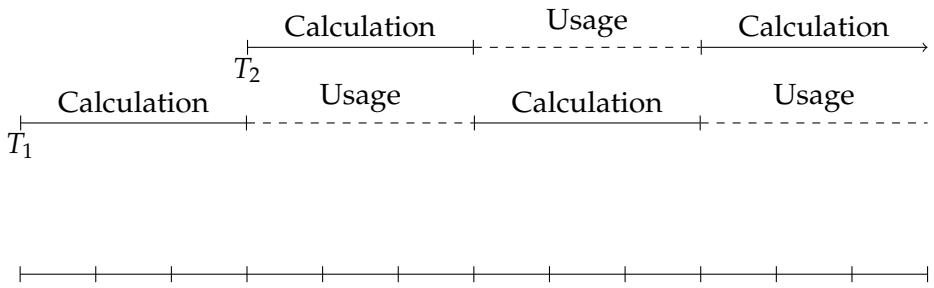

Figure 6.1: Timeline of alternating type calculations

6.2 Possible Correlation of Time and Player Types

We have already discussed the possibility of Bartle types changing over time. However, as of now, there is no research done on how exactly play behaviour changes over time. Our implementation with dynamic player detection allows us to analyse not only the player's behaviour but also the development of play behaviour in the course of time. We could change the implementation in a way that would calculate the Bartle type after every time step h and print the result.

If we can connect certain changes in play behaviour to either time or a specific in-game event, we could use these new found rules and patterns for the game design process. Creating the game flow is a crucial part of designing a game. Adapting the game to the newly found natural flow of play behaviour could help game developers in improving the user experience.

6.3 Adapting Gameplay During Runtime

Now that we have found a way to determine the Bartle player type during runtime, we can use this information to our advantage. With the type of our player determined, we can now adapt our gameplay to appeal to the type of our user.

Bartle himself suggested a couple of ways to attract the types by putting emphasis on the different aspects of the axes.

Putting a focus on *Players* is relatively easy: we only need to provide our players with different ways of communication and functionality for our communication systems. However, this needs to be balanced to ensure that our game stays a game and does not turn into a slightly fancier social network. [4] Possible ways of doing so include:

- Adding intuitive and easy communication facilities

- Adding more player-on-player commands (e.g. *Tickle* or group-building commands)
- Decreasing size of the world
- Maximizing the number of player in game [4]

Emphasizing *World* works exactly the other way around: create a large world with as few players as possible and minimal ways of interacting with them. However, a focus on the game world that is too large might take some of the motivation off of the game. After all, one of the appeals of playing a multiplayer game is interacting with other players. [4] Putting emphasis on the *World* can be done by:

- Minimizing the possibilities to interact with other players
- Enlarging the size of the game world
- Making building facilities easy and intuitive [4]

By restricting the freedom of players, we can emphasize *Interacting*. If the possibilities of the player to make their own decisions and choices are limited, they are rather watching the game than being an active part of it. [4] Game genres that brought this balancing to an extreme, are visual novels and walking simulators. As we've discussed previously, most definitions of play include the aspect of play being an activity. The definition by Schell which was chosen by us, covered this by defining play as a form of manipulation. However, it is at least debatable and most likely dependant of the players taste if a total lack of freedom of choice is still sufficient enough to count as manipulation and furthermore, if it still indulges curiosity. Ways of emphasizing *Interaction* are:

- Only providing cryptic hints and vague information
- Minimizing the number of available commands in one area
- Lowering the rewards of achievements
- Only having a shallow class, rank or level system
- Having a lot of smaller puzzles [4]

When a game focuses on *Acting*, tasks are usually executed repeatedly, instructions are clear and game mechanics are often lacking depth which can quickly become boring when overdone. [4] Possible ways of focusing on *Acting* include:

- Providing a manual and auto-mapping facilities
- Having an extensive class, rank or level system
- Raising rewards for achievements
- Having some larger puzzles [4]

Of course, once again, Bartle suggested these methods for an MUD context and nearly all of his suggestions are only achievable by major changes of the game for all players either through programming or management. Furthermore, Bartle's goal was to balance the amount of players from different types in the game itself and not to customize the game specifically for each individual.

Of course, our determination method also gives game administrators the opportunity to analyse their player base and to adapt their game accordingly, however, a dynamic detection also enables dynamic changes for each player individually.

The basic idea is to increase the amount of content preferred by the player's type while decreasing disliked content. While this seems easy enough, there are a couple of aspects that should definitely be considered when implementing.

Changing a game dynamically must not break the flow of the game meaning the player must not notice an abrupt change in the game. E.g. deleting quests from the map is generally speaking a bad idea since the player might have already noticed the quest even though they have not marked it. If we delete it, our user might look for it unsuccessfully which then causes frustration. Therefore, adding new or changing existing content of our game are possibly the best options we have. This should be done at dedicated points in time and not randomly. A lot of games already do this by unlocking new quests after certain in-game events, e.g. after progress in the main story or after exploration of viewpoints (like e.g. in the *Assassins Creed* series).

Furthermore, the adaptation of the game must not interfere with the balancing of the game. This applies to both the composition of the game play but also the overall difficulty and fairness. A huge selling point for a lot of video games like the *The Witcher* series or *Skyrim* is the diverse and wide range of different game elements. When adapting our game, we want to slightly tip the balancing of the different game components to elements that our player prefers, however, we also want to keep the overall feel of freedom of choice and almost unlimited possibilities. Additionally, we still want to have a variety of game elements suitable for different types since we need to make sure that a change of player type can still be detected which would then require us to tip the balance into another direction.

A similar act of balancing needs to be done in terms of difficulty and fairness. We need to make sure that every part of our game and every content is still achievable

with comparable workload, no matter the player type. This is especially important in multiplayer games where players can compare themselves instantaneously. E.g. if we have a rank or level system in our game, a suitable adaptation to our game would be to make *Achievers* level up more quickly since they enjoy the feeling of reaching in-game goals, however, other players with a similar amount of time spent in-game and comparable effort put into the game would probably feel treated unfairly. A possible solution for this issue would be to give our players the freedom to choose e.g. their rewards independently. An *Achiever* would maybe still end up with a higher rank than their co-players after the same amount of time in-game since they would most likely gravitate towards experience points as their main form of rewards but the acceptance in the player base would be considerably higher since other players actively choose e.g. an impressive inventory over a high level.

6.4 Neural Network for Type-Mapping of Measurables

As for now, we determined player types by manually assigning effects on different measurables and using these in our prototype. However, this will always cause some inaccuracy since we don't have scientific data on how relevant specific game mechanics or measurables are for type determination and with which type these measurables are connected to. So as a next step, we need to find possible assignments and weights for game mechanics and game elements. To do so, we need to analyse play logs of our players and look for possible patterns but doing so manually is tedious and it is easy to overlook something.

A possible solution would be to use a neural network as we've suggested earlier. We could apply supervised learning with logs from various players who's player types we've determined beforehand. After learning, we could input different game measurables and see which player type is put out.

Of course, this neural network could also be used to determine the player type dynamically during runtime, however, this would have a severe impact on performance and is therefore impractical for a video game. Nevertheless, such a neural network could be used during development to determine effects for different measurables specifically for our game since we have to assume that the preferences in measurables of the different play types also depend on the game itself. E.g. typically, picking up items is often characteristic for *Achievers* but in a game where these items can be gifted to other players, this task might also be interesting for *Socializers*.

6.5 Research on Player Types

We have looked at different player type taxonomies and discussed advantages and disadvantages of the different models. As of now, the models are usually fitting for different purposes and are focusing on different aspects but none of them seem complete so far. E.g. the Bartle's taxonomy focuses on a players in-game behaviour but mostly for MMORPGs, the study of the University of Turku on the other hand presents a solid base for overall preferences in players, however their types are not yet connected to preferences in genres or behaviour in-game. Therefore, a lot of research still needs to be done on players, their preferences and their play style.

A first possible task could be the redesigning of the *Bartle's test*. The *Bartle's test* is a short online questionnaire designed for entertainment purposes. It is often seen as flawed which we have partly discussed earlier in this thesis. But not only the before mentioned dichotomous nature is problematic: the Bartle's Test is clearly designed with old MUD's in mind meaning high fantasy settings (e.g.: "You're a player in an online game, and you want to fight a really tough dragon. How would you approach this problem?" [18]). However, modern online multiplayer games like *GTA V Online*, *Warframe* or *DC Universe Online* play in a very different setting, therefore having these high-fantasy focused questions in a test might distort the result. Because of the flawed nature of the Bartle's Test, redesigning it with the help of psychologists might be interesting to get a reliable tool for play type determination.

A second interesting opportunity for further research might be a possible connection between the Barte's taxonomy and the research for the University of Turku. It is plausible that a preference for specific game mechanics also influences ones behaviour in-game. It might be of interest to look at the seven types defined in the later study, look at their play styles, maybe also in games of different genres, and look for possible patterns.

Lastly, there has been some doubt about the accuracy of the Bartle taxonomy as a whole, especially about its portability onto game genres other than MUD's. A study examining the player behaviour not only of various users but also across different games of different genres could give us valuable information, either on newly found player taxonomies or on how existing models manifest in other genres.

7 Conclusion

In this thesis, different definitions of play from multiple fields of research were discussed.

Following, we have inspected different player taxonomies and player type models. While some of them seem promising especially for future research, like e.g. the play types concluded by researchers from the University of Turku, Bartle's player types were chosen to be the most ideal for our use case of determining a player type during runtime.

In a short prototype, we have proven that player types can be determined during runtime, giving us the opportunity to adapt our gameplay dynamically to our player. Our implementation is simple and effective but leaves room for improvement. The possible inaccuracy resulting from manual assignments of effects on game mechanics and measurables can be accepted to some extend since we are working in a video game context. Nevertheless, in a real life application, this inaccuracy should be tweaked through play testing. The change of algorithm explained in the discussion is a first step towards improving our determination method but different, more elaborate approaches for player type determination might also be promising.

For adaptation, we have discussed multiple ways of how customizing a game for players individually can look and what needs to be considered when changing a game during runtime. But specific ways of adaptation obviously depend on the game and can be chosen by developers depending on which level of adaptation they desire for their game.

A dynamic play type detection and the possibility to adapt a game according to a players preference creates new opportunities for game developers and designers. Not only can it improve the individual user experience, it can also simplify the balancing of the game since the adaptive gameplay creates a new balance for each player respectively. Finally, adaptive gameplay can draw in and appeal to new players who don't typically play video games, and therefore effectively help to further spread the popularity of the medium.

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Bibliography

[1] 3Blue1Brown. *But what is a Neural Network? | Deep learning, chapter 1*. YouTube. Oct. 2017. URL: https://www.youtube.com/playlist?list=PLZHQObOWTQDNU6R1_67000Dx_ZCJB-3pi (visited on 10/28/2020).

[2] E. Andreasen. *Erwin's MUD resource page*. URL: http://www.andreasen.org/mud.shtml (visited on 10/28/2020).

[3] R. Bartle. *A Sense of Self*. June 2003. URL: https://mud.co.uk/richard/selfware.htm (visited on 10/28/2020).

[4] R. Bartle. *Hearts, Clubs, Diamonds, Spades: Players who suit MUD's*. 1996, April 28. URL: http://mud.co.uk/richard/hcds.htm#2 (visited on 10/28/2020).

[5] R. Bartle. "Virtual worlds: Why people play." In: *Massively multiplayer game development* 2.1 (2005), pp. 3–18.

[6] C. Bateman, R. Lowenhaupt, and L. Nacke. "Player Typology in Theory and Practice." In: *Proceedings of DiGRA 2011 Conference: Think Design Play* (2011).

[7] R. Caillois. *Man, Play and Games*. Urbana and Chicago: University of Illionois Press, 2001.

[8] *DGD1 Questionnaire - What Play Style Do You Prefer? The Results*. Mar. 2007. URL: http://survey.ihobo.com/DGD/DGD1_thanks.shtml (visited on 10/28/2020).

[9] L. Fuentes Perez, L. Romero Calla, L. Valente, A. Montenegro, and E. Clua. "Dynamic Game Difficulty Balancing in Real Time Using Evolutionary Fuzzy Cognitive Maps." In: Nov. 2015, pp. 24–32. DOI: 10.1109/SBGames.2015.17.

[10] C. Garvey. *Play*. Enlarged edition. Cambridge, Massachusetts: Harvard University Press, 1990.

[11] J. Hamari and J. Tuunanen. "Player Types: A Metasynthesis." In: *Transactions of the Digital Games Research Association* 1.2 (2013).

[12] J. Huizinga. *Homo Ludens: Vom Ursprung der Kultur im Spiel*. 22nd ed. Reinbek bei Hamburg: Rowohlt Taschenbuch Verlag, 2011.

[13] J. Mulligan and B. Patrowski. *Developing Online Games: An Insider's Guide*. 1st edition. Indianapolis: New Riders Publishing, 2003.

[14] K. Salen and E. Zimmermann. *Rules of Play*. Cambridge, Massachusetts: The MIT Press, 2003.

[15] T. Saunders. *Resident Evil 2 Adaptive Difficulty: How does it work?* Feb. 2019. URL: https://www.gamerevolution.com/guides/491409-resident-evil-2-adaptive-difficulty-zombies-ammo#/slide/1 (visited on 10/28/2020).

[16] J. Schell. *The Art of Game Design: A Book of Lenses*. 3rd edition. Boca Raton: CRC Press, 2019.

[17] B. Stewart. *Personality And Play Styles: A Unified Model*. Sept. 2011. URL: http://www.gamasutra.com/view/feature/6474/personality_and_play_styles_a_.php (visited on 10/28/2020).

[18] *The Bartle Test for Gamer Psychology*. URL: http://matthewbarr.co.uk/bartle/ (visited on 10/28/2020).

[19] *Until Dawn*. [Playstation 4]. United Kingdom: Supermassive Games, 2005.

[20] J. Vahlo, J. K. Kaakinen, S. K. Holm, and A. Koponen. "Digital game dynamics preferences and player types." In: *Journal of Computer-Mediated Communication* 22.2 (2017), pp. 88–103.

[21] N. Yee. *Unmasking the Avatar: The Demographics of MMO Player Motivations, In-Game Preferences, and Attrition*. Sept. 2004. URL: https://www.gamasutra.com/view/feature/130552/unmasking_the_avatar_the_.php (visited on 10/28/2020).