

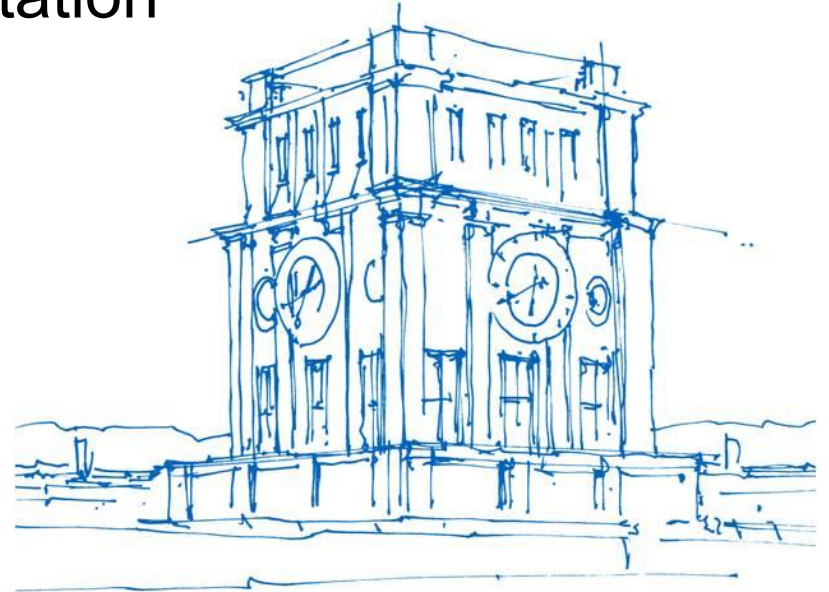
Agent-Based Modeling as Level Design Method for Balanced Gamespaces - Presentation

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Uhrenturm der TUM

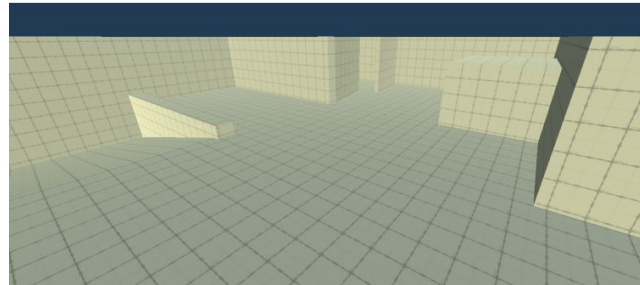
When is a Gamespace balanced?

What is a Gamespace?

- Thesis dealt with gamespaces of arena first-person Shooters
- every game takes place in some **space**
 - "[...] the 'magic circle' of **gameplay**" [Sch20, p. 166]
 - "[...] embod[ies] **gameplay and facilitate[s] the player's journey** through it" [Tot19, p. 24]
- can be split into **functional** and **aesthetic** space



Screenshot from playable map "de_dust2" from the game Counter-Strike: Global Offensive



Rough breakdown of the functional space seen above

When is a Gamespace balanced?

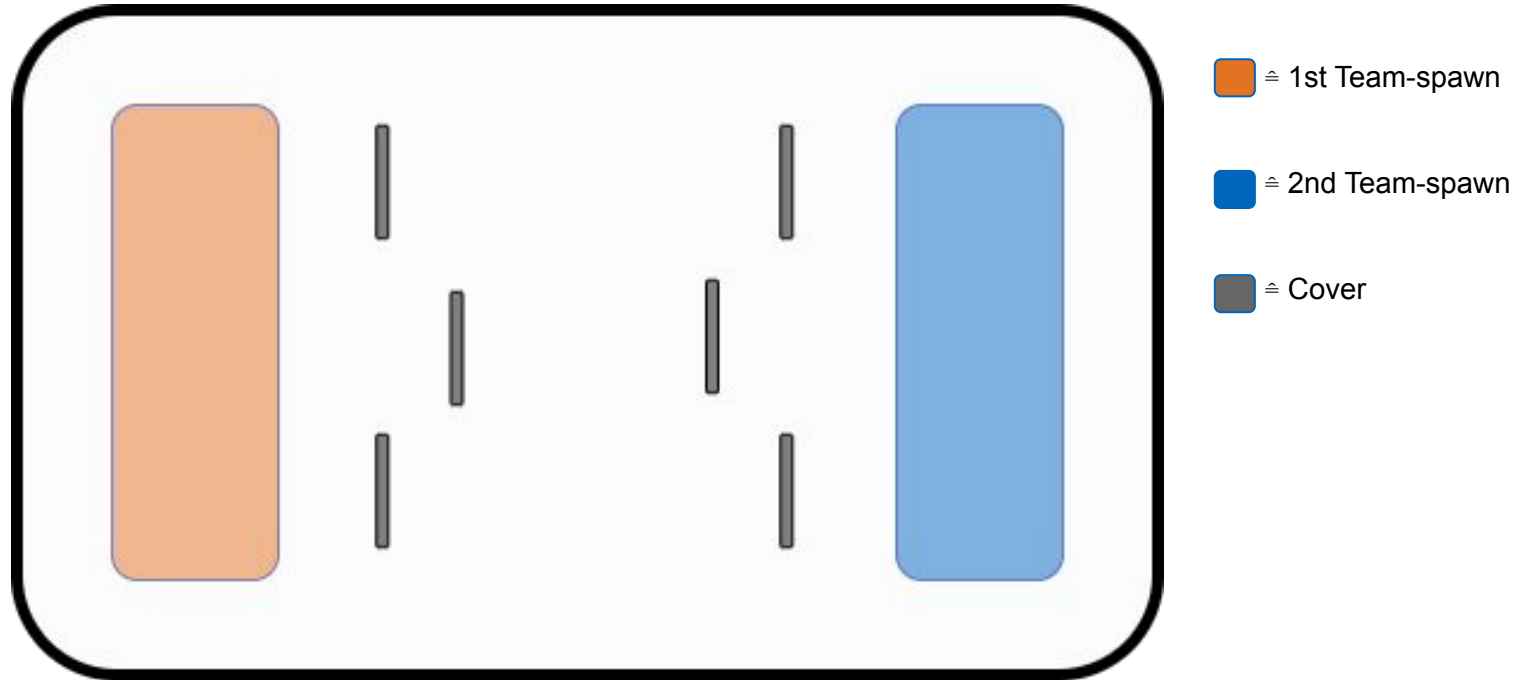
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What is Balance?

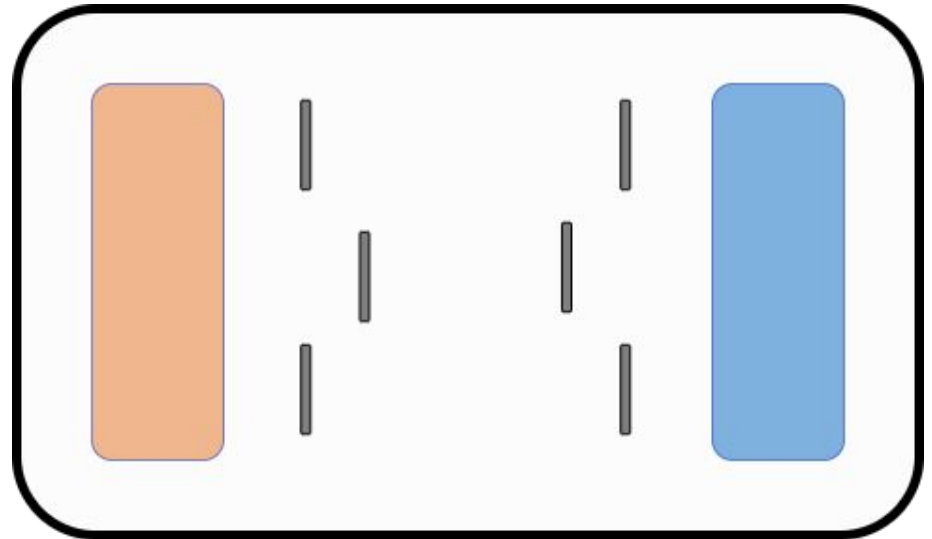
- Without Balance a game might feel "**monotonous, confusing, and frustrating**" [Sch20, p. 212]
- **No central definition** exists [BG20, p. 38]
- However **important points** are:
 - fairness
 - no perfect symmetry
 - no dominant strategies

When is a Gamespace balanced?



When is a Gamespace balanced?

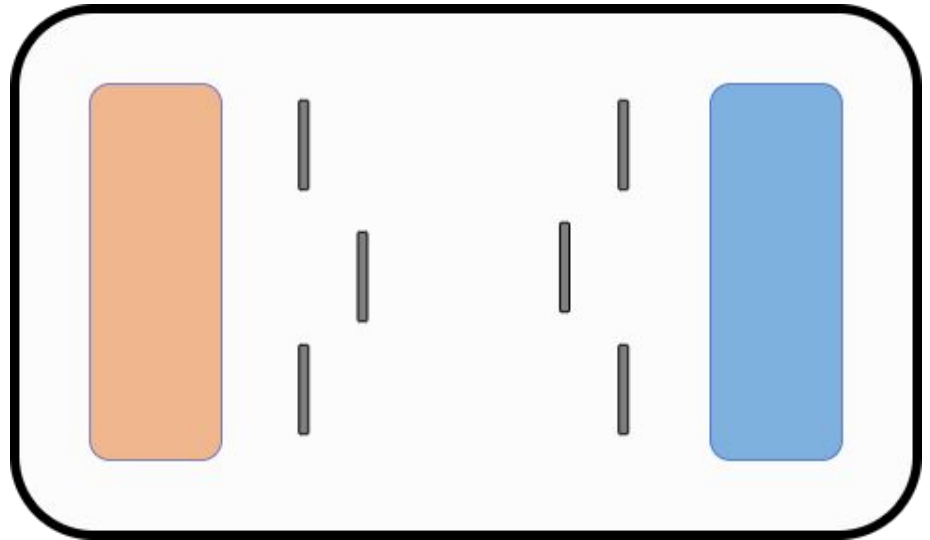
- It is **symmetrical**
 - thus inherently **fair** [BG20, p. 38]
 - but gets **boring** fast [Ada13, Chapter 15]
- No obvious **dominant strategies**
- Both teams [Ada13, Chapter 15]:
 - are **not privileged** by gamespace
 - have **same starting options**



When is a Gamespace balanced?

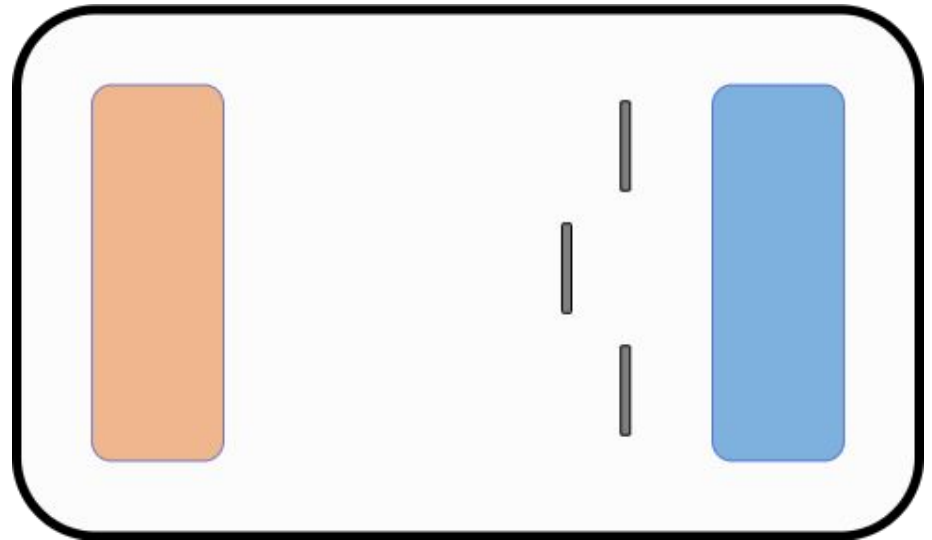
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=> **Balanced**



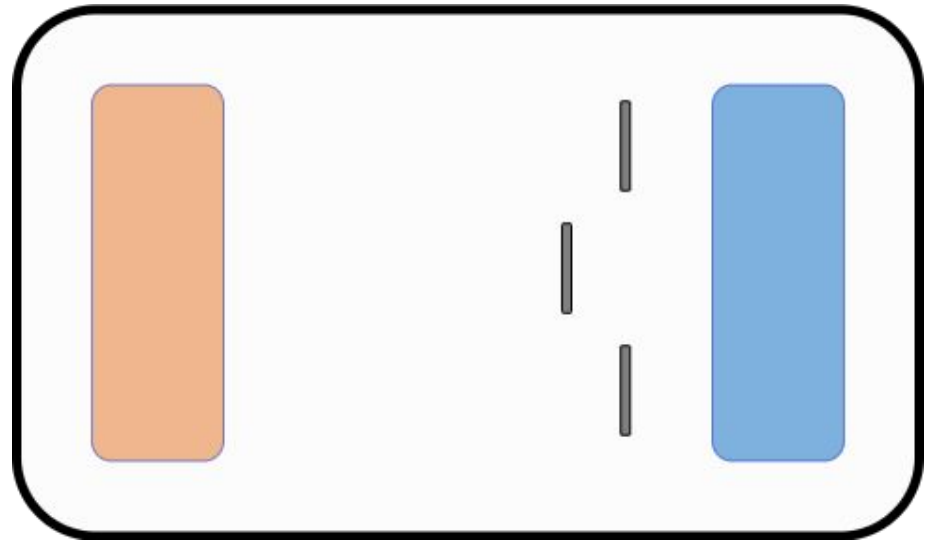
When is a Gamespace balanced?

- not symmetric
 - the **more asymmetric** a gamespace, the **more difficult it is to balance**
- unequal starting options
- the blue team has an advantage



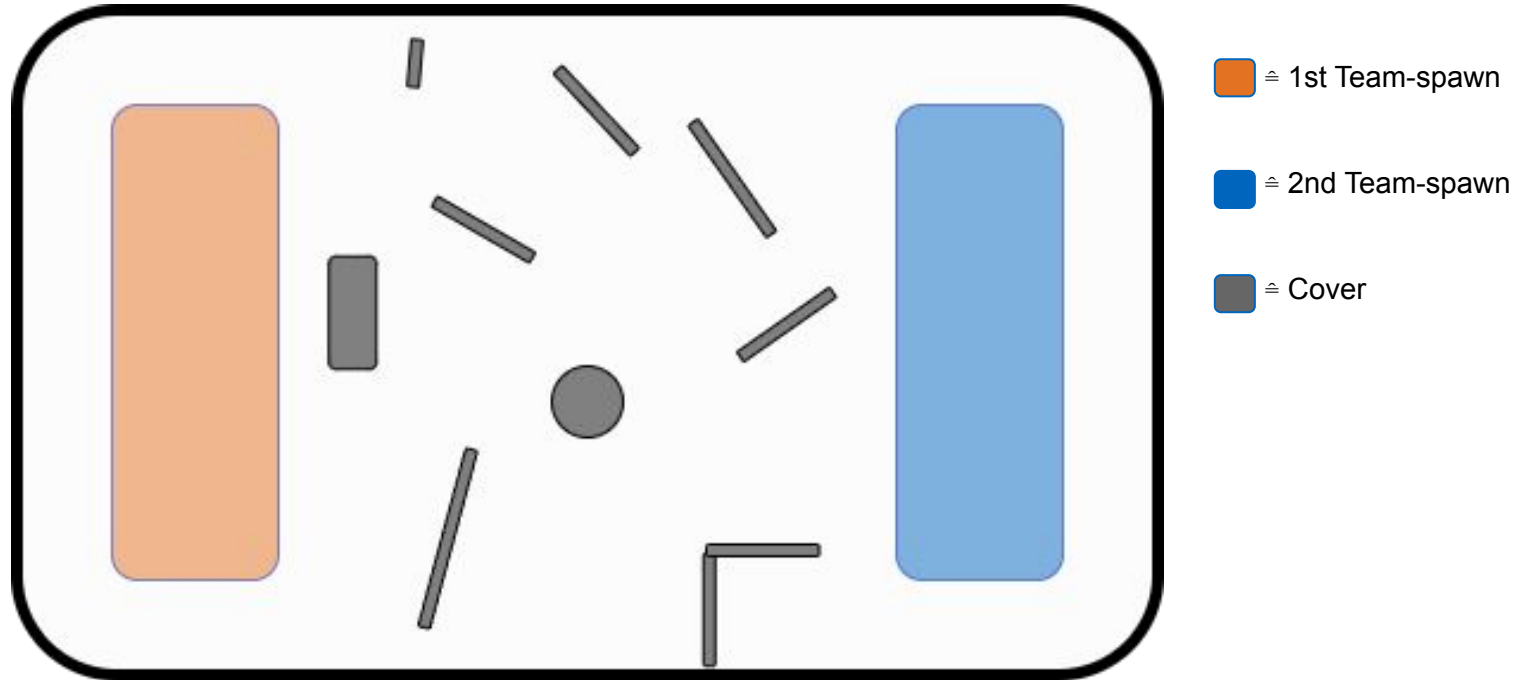
When is a Gamespace balanced?

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 - the **more asymmetric** a gamespace, the **more difficult it is to balance**
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=> Unbalanced

When is a Gamespace balanced?



Another Approach to Balance Gamespaces

- Gamespace design is an **iterative process** [KTy, Chapter: Balance]
- Possible Approach to balance: **Playtesting with Humans**
- But:
 - takes time
 - costs money
- Proposed Approach: **Replace Human Players with Artificial Agents (apply agent-based modeling)**
 - Simulate Playtests using Artificial Agents
 - Gather Data regarding Balance

Agent-based Modeling (ABM) to gather playtest data relevant for Gamespace balancing

- An agent-based model consists of **five components** [WR15]:
 - the **agents** that are being modeled
 - their **environment** they exist in
 - the **observer** controlling the simulation
 - the **schedule** of the simulation
 - all the **interactions** possible within the simulation
- in a game applying the principles of **low coupling & high cohesion** it is easy to implement most of the components
 - except for the required **human-like agent behavior**

Machine Learning Agents to achieve Human-like Behavior

- Prototype built in Unity
- Used [Unity ML-Agent](#) package
- Created [Agents for Arena FPS](#) game
- Trained Agents to achieve certain Behaviors
- Unity ML-Agents require [Actions](#) and [Observations](#)

Machine Learning Agents to achieve Human-like Behavior

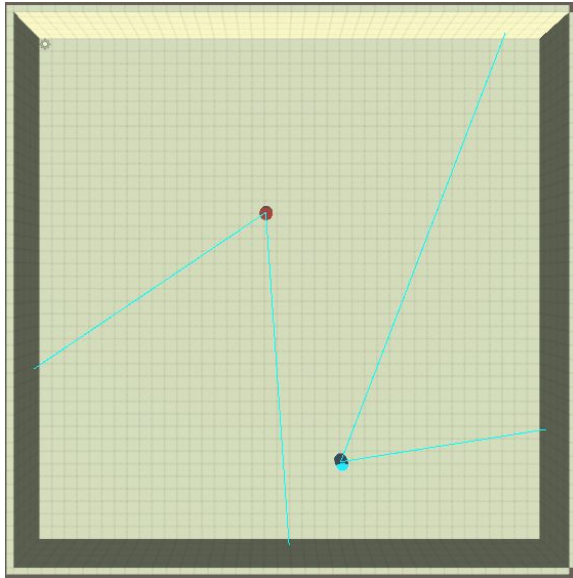
Agent-Actions

- free **Navigation** through the gamespace
- (None, Left, Right-hand) **Rotation**
- Shooting is done automatically by a **line of sight** system

Agent-Observations

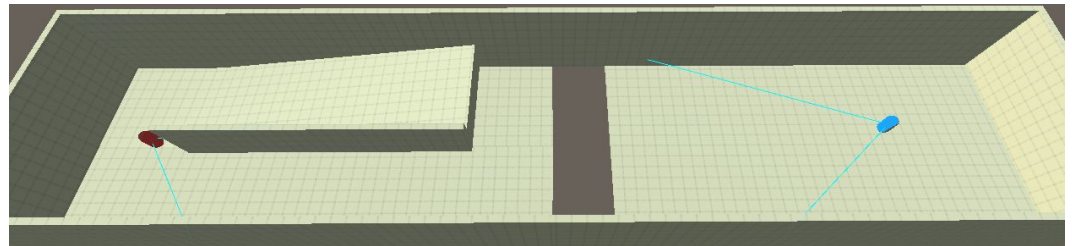
- Agent's own **Position** and **Rotation**
- For every opponent
 - **angle difference** towards opponent
 - **vision score** from **agent to opponent**
 - vision score from **opponent to agent**
- All observations are normalized

Machine Learning Agents to achieve Human-like Behavior



← “Aiming” and Moving in an Empty Gamespace

Usage of a Ramp as advantageous Cover



Conclusion

- Trained agents usable in specific scenarios
- More **complex behaviors require more sophisticated training** and agent model
- Approach seems **promising to gather data for gamespace balancing**
- But: Should be **used in combination with Human Playtesting**
 - Otherwise no data on play experience can be gathered

Thank you!

Any Questions?

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- [BG20] A. Becker and D. Görlich. “What is game balancing?-an examination of concepts.” In: ParadigmPlus 1.1 (2020), pp. 22–41.
- [Ada13] E. Adams. Fundamentals of game design, ThirdEdition. New Riders, 2013.
- [KTy] A. K."TychoBold". Level Design - In Pursuit of Better Levels. url: <https://docs.google.com/document/d/1fAlf2MwEFTwePwzbP3try1H0aYa9kpVBHPBkylq-caY/edit#> (visited on 07/19/2022).

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- [WR15] U. Wilensky and W. Rand. An introduction to agent-based modeling: modeling natural, social, and engineered complex systems with NetLogo. Mit Press, 2015.