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Procedural Generation in the age of AI

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1 Abstract

bliblablup todo

Fragestellung: How does content creation in games differ between [Procedural Content Generation \(PCG\)](#) and [Machine Learning \(ML\)](#) content creation?

2 Definitions

2.1 Content

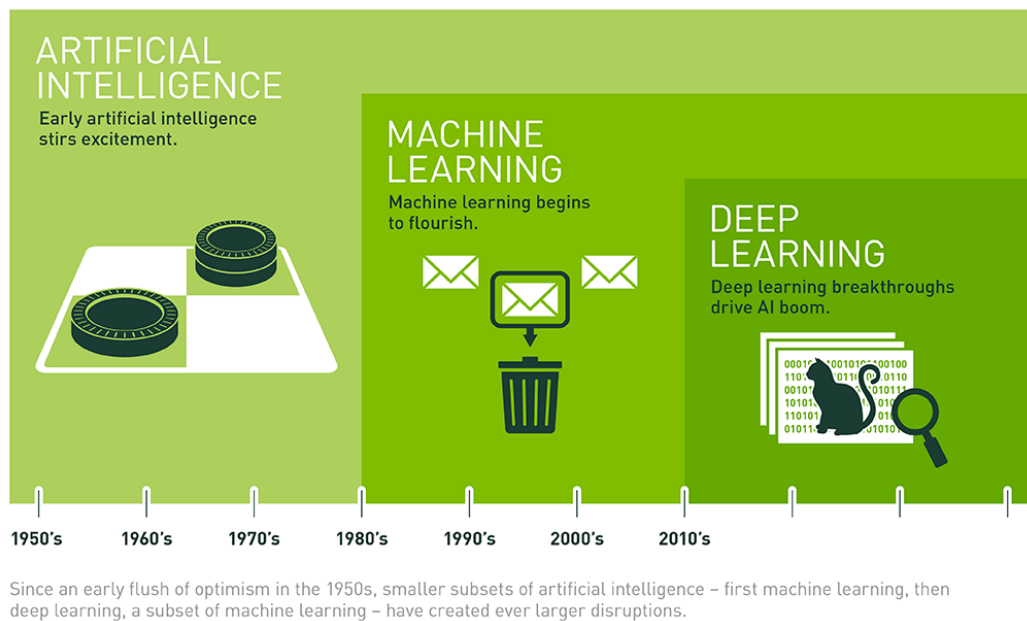
Content in games can refer to various parts. Some known areas include level generation (dungeons,

2.2 Procedural Content Generation

The term [PCG](#) ..

2.3 AI, Machinelearning, Deeplearning

blibla [\[1\]](#) TODO: research definitions



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Figure 1: Levels of AI as Image. [\[1\]](#)

3 Motivation

Games that are meant to be replayed a lot benefit from Procedural Generation.

4 Recurrent Neural Networks

As explained in [subsection 2.3](#) ML is a broad term and includes a variety of models. The [Recurrent Neural Networks \(RNN\)](#) are networks for tasks where we need some kind of persistence. If we want to classify videoframes the network should have some kind of consistency.[\[2\]](#) A network should persist the last seen data and not reclassify items every frame. Reclassifying without previous context could lead to different recognitions in every frame for the same object.

5 Long short-term memory

[RNN](#) are good for persisting very recent information. Sentences are a great example: "Ships are built to float on *water*". The [RNN](#) is great in filling the end of this sentence. Problems arise when the information is needed a lot later. The more information is inbetween the contextual references the more unreliable a basic [RNN](#) gets. Books for example can have references on the last page to the very beginning. For such tasks a [Long short-term memory \(LSTM\)](#) model is the perfect fit. The [LSTM](#) network was introduced by Hochreiter Sepp and Uergen Schmidhuber[\[3\]](#). A [LSTM](#) is a specialized version of a [RNN](#) which is designed for these kind of tasks. Almost all [RNN](#) tasks can be achieved with a [LSTM RNN](#)[\[2\]](#). to read: https://en.wikipedia.org/wiki/Long_short-term_memory <https://colah.github.io/posts/2015-08-Understanding-LSTMs/>

6 The artistic vision and the generation

Generating content for games is a fundamental artistic choice for gamedevelopers. The generation in various forms is linked to a decrease in the artistic vision. Designers have to step away from micro-controlling gameparts like environment, shapes, colors, enemy behaviours etc. Therefore games do include [PCG](#) in different ways and in various depths. Big studios tend to stick to more controlled experiences and have more (human-)resources to ensure this vision. We define a list of various depths of [PCG](#):

1. **No generation** (ex. *Super Mario Bros* (Nintendo, 1985) where everything was handplaced, drawn and animated as explained in *Super Mario Bros*. Level 1-1[\[4\]](#))
2. **Content generation in the game making phase.** (ex. *The Elder Scrolls Oblivion* (Bethesda Softworks, 2006) used [PCG](#) to generated most of the world before the artists curated it.[\[5\]](#) An example of a widely used [PCG](#) algorithm middleware for game studios is SpeedTree[\[6\]](#))
3. **Gameplay (partially) defined or influenced** by [PCG](#) such as the sidequests for *The Elder Scrolls Skyrim* (Bethesda Softworks, 2011) which were endlessly generated[\[7\]](#) or Castles in *Rogue Legacy* (Cellar Door Games, 2013) which are generated procedurally but the game has some kind of continuosity and progress on top of the castle runs.[\[8\]](#))
4. **Games almost completely generated** ex. *Dwarf Fortress* (Dwarf Fortress, 2006) doesn't stop at the map generation. It starts out generating the history of this world and everything that happened before.[\[9\]](#))

Games and even game genres do fall into these different levels of [PCG](#). A major role for this classification of games and game genres is the depth of artistic controll or lack therefore. Games that do rely more on [PCG](#) tend to focus more on the fun gameplay rather than an intriguing story and complex characters.

7 shortcomings of AI

, generation [Role Play Game \(RPG\)](#)s started to rely more on generation and artists curation of content to fill the initial world.

super mario level 1-1 teaching ...

8 OLD:

9 TensorFlow.js

As of April 2018 Google released a new JavaScript [ML](#) library called [Tensorflow.js](#). [Tensorflow.js](#) is build on [deeplearn.js](#) and can be used for a broad variety of [ML](#) tasks. The library allows to train and run models in the webbrowser. Models can be pre-trained on a server or offline computer and then be used on the website.

10 Challenges

various challenges:

- level is playable
- Levels getting harder
- build up, learn new thing and then master it

11 Goal

The goal of this work is to generate maps for games. Maps from "Super Mario" or "Super Meat Boy" contain mostly solid or empty blocks. With that knowledge, the levels can probably be represented in an easy to read text format instead of an image format. The text can probably be feed into an [ML](#) system and new maps can be generated with the assistance of a [ML](#) model.

12 Referenzen und Akronyme

Glossary

Tensorflow.js The Tensorflow software released as a JavaScript library for websites and webapplications [4](#)

Acronyms

LSTM Long short-term memory. [3](#)

ML Machine Learning. [2–4](#)

PCG Procedural Content Generation. [2–4](#)

RNN Recurrent Neural Networks. [3](#)

RPG Role Play Game. [4](#)

References

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