Procedural Generation in the age of AI

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Inhalt

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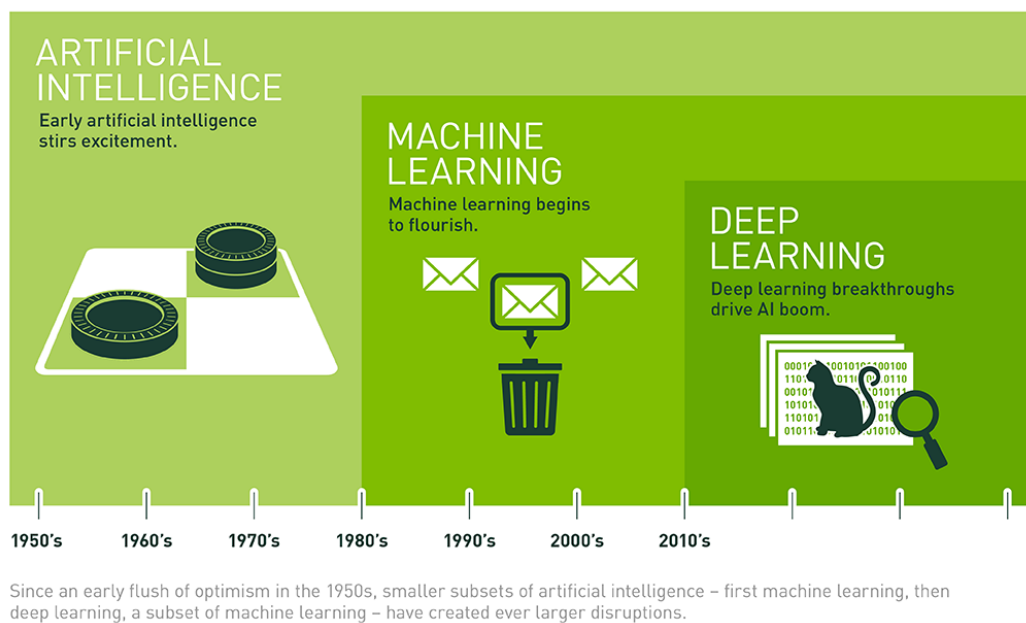
Content in games can refer to various parts. Some known areas include level generation (dungeons,

2.2 Procedural Content Generation

The term PCG ..

2.3 AI, Machinelearning, Deeplearning

blibla [1] TODO: research definitions

§

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 persistance. 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 unreiable 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 Urgen 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) definded 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 then an intriguing story and complex characters.

7 Procedural Content Generation and AI

As explained in The artistic vision and the generation there are various genres and games falling into different levels of automation and generation. Due to the type of gameplay and game mechanics linked to PCG, games with high levels of generation can easily be identified. We hope to blur the lines more and create PCG games that are less distinguishable from handcrafted counterparts. By extending the PCG with Artificial Intelligence (AI) we hope to have a more natural and handcrafted feel to PCG type games. As ML gets used more in games, the applications starts to vary further.

8 Applications of AI systems

8.1 Face representation in games

[10]

8.2 game mechanics

ai game mechanics?

8.3 evolution

asdf

8.4 art etc.

9 shortcomings of AI

, generation Role Play Game (RPG)s started to rely more on generation and artists curation of contet to fill the initial world. -even more lack of controll -same problems as with PCG because a more complex understanding is needed for an artistic vision across levels

10 Procedural Content Generation and Machine Learning

The different strengths of PCG and ML suggest, that ML is an extension in the content generation toolbox rather then a replacement.

super mario level 1-1 teaching ...

11   OLD:

12   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.

13   Challenges

various challenges:

- level is playable

- Levels getting harder

- build up, learn new thing and then master it

14   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.

15   Referenzen und Akronyme

Glossary

Tensorflow.js The Tensorflow software released as a JavaScript library for websites and webapplications 5

Acronyms

LSTM Long short-term memory. 3

ML Machine Learning. 2–5

PCG Procedural Content Generation. 2–4

RNN Recurrent Neural Networks. 3

RPG Role Play Game. 4

References

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