VRIJE
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COMPUTER GENERATED CAR DESIGN

Assignment 1 - Computational Creativity

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February, 2020-2021

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Abstract

As per requirement of the Computational Creativity course, a small computational creative system will be designed and constructed. This will be done by completing multiple smaller milestones. This report focuses on the first of those milestones. The creative domain, car design, is defined and discussed in this report.

In part I, a backstory is given to explain how the idea of choosing car design came to be. Section 1.1 introduces the domain and where creative systems can and have been used. In section 1.2 my personal background knowledge in this domain is given.

Part II explains abstractly how the creative system will function by discussing what the system will generate and what data it will use. This will flow into part III which briefly touches upon which components will be needed for this system and what the expected hurdles are.

All source files for this project are available on GitHub (Bontinck, 2021). It is noted that this report is written by modifying the VUB based LaTeX template from De Smet (2020).

Contents

Part I

The backstory

1.1 A new era of cars

The car industry is only just over a century old and has already evolved from a motorized luxury carriage for the rich to a multi-billion euro industry for the masses. In the last decade, the car industry has undergone major changes, with electrification and autonomous driving being the most prominent. Artificial intelligence (AI) plays a key role in these changes to insure save autonomous driving and optimal battery usage.

But AI can do much more for the car industry, it finds its usage in crash test simulations (Fang et al., 2016), automotive aerodynamics (Dube & Hiravennavar, 2020) and more. This raises the question, if the industry uses so many computer-generated simulations and calculations for validating the design of cars, can't a computer generate a car design? This is a task that is gaining interest by big brands, especially in Formula 1 and hypercar design.

I would like to create a simple and fun Deep Convolutional Generative Adversarial Network (DCGAN) that can generate images of *new cars* based on cars it has learned from. A similar task has already been done by Soomar (2019) and Trivedi (2019). These make use of StyleGAN (Karras et al., 2019). The second milestone will go into more detail regarding relevant literature.

To be more specific I would like to introduce a creative system that can generate a creative interpretation of what a car could look like when design elements from different car models are combined. This could give interesting results in different situations, for example:

- PSA and FCA have recently merged their powers, what could a car look like when taking design cues from Peugeot (PSA) and Fiat (FCA)?
- If feeding the AI with the oldest and newest variant of a certain car model, does it generate a model that looks like an existing intermediate model?
- Can humans that are interested in cars link a certain generated car to a specific brand?

1.2 The car guy in me

I've always said that, if you can't find me behind a computer screen, you'll most likely find me behind the steering wheel. I've had an interest in the car sector since I was born and my dad has been a Peugeot mechanic for his whole life. This gives me access to a lot of people who should be able to distinguish design cues from different car brands which can come in handy when evaluating the system. The fact that I'm genuinely interested in such research and keep myself up to date on how AI is used in the car manufacturing process will hopefully also aid in the development of this system.

Part II

The creative system

2.1 Viability

It has already been discussed that this topic is gaining interest in the car industry, thus the idea of an actual AI designed production car is likely to become reality. The Hack Rod project already teased this idea, it is seen as the world's first AI-generated car (Pette, 2016). More recently, the Czinger 21C is a 3D printed hypercar that claims to have used AI in several steps of the designing process (Girish, 2020). This would have enhanced performance and lowered the cost according to Czinger.

Whilst these are interesting, they aren't viable for this project due to limited resources. This project would limit itself to a more simple and fun DCGAN based on existing technology such as StyleGAN to produce images of cars created by the system. No attention will be paid to whether or not these cars may be possible to be produced and driven, only the visual aspect is of importance for this project.

2.2 System generated creativity

It is planned to make a simple and fun DCGAN, as already pointed out previously. This system will generate images of *non existing* cars that take design cues from the cars of the input data. Ideally, the situations proposed in section 1.1 would be addressable with the system.

In future milestones, it will be important to pay attention that the system is describable in terms of the creative systems framework. Ritchie's criteria and Jourdanous's four perspectives will also have to be addressed as seen during the lectures.

2.3 Available data sources

One of the issues with DCGAN is the sheer amount of data that is needed. The next assignment will give more insight into this but it is not uncommon to need 50 thousand images or more. Luckily some tricks could aid in gathering this data:

- Taking images from car listing sites (e.g. CarMax).
- Using existing data sets.
- Starting from an already trained CNN.

This is again something the literature study in the next milestone will hopefully give more insight into.

Part III

Expected hurdles

3.1 Needed components

This section will be kept abstract but the following components will most likely be needed for the system:

- A crawler that collects input training images from the web.
- A DCGAN that generates images of cars based on the training images.
  - StyleGAN seems like a good starting point. Further literature exploration in the next milestone will give more insight.
- An online questionnaire to:
  - Get human feedback on whether or not the resulting cars look like actual cars.
  - Get feedback from car enthusiast if they recognize certain design cues from famous car brands.
- Much more as this project evolves...

3.2 Black box principle

One of the biggest problems with CNN and DCGAN is the use of hidden layers by the model. This means getting insight on the working will be hard and troubleshooting unexpected results won't be trivial.

3.3 Evaluating creativity

The criteria of Ritchie and others as seen during the lectures will have to be analysed for the system to determine whether or not the system is an actual creative one. Guidance is asked from the teaching assistant to be on the right path when starting with implementing the code to ensure it will be an actual creative one.

References

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