FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

Title of the Dissertation

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WORKING VERSION

Programa Doutoral em Engenharia Informática

Supervisor: Name of the Supervisor

July 31, 2008

Abstract

Here goes the abstract written in English. In Portuguese

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O Nome do Autor

"You should be glad that bridge fell down.
I was planning to build thirteen more to that same design"

Isambard Kingdom Brunel

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Abreviaturas e Símbolos

ADT	Abstract Data Type
ANDF	Architecture-Neutral Distribution Format
API	Application Programming Interface
CAD	Computer-Aided Design
CASE	Computer-Aided Software Engineering
CORBA	Common Object Request Broker Architecture
UNCOL	UNiversal COmpiler-oriented Language
Loren	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Sed vehicula lorem commodo dui
WWW	*World Wide Web*

Chapter 1

Introduction

1.1 Context

The current developments of tools are advancing such existing models, further lead to modeling new sounds, providing possibilities to generate audio efficiently and faster but at the same time interesting results from the trained data set of samples in audio domain. [2]
Deep learning with audio shifts the focus to next level of real-time synthesis of sound by creating completely new-sounding sounds. [2]

1.2 Motivation

Today, digital technologies and advanced computational features, e.g. deep learning and artificial intelligence (AI) tools are shaping our relationships with music as well as enabling new possibilities of utilising new musical instruments and interfaces. [2]

1.3 Objectives

1.4 Dissertation Structure

Para além da introdução, esta dissertação contém mais x capítulos. No Capítulo 2, é descrito o estado da arte e são apresentados trabalhos relacionados. No Capítulo **??**, ipsum dolor sit amet, consectetuer adipiscing elit. No Capítulo **??** praesent sit amet sem. No Capítulo 5 posuere, ante non tristique consectetuer, dui elit scelerisque augue, eu vehicula nibh nisi ac est.

Chapter 2

State of the Art

2.1 Background

2.2 Related Work

2.3 Existing Technologies

2.3.1 WaveNet

[1]
A single WaveNet can capture the characteristics of many different speakers with equal fidelity, and can switch between them by conditioning on the speaker identity. When trained to model music, we find that it generates novel and often highly realistic musical fragments.
The dataset consisted of 44 hours of data from 109 different speakers.
Because the model is not conditioned on text, it generates non-existent but human language-like words in a smooth way with realistic sounding intonations. This is similar to generative models of language or images, where samples look realistic at first glance, but are clearly unnatural upon closer inspection. The lack of long range coherence is partly due to the limited size of the model's receptive field (about 300 milliseconds), which means it can only remember the last 2-3 phonemes it produced.
Finally, we observed that the model also picked up on other characteristics in the audio apart from the voice itself. For instance, it also mimicked the acoustics and recording quality, as well as the breathing and mouth movements of the speakers.
Even with a receptive field of several seconds, the models did not enforce long-range consistency which resulted in second-to-second variations in genre, instrumentation, volume and sound quality. Nevertheless, the samples were often harmonic and aesthetically pleasing, even when produced by unconditional models.
When applied to TTS, WaveNets produced samples that outperform the current best TTS systems in subjective naturalness. Finally, WaveNets showed very promising results when applied to music audio modeling and speech recognition.

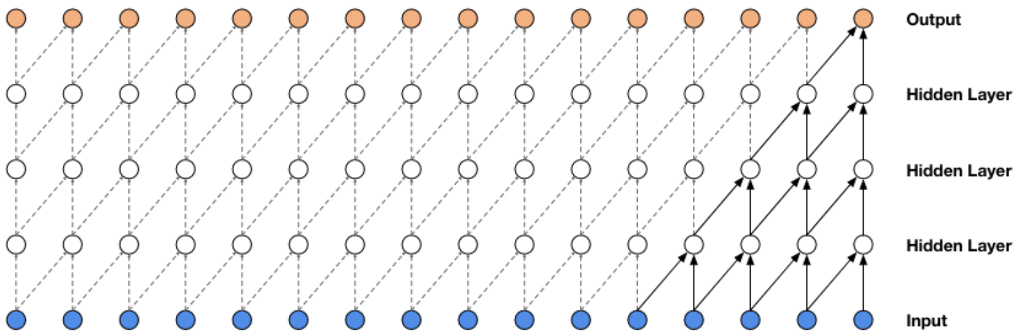
Previously, autoregressive models like WaveNet (used in NSynth) represented the state of the art in neural audio synthesis. These models are good at learning the characteristics of sounds over very short time periods (local latent structure) but struggle with longerterm features (global latent structure). They are also very slow, since they have to generate waveforms one sample at a time. In contrast, GANs are capable of modeling global latent structure, as well as synthesising more efficiently. [2]

2.4 Approaches to Related Problems

2.4.1 WaveNet

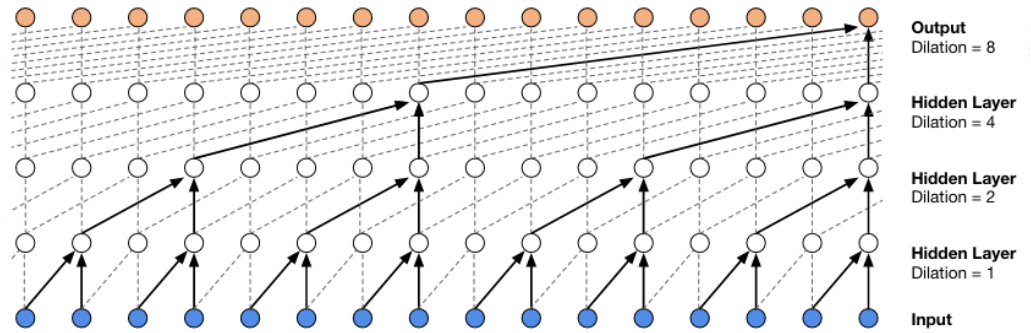
By using causal convolutions, we make sure the model cannot violate the ordering in which we model the data: the prediction p (xt+1 | x1, ..., xt) emitted by the model at timestep t cannot depend on any of the future timesteps xt+1, xt+2, . . . , xT as shown in Fig. 2.1. [1]

Figure 2.1: Causal convolution.



One of the problems of causal convolutions is that they require many layers, or large filters to increase the receptive field.
A dilated convolution (also called ‘ a trous, or convolution with holes) is a convolution where the filter is applied over an area larger than its length by skipping input values with a certain step. Fig. 2.2 shows a dilated convolution.
Stacked dilated convolutions enable networks to have very large receptive fields with just a few layers, while preserving the input resolution throughout the network as well as computational efficiency.
By conditioning the model on other input variables, we can guide WaveNet’s generation to produce audio with the required characteristics. For example, in a multi-speaker setting we can choose the speaker by feeding the speaker identity to the model as an extra input. Similarly, for TTS we need to feed information about the text as an extra input.
if a model is not conditioned on text, it will generate human-like sounds without any meaning behind it

Figure 2.2: Dilated convolution.



these models also capture extra sounds such as the breathing and background noises

Chapter 3

Problem

audio is 1-D data.[1]
raw audio is typically stored as a sequence of 16-bit integer values (one per timestep). [1]

Chapter 4

Solution

It is common to use a deconvolutional neural network (DNN) as generator and a convolutional neural network (CNN or ConvNet) as the discriminator. [2]

4.1 Tasks

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(a) UP at the left (b) UP at the right

Figure 4.1: Two Figures side by side

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Chapter 5

Conclusions

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[1] Aaron van den Oord, Sander Dieleman, Heiga Zen, Karen Simonyan, Oriol Vinyals, Alex Graves, Nal Kalchbrenner, Andrew Senior, and Koray Kavukcuoglu. WaveNet: A Generative Model for Raw Audio, September 2016. arXiv:1609.03499 [cs].

[2] Koray Tahiroğlu, Miranda Kastemaa, and Oskar Koli. Al-terity: Non-Rigid Musical Instrument with Artificial Intelligence Applied to Real-Time Audio Synthesis. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, Proceedings of the International Conference on New Interfaces for Musical Expression, pages 337–342. International Conference on New Interfaces for Musical Expression, July 2020.

Appendix A

Lorem Ipsum

Depois das conclusões e antes das referências bibliográficas, apresenta-se neste anexo numerado o texto usado para preencher a dissertação.

A.1 O que é o *Lorem Ipsum*?

Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged. It was popularised in the 1960s with the release of Letraset sheets containing Lorem Ipsum passages, and more recently with desktop publishing software like Aldus PageMaker including versions of Lorem Ipsum [**?**].

A.2 De onde Vem o Lorem?

Contrary to popular belief, Lorem Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintock, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, consectetur, from a Lorem Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Lorem Ipsum comes from sections 1.10.32 and 1.10.33 of "de Finibus Bonorum et Malorum" (The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Lorem Ipsum, "Lorem ipsum dolor sit amet...", comes from a line in section 1.10.32.
The standard chunk of Lorem Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from "de Finibus Bonorum et Malorum" by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

A.3 Porque se usa o Lorem?

It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout. The point of using Lorem Ipsum is that it has a more-or-less normal distribution of letters, as opposed to using “Content here, content here”, making it look like readable English. Many desktop publishing packages and web page editors now use Lorem Ipsum as their default model text, and a search for “lorem ipsum” will uncover many web sites still in their infancy. Various versions have evolved over the years, sometimes by accident, sometimes on purpose (injected humour and the like).

A.4 Onde se Podem Encontrar Exemplos?

There are many variations of passages of Lorem Ipsum available, but the majority have suffered alteration in some form, by injected humour, or randomised words which don’t look even slightly believable. If you are going to use a passage of Lorem Ipsum, you need to be sure there isn’t anything embarrassing hidden in the middle of text. All the Lorem Ipsum generators on the Internet tend to repeat predefined chunks as necessary, making this the first true generator on the Internet. It uses a dictionary of over 200 Latin words, combined with a handful of model sentence structures, to generate Lorem Ipsum which looks reasonable. The generated Lorem Ipsum is therefore always free from repetition, injected humour, or non-characteristic words etc.