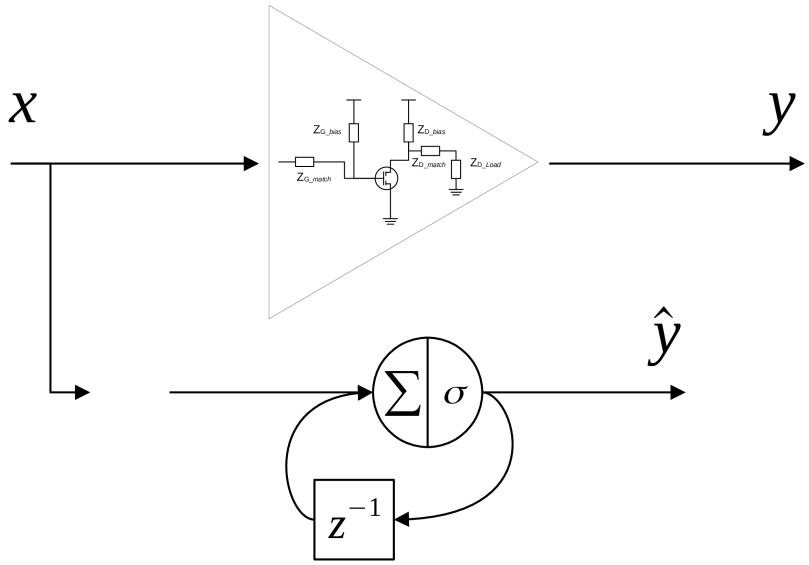
2023-2024 ICS Internship Project: Performance analysis of recurrent neural networks (RNN) for power amplifier (PA) modeling



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Project topics : Machine learning, Optimization, Signal processing, Communication systems

This intership project is a continuation of the ICS Mini-Project Teaching the Backpropagation Through Time Algorithm (https://c2s.telecom-paristech.fr/ICSProjectsInterships/Germain/projects/BackProp-Through-Time.html). It is highly recommended to achieve this mini-project to apply for this intership project.

This project is eligible for extension to a PhD thesis.

Project description

PAs are electronics devices that amplify the power of a signal, but they also introduce distortion into the signal. This distortion can be problematic for communication systems, so it is important to have accurate models of PAs in order to design and optimize communication systems.

RNNs are a type of machine learning model that are well-suited for modeling sequential data, such as the time-domain waveforms of PA signals. RNNs have been shown to be effective for modeling the behavior of PAs, but there is still room for improvement.

This project aims to evaluate the performance of different types of RNNs (like GRU or LSTM) for modeling the behavior of PAs. The training of the RNNs will be done using the BPTT algorithm (hence the requirement to achieve the mini-project).

The project will give students the opportunity to learn about the latest advances in RNN technology and to apply their knowledge to a real-world problem. The project will also give students the opportunity to develop their research and development skills.

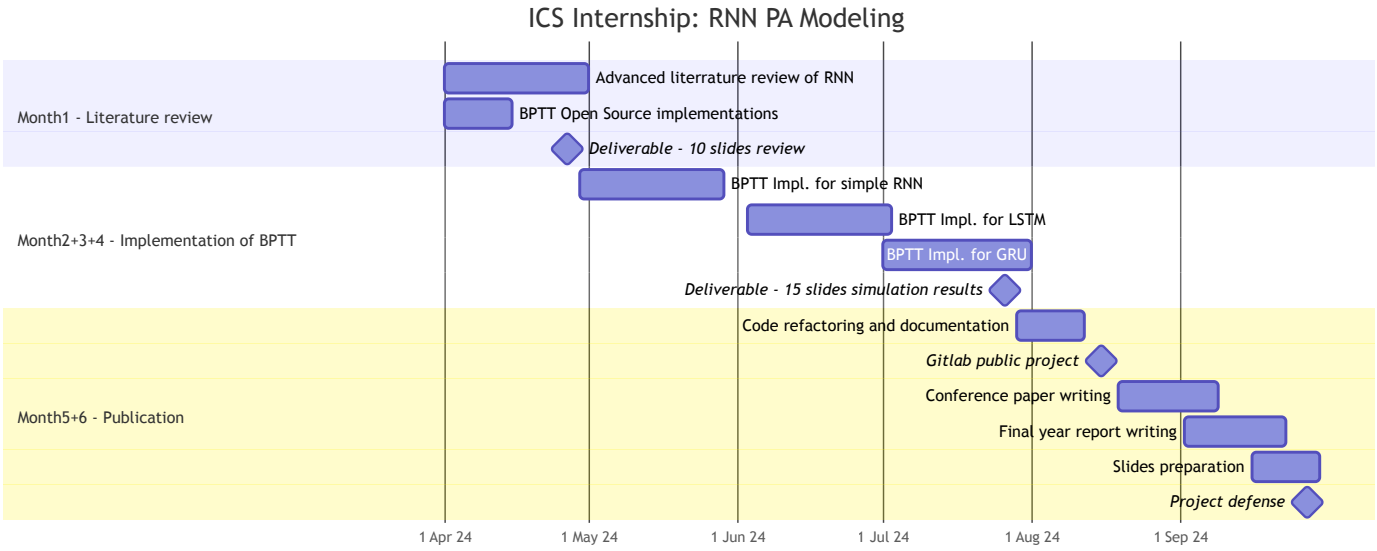
In addition, the project is likely to be of interest to industry partners, so students who complete this project may have the opportunity to pursue employment opportunities after their internship.

Required skills

This project requires a good knowledge of machine learning concepts, such as neural networks, gradient descent, and backpropagation.

- Mandatory
  - Signal processing
  - Matlab programming experience (matrix manipulation, computing, programmatic plotting)
  - practical elements of Latex (writing equations)
  - practical elements of `git`
  - Linux OS basics (usage of `terminal` command lines, `ssh` , `make` ,...)
  - BPTT algorithm (see the mini-project)

Workplan (6 months)



Location

School

Télécom Paris (https://www.telecom-paris.fr/) trains its students to innovate in today's digital world. Its training and research cover all fields of information and communication sciences and technologies with a strong societal foundation in order to address the major challenges of the 21st century. Its offers engineering, PhD and professional degree programs, with international students accounting for 55% of its student body. Its research offers original, multidisciplinary world-class expertise in nine strategic areas: Data Science and Artificial Intelligence — Visual and Audio Computing, Interaction — Digital Trust — Innovation Regulations — Transformation of Innovative Firms — Cyber-Physical Systems — Communication Systems and Networks — Mathematics and Applications — Uses, Participation, Democratization of Innovation.

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Hosting laboratory

Laboratoire Traitement et Communication de l'Information (LTCI)
(https://www.telecom-paris.fr/fr/recherche/laboratoires/laboratoire-traitement-et-communication-de-linformation-ltci)

Research team

The Circuits et Systèmes de Communication (C2S)
(https://www.telecom-paris.fr/fr/recherche/laboratoires/laboratoire-traitement-et-communication-de-linformation-ltci/les-equipes-de-recherche/circuits-et-systemes-de-communication-c2s)
team is internationally recognized for its ability to integrate digital intelligence into AMS and RF SoCs such as analog-to-digital converters (ADCs) or RF receivers for cognitive radio. By combining its expertise in the physical realization of the CMOS chip with its experience in signal processing and its knowledge of the other network layers for which LTCI's skills are recognized, the group designs high-performance AMS and RF SoCs. The aim is to develop elements or "building blocks", enabling the system of connected objects to be interfaced on one side with the physical world via sensors, and on the other side with the system core via communications, in particular RF.

References

In addition to the references of the related mini-project
(https://c2s.telecom-paristech.fr/ICSProjectsInterships/Germain/projects/BackProp-Through-Time.html), literrature review will focus on the following papers:

- [Salehinejad17] Salehinejad, H., Sankar, S., Barfett, J., Colak, E., & Valaee, S. (2017). Recent advances in recurrent neural networks. arXiv preprint arXiv:1801.01078. URL: https://doi.org/10.48550/arXiv.1801.01078
- [Horne94] Horne, B., & Giles, C. (1994). An experimental comparison of recurrent neural networks. Advances in neural information processing systems, 7. URL: https://proceedings.neurips.cc/paper_files/paper/1994/file/31b3b31a1c2f8a370206f111127c0dbd-Paper.pdf

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