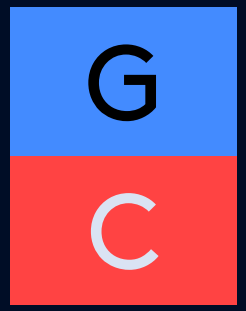
R2.B.09

Real-Time Identification of Common and Extended Musical Chords using Artificial Neural Networks

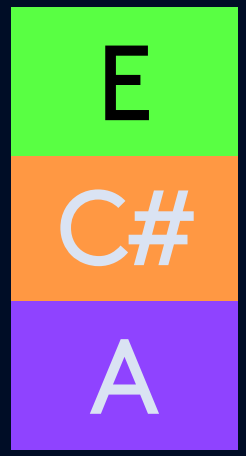
Coronel, Lesli Natasha A.
Navarro, Joachim Alfonso A.

Musical Chords

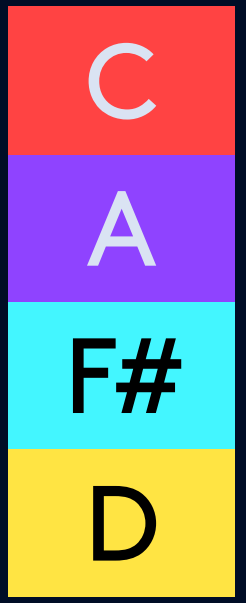
BACKGROUND



2 or more notes



Played together



Follow “rules of harmony”

(Leino, Brattico, Tervaniemi, & Vurst, 2007)

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Musical Chords

BACKGROUND

Each has a name

C5
G
C

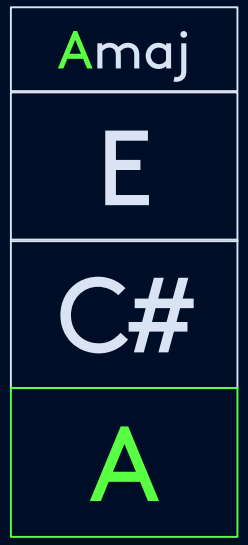
Amaj
E
C#
A

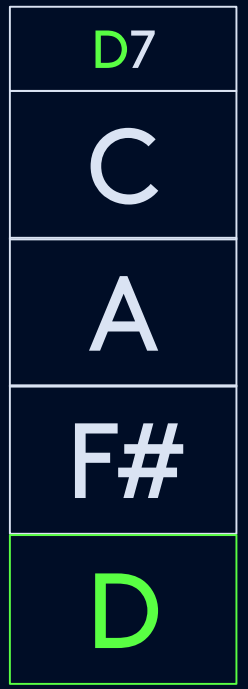
D7
C
A
F#
D

Musical Chords

BACKGROUND

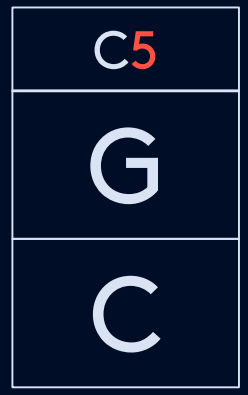
Each has a root note

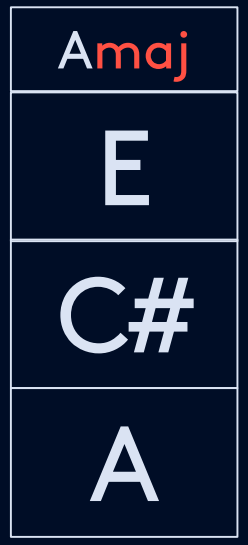


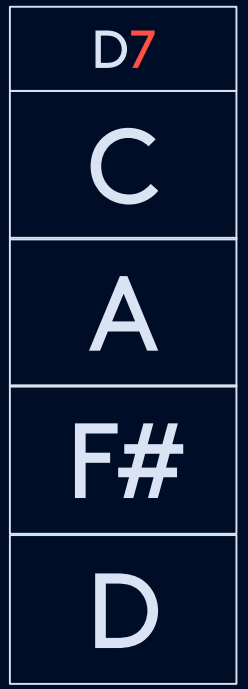


Musical Chords

Each has a type



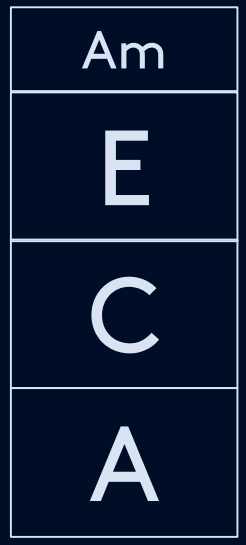




Musical Chords

Non-extended vs Extended

Chord types

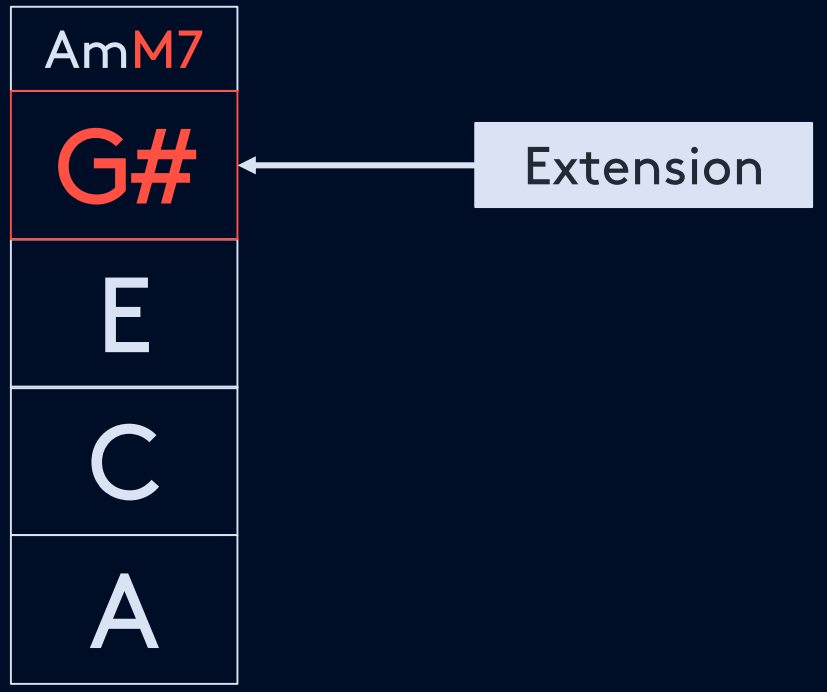


Non-extended

More common chord type

Musical Chords

BACKGROUND



Extended

Less common chord type

Non-extended vs Extended

Chord types

Chord Identification DEFINITION

The determination of the name of the chord from the notes that constitute it

Definition of chord identification

Chord Identification

PROBLEM

> "The general music learning public places a high demand on chord-based representations of popular music."
>
> Humphrey, Bello, & Cho, n.d., par. 1

Chord Identification

PROBLEM

A majority of the general music learning public can't do this by themselves.

Why?

Inference

Absolute pitch

PROBLEM

Absolute pitch

PROBLEM

Rare amongst music-learning individuals

Zatorre, Perry, Beckett, Westbury, & Evans, 1998

Absolute pitch

PROBLEM

Expressed in a low percentage of the human population

Baharloo, Service, Risch, Gitschier, & Freimer, 2000

Absolute pitch

Acquired through favorable genes or early music training

Baharloo, Service, Risch, Gitschier, & Freimer, 2000

Neural networks

DEFINITION

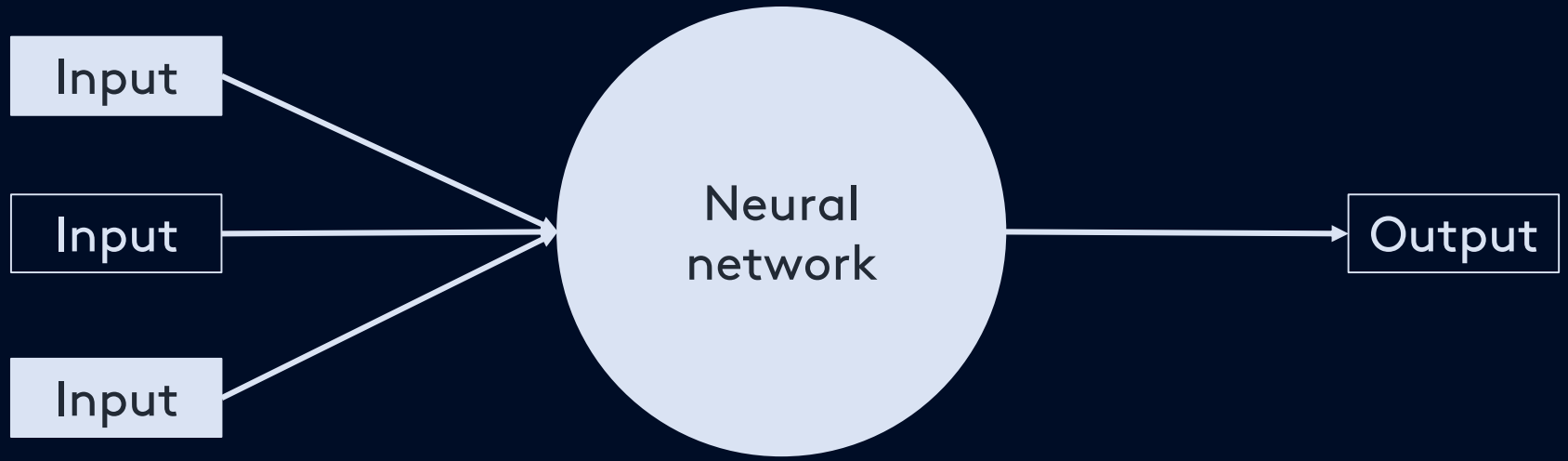
Computational model of neurons in a brain

Neural networks

DEFINITION

Many of these make up a neural network

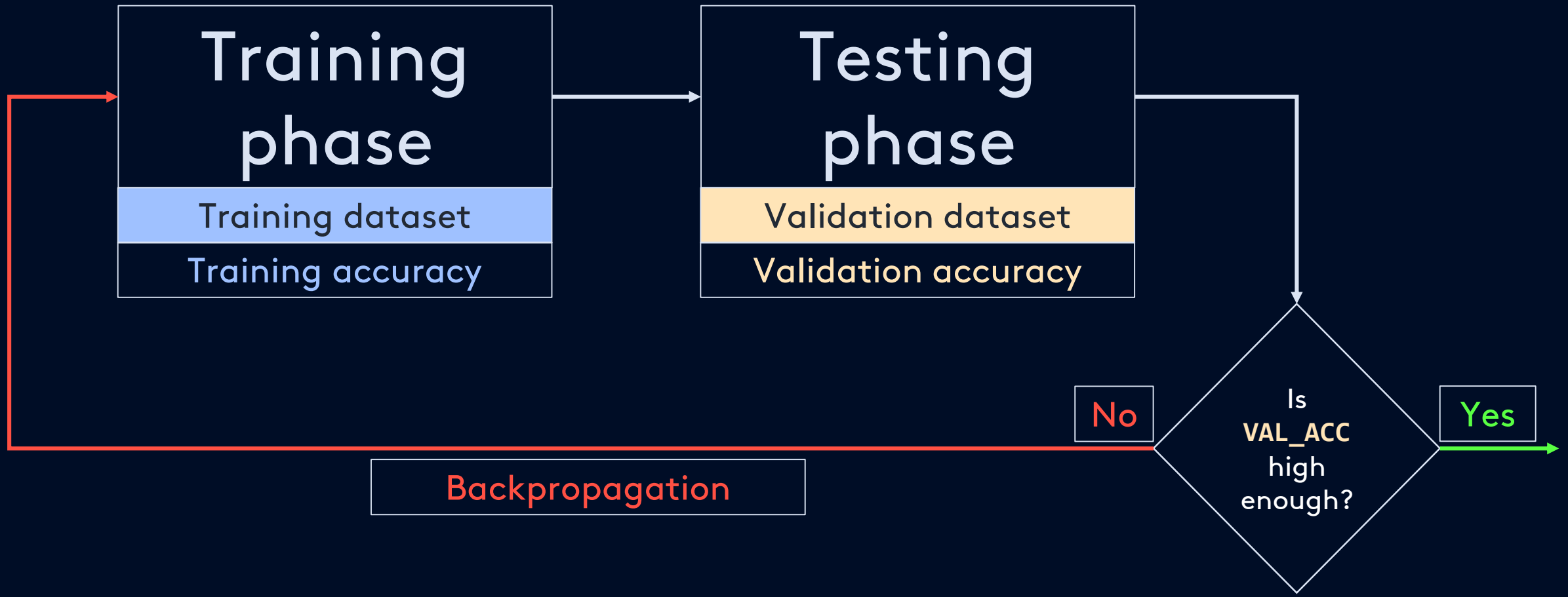
Artificial Neural Networks (ANNs)



ANN learns by repetitive training

Colina, Perez, & Paraan, 2017

ANN training & testing



Why neural networks? PROBLEM

Previous studies with neural network implementations have not included extended chords in their research

Osmalskyj, Embrechts, Piérard, & Van Droogenbroeck, 2012
Perera & Kodithuwakku, 2005
Zhou & Lerch, 2015

Problem statement

PROBLEM

Using neural networks to identify both common and extended chords is **unexplored**

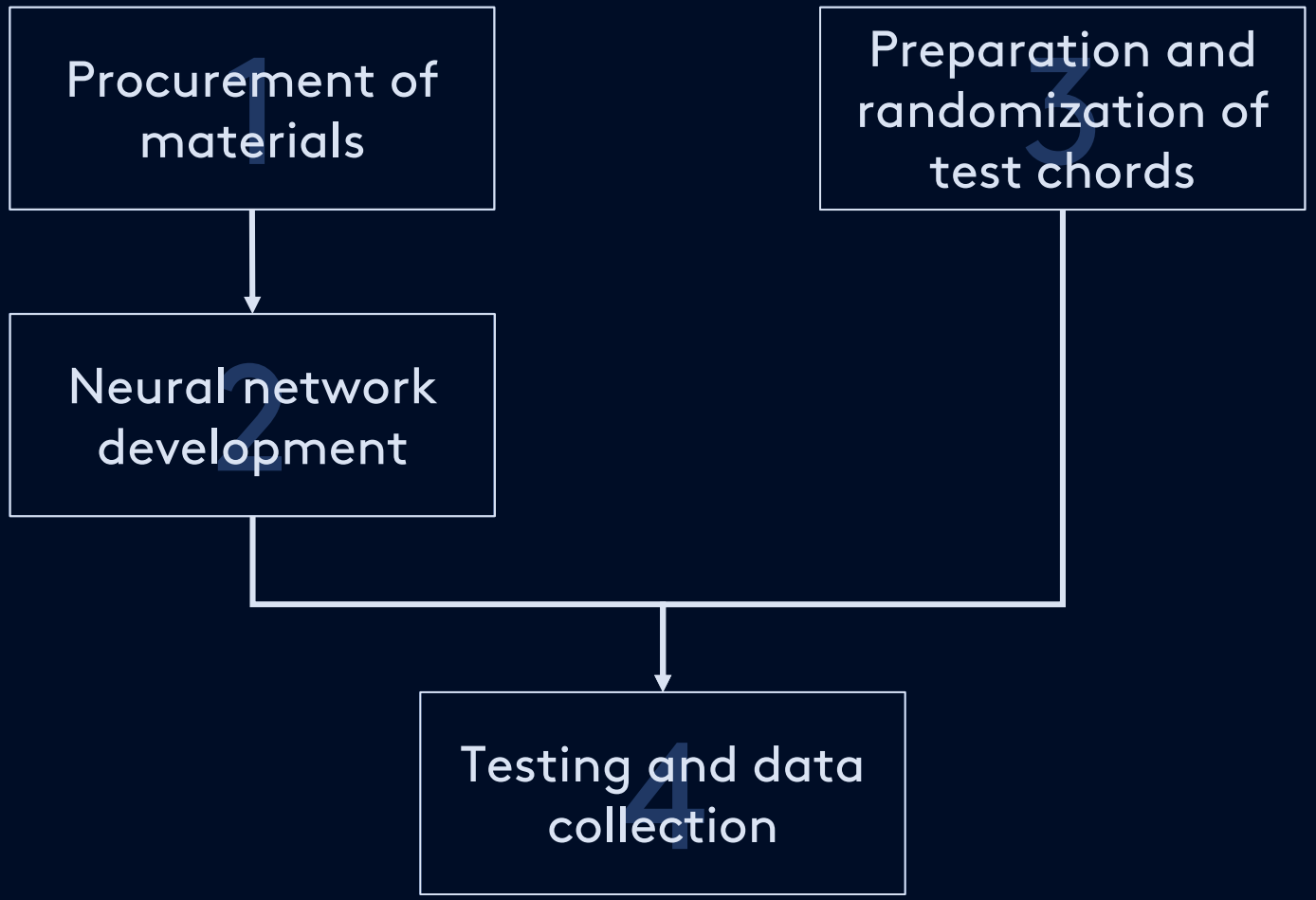
Osmalskyj, Embrechts, Piérard, & Van Droogenbroeck, 2012
Perera & Kodithuwakku, 2005
Zhou & Lerch, 2015

OBJECTIVE

Develop a neural network that quickly identifies common and extended musical chords

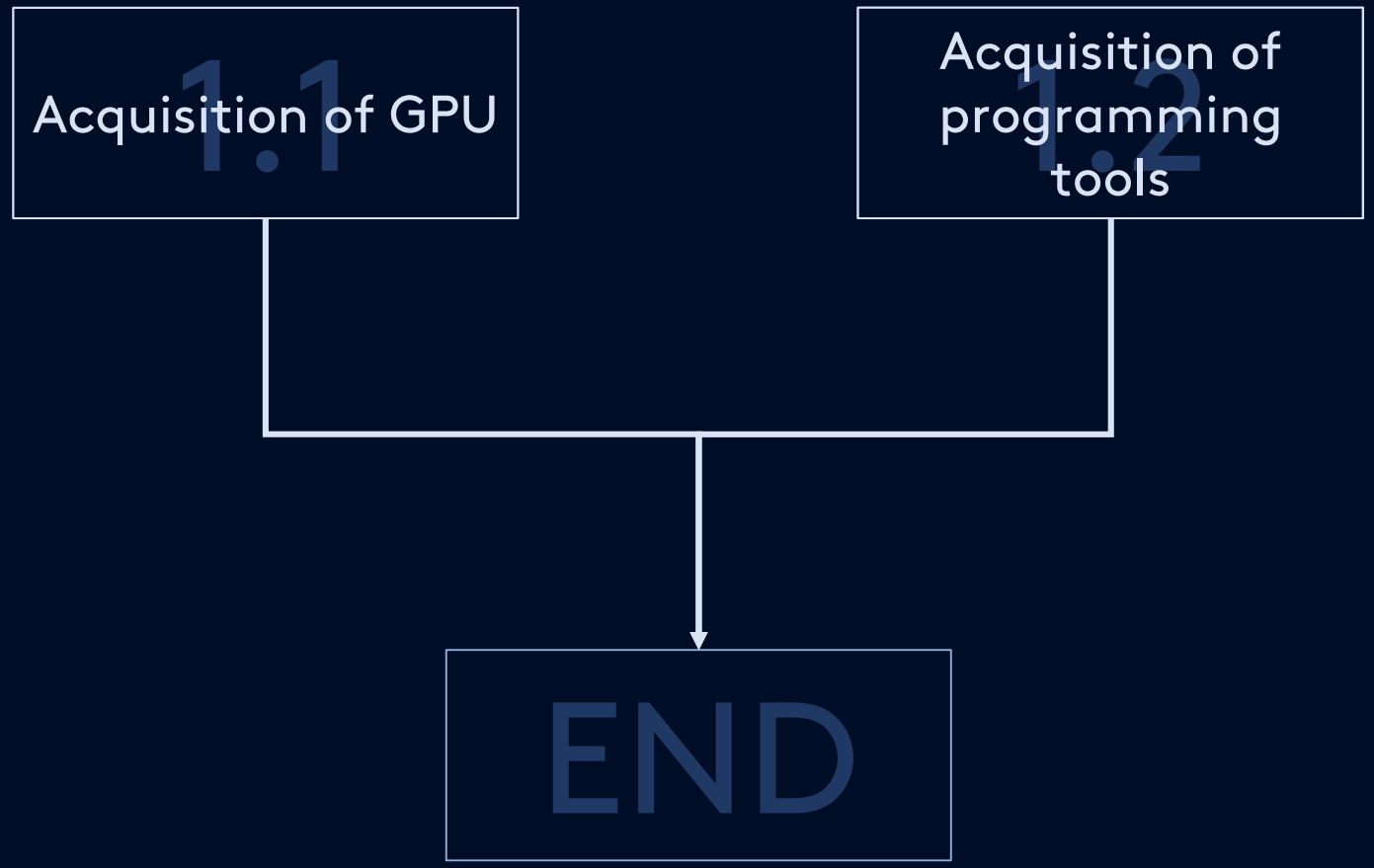
Level 0

PROCESS



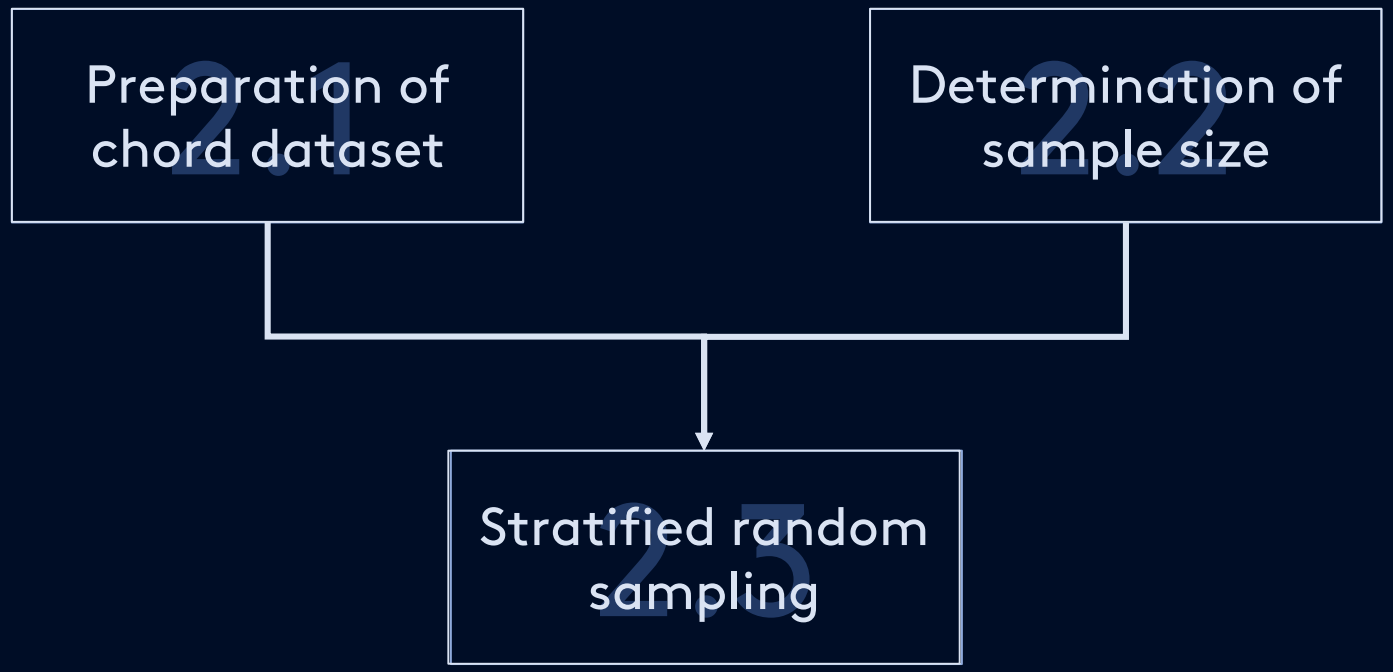
1 Procurement

PROCESS



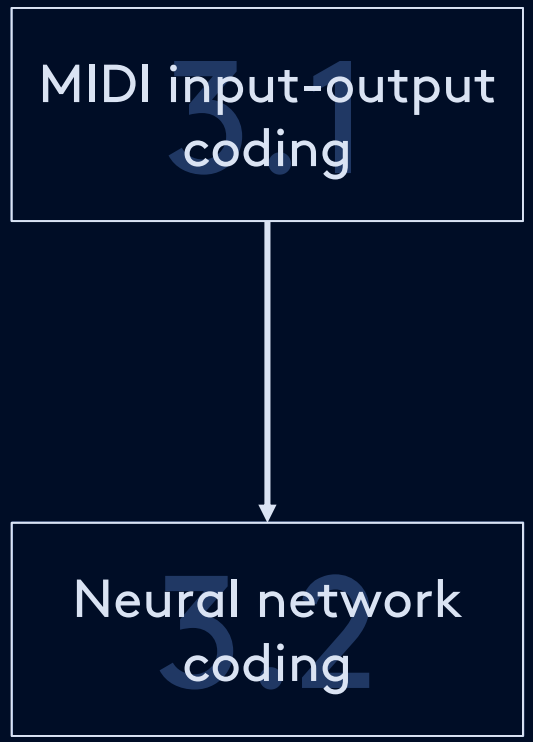
2 Dataset Prep & Rn

PROCESS



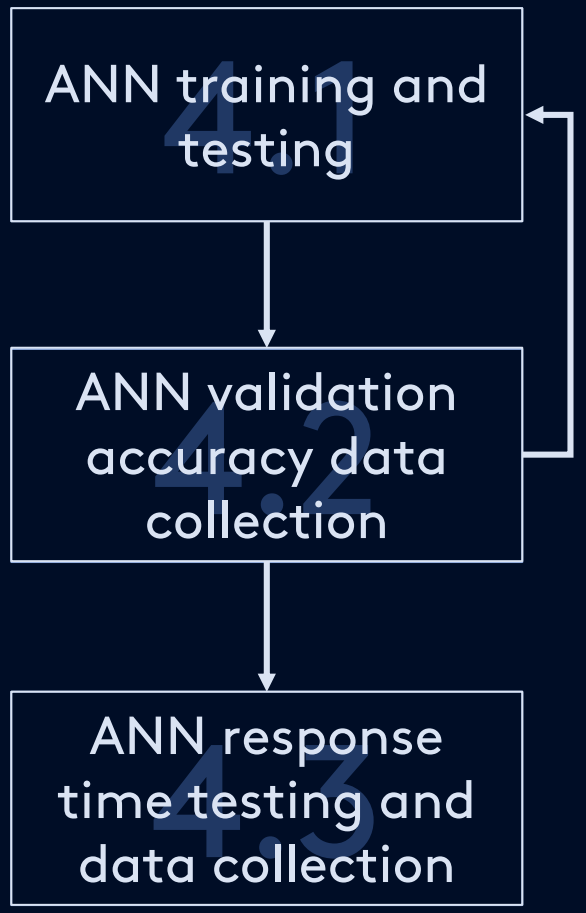
3 ANN Development

PROCESS



4 Training, Testing, DC

PROCESS

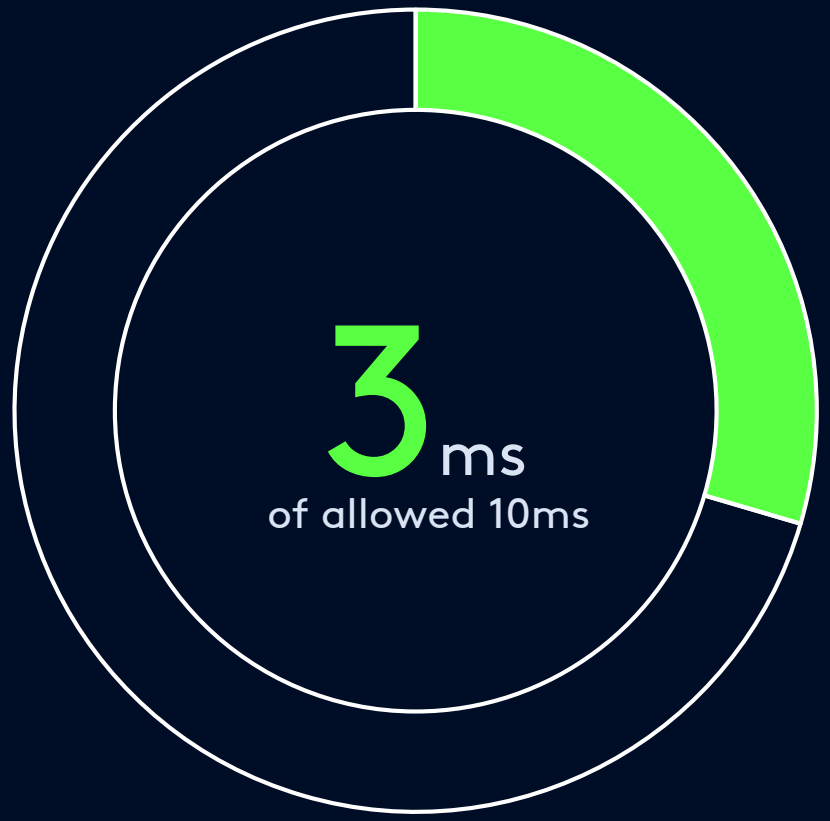


Performance

RESULTS

Peak validation accuracy after 2400 epochs

Mean total response time, 30 samples



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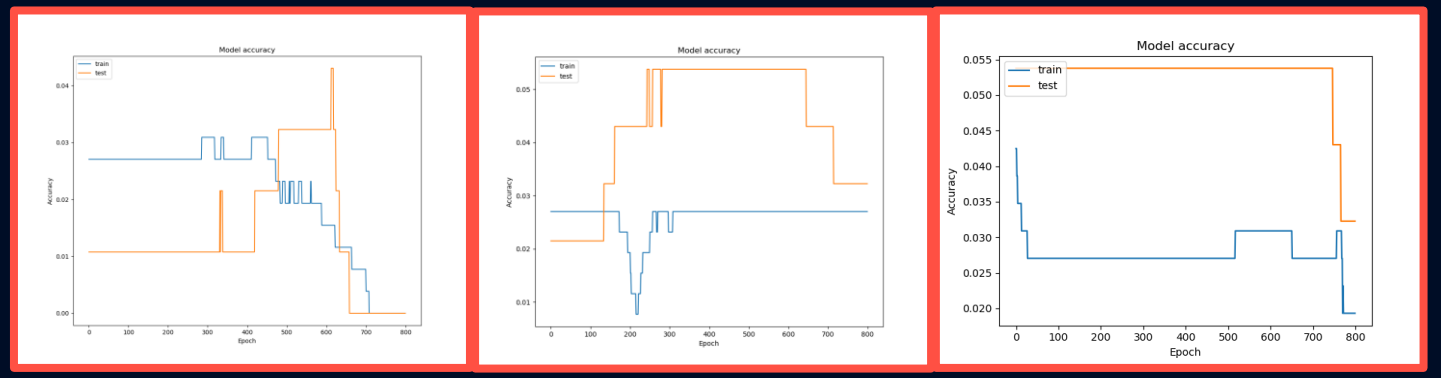
Performance

RESULTS

Peak validation accuracy
after 2400 epochs



Irregular and sporadic

Validation accuracy trends

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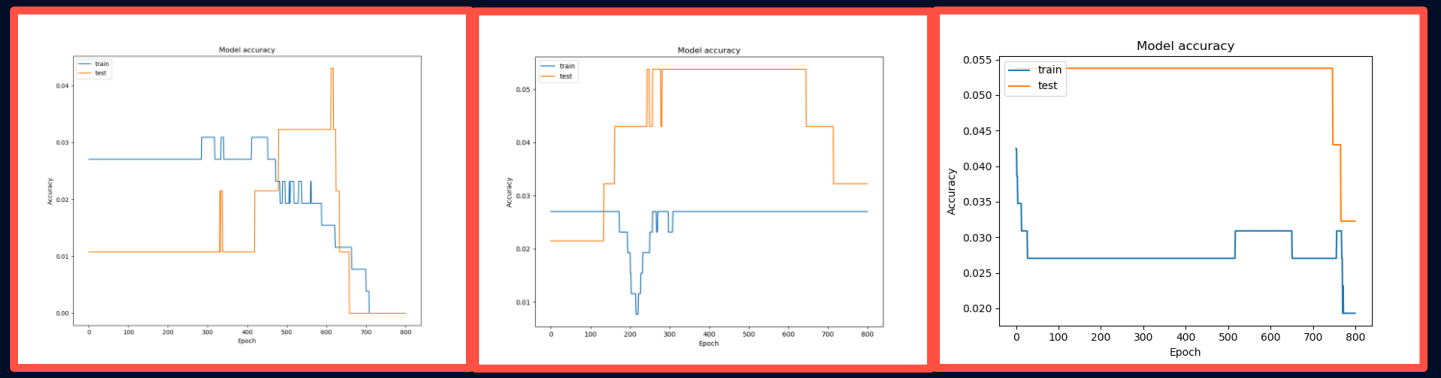
Performance

RESULTS

Peak validation accuracy
after 2400 epochs



Model is underfitting

Bodik, 2018

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Performance

RESULTS

Mean total response time,
30 samples

Null hypothesis	Alternative hypothesis
$r \geq 10ms$	$r < 10ms$

T-test for one mean

Sample size = 30; Significance = 5%

Performance

Mean total response time,
30 samples

Null hypothesis	Alternative hypothesis
$t \geq -1.6_{99}$	$t < -1.6_{99}$

T-test for one mean

Sample size = 30; Significance = 5%

Performance

RESULTS

Mean total response time,
30 samples

Null hypothesis	Alternative hypothesis
$t \geq -1.6_{99}$	$t < -1.6_{99}$
$t_{3ms} = -17.19$	

T-test for one mean

Sample size = 30; Significance = 5%

Performance

RESULTS

Mean total response time,
30 samples

Null hypothesis	Alternative hypothesis
~~t ≥ -1.699~~	t < -1.699
NN is faster than standard!	

REJECT

T-test for one mean

Sample size = 30; Significance = 5%

Conclusion

CLOSING

The proposed ANN design is inaccurate...

But ANNs can be used for real-time tasks

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Recommendations

Revise ANN design
1

More training
2

T	H	E	Rev. 4	E	N	D
Thank you!						

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