

R2.B.09

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

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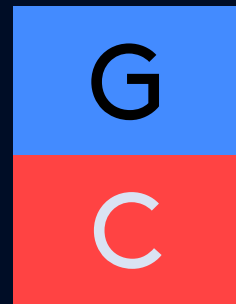
Pitch Classes / Notes

BACKGROUND

C	C#	D	D#	E	F
B	A#	A	G#	G	F#

Musical Chords

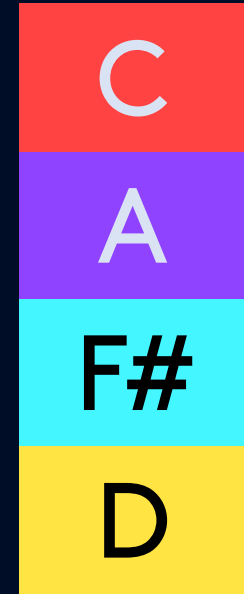
BACKGROUND



2 or more
notes



Played
together



Follow “rules of
harmony”

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

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

C5
G
C

A ^{maj}
E
C [#]
A

D ⁷
C
A
F [#]
D

Musical Chords

BACKGROUND

Each
has a
type

C ⁵
G
C

A ^{maj}
E
C [#]
A

D ⁷
C
A
F [#]
D

Musical Chords

BACKGROUND

Each
has an
inversion
number

C5
G
C
0

Amaj
E
C#
A
0

D7
C
A
F#
D
0

Not part of the scope of the study

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



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

PROBLEM

Acquired through **favorable
genes and early music
training**

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

What role does absolute
pitch play in **chord**
identification?

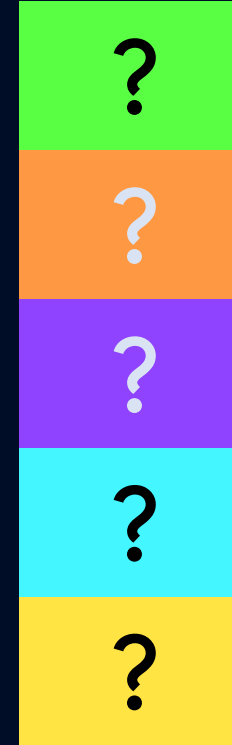
Question

Chord Id'n and A.P.

PROBLEM

Notes of
chord
cannot be
identified

Without AP

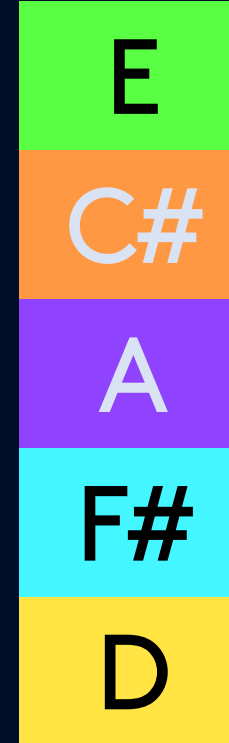


Chord Id'n and A.P.

PROBLEM

Notes of
chord are
identified
exactly

With AP

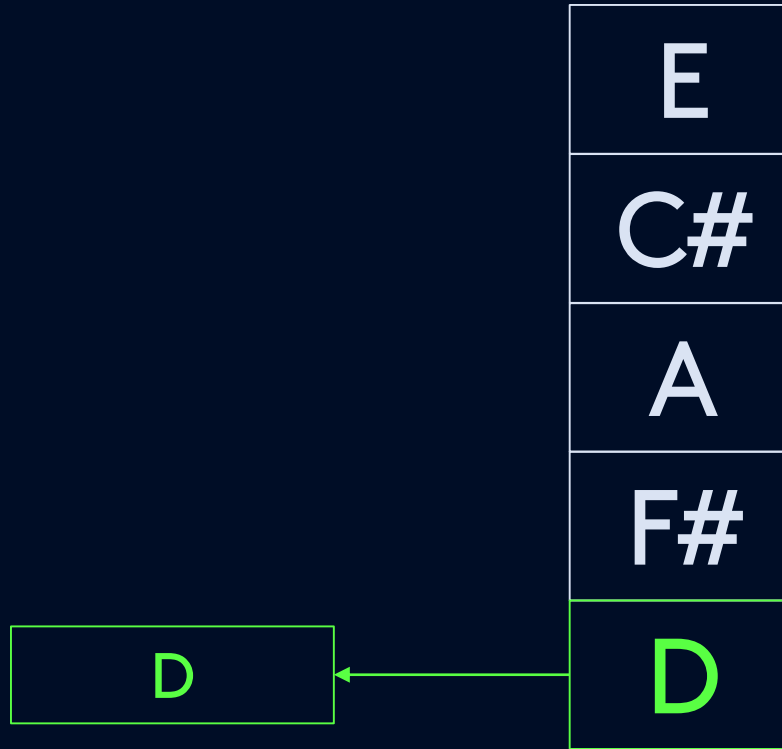


Chord Id'n and A.P.

PROBLEM

Root note
is identified

With AP



Chord Id'n and A.P.

PROBLEM

Chord type
is identified

With AP & common RP

maj9

E

C#

A

F#

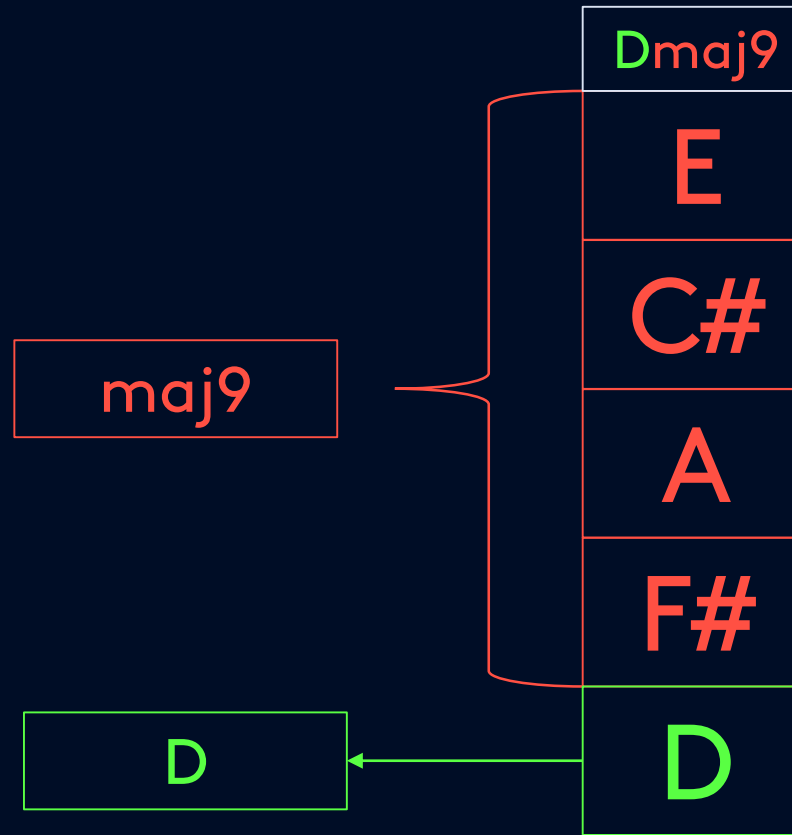
D

Chord Id'n and A.P.

PROBLEM

Chord
name is
identified

With AP & common RP



*The process of determining the name of a chord is also called chord identification.

Chord Id'n and A.P.

PROBLEM

Chord
name is
identified

With AP & common RP

Dmaj9

E

C#

A

F#

D

*The process of determining the name of a chord is also called chord identification.

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

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

Input is a group of **3 or more MIDI signals** played in **real-time**

Input chords have **one root**
and are in the **0th inversion**

Identification must be quick
enough to be used in **live
performance**

Implemented in
programming languages
with **neural network, real-
time MIDI, and GPU
processing** libraries

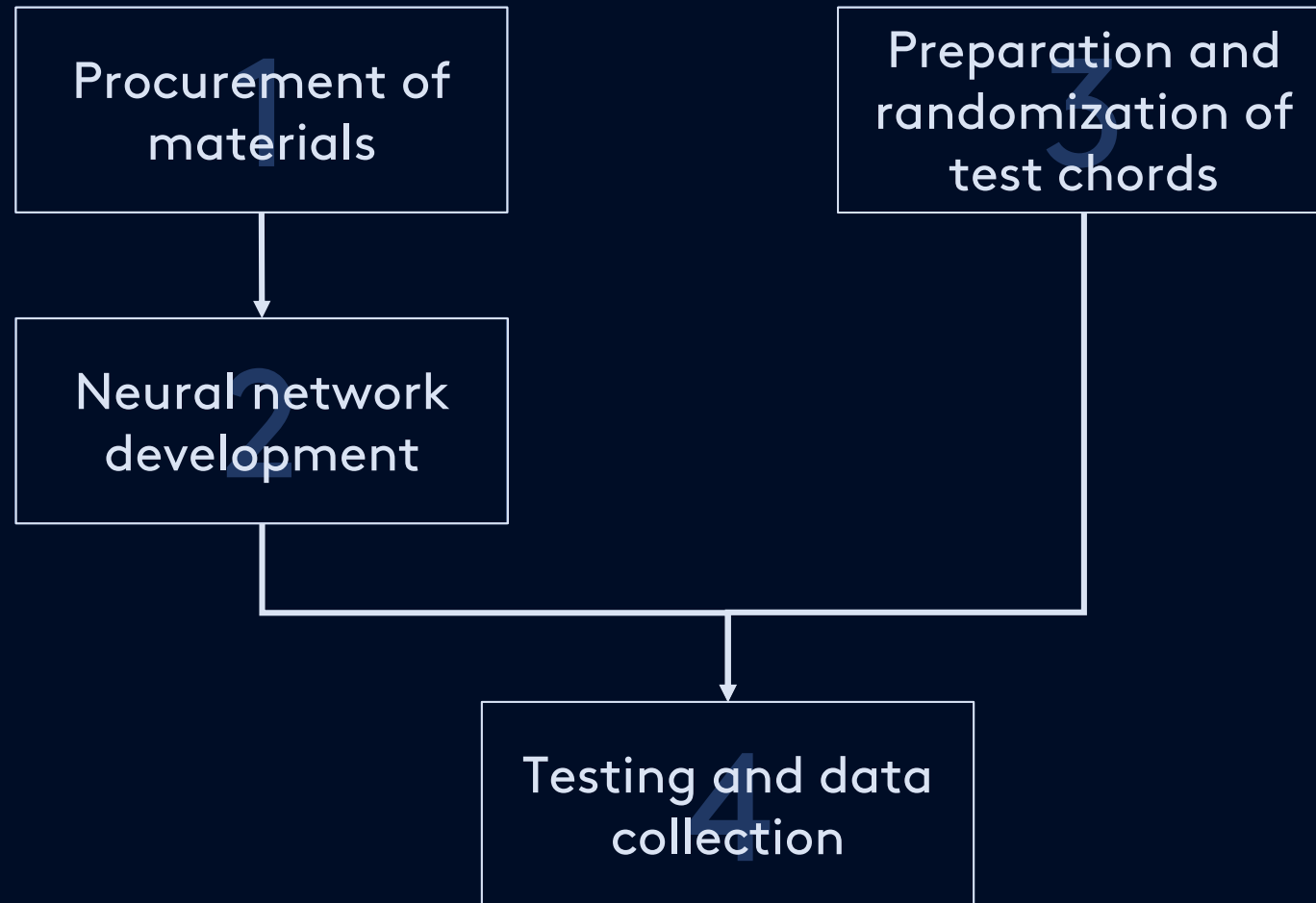
thestk, 2017; Bretschneider, 2017

Neural network must be run
on a GPU for efficient
processing

Nickolls, Buck, Garland, & Skadron, 2008

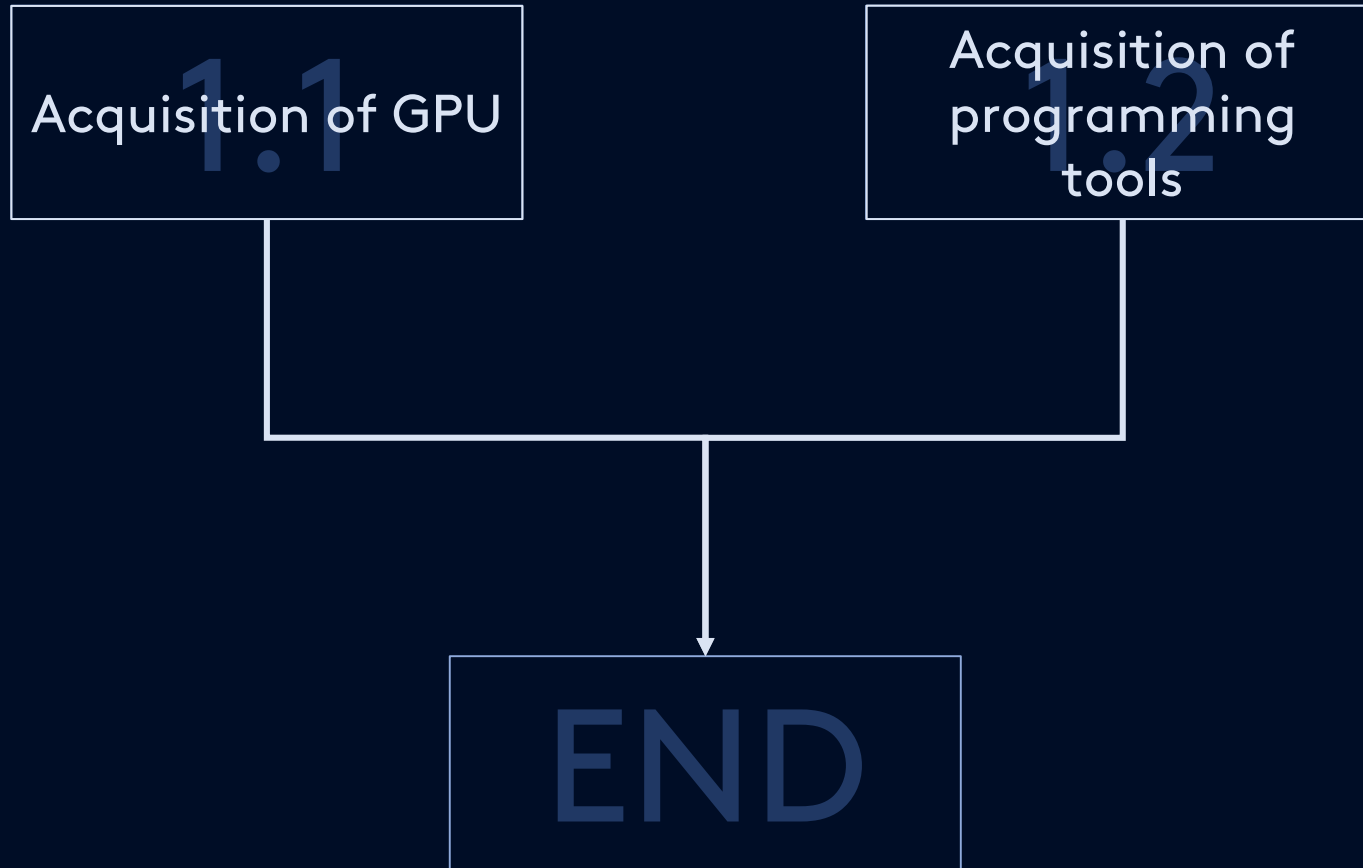
Level 0

Process



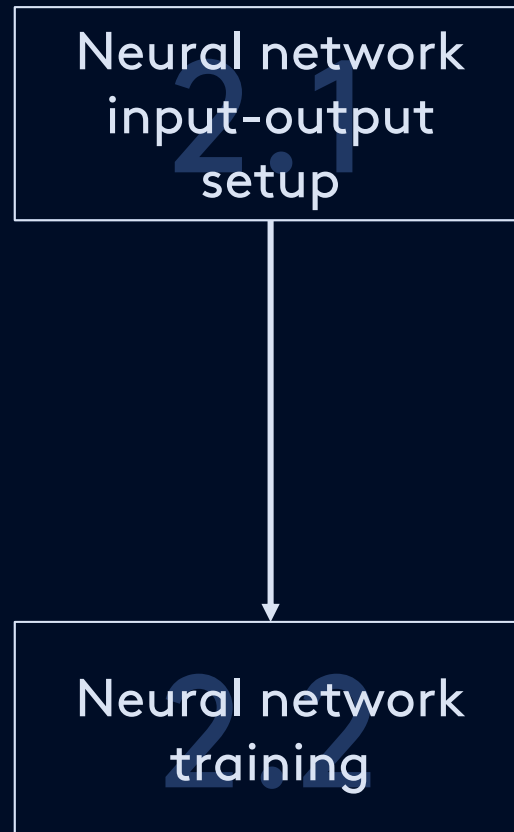
1 Procurement

Process



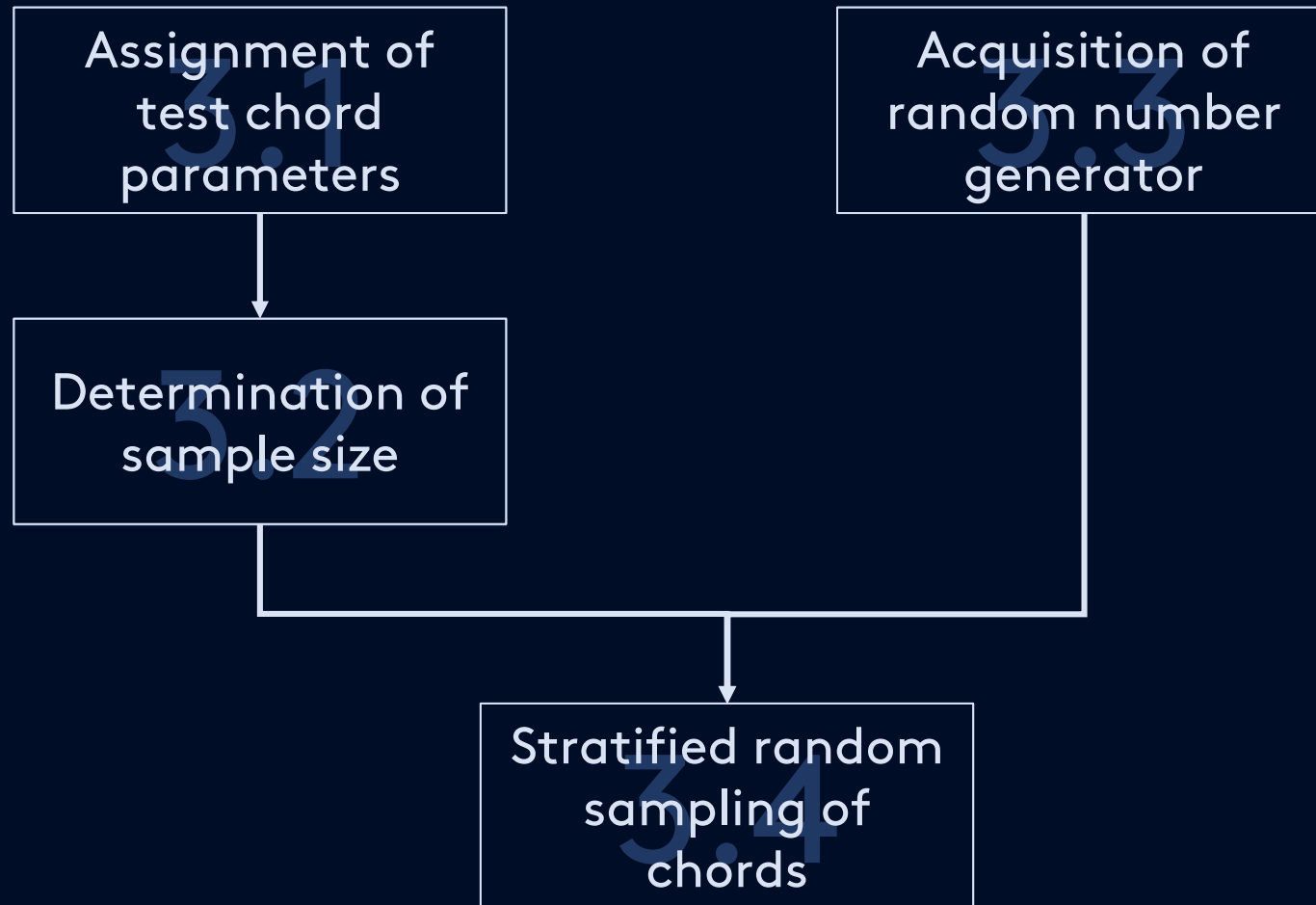
2 NN Development

Process



3 Test Chord Prep & Rn

Process



4 Testing & DC

Process



T	H	E	Rev.0	E	N	D
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