Embedded Real-time Expressive Guitar Technique Recognition

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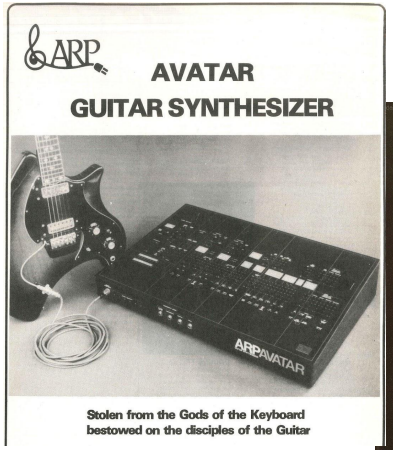
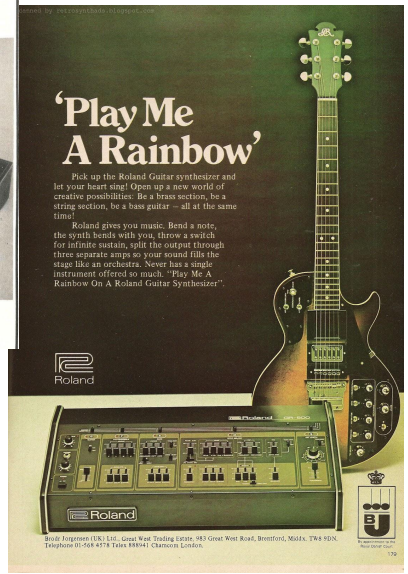
Expressive Technique Recognition

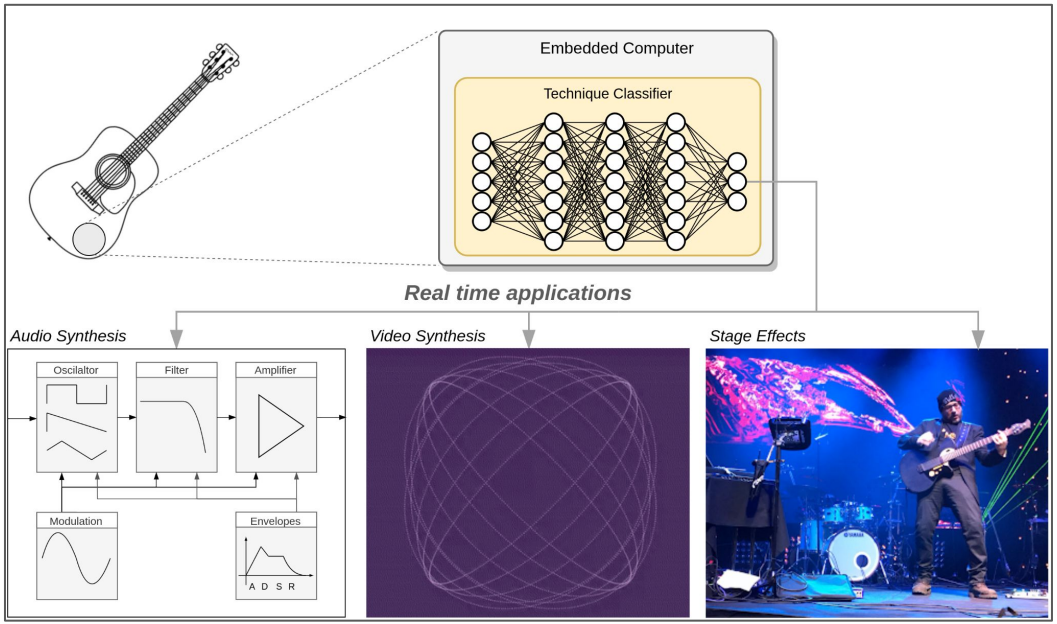
for Smart Musical Instruments [5]

(1)



(2)

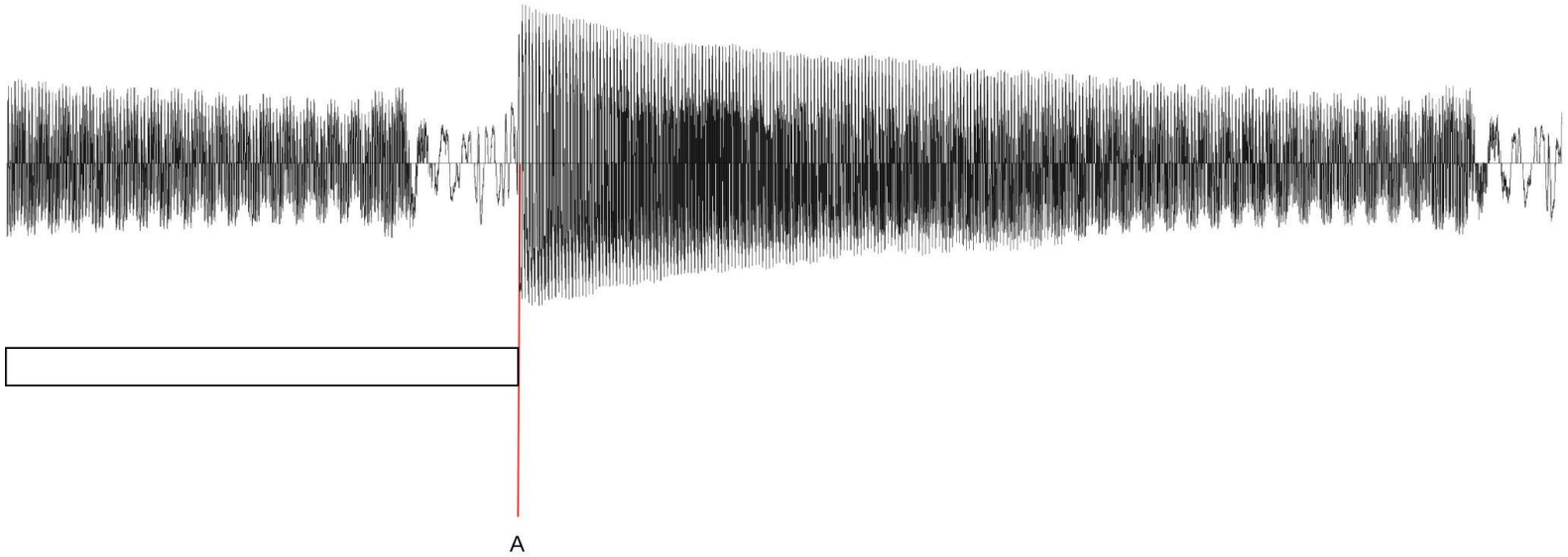




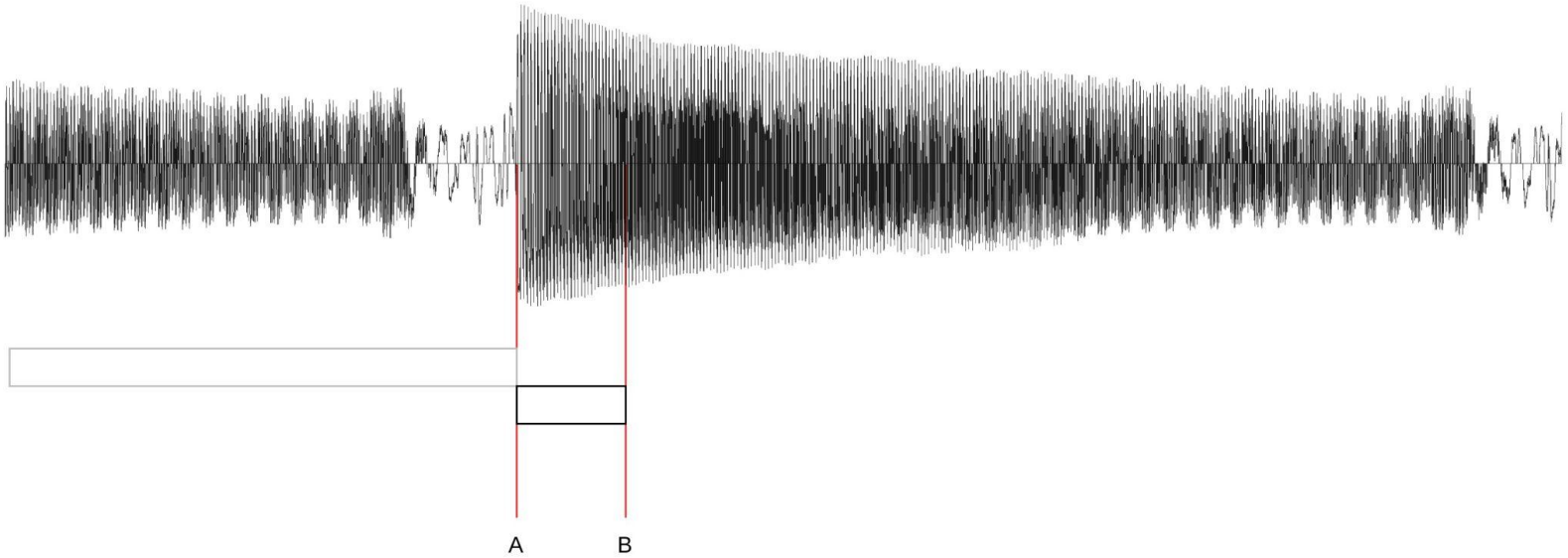
Real-time & Embedded

(1) UK ARP Avatar advert from 1978.
(2) from page 179 in the March (UK) / April (US) 1978 issue of International Musician and Recording World.

Real-time challenges



Real-time challenges



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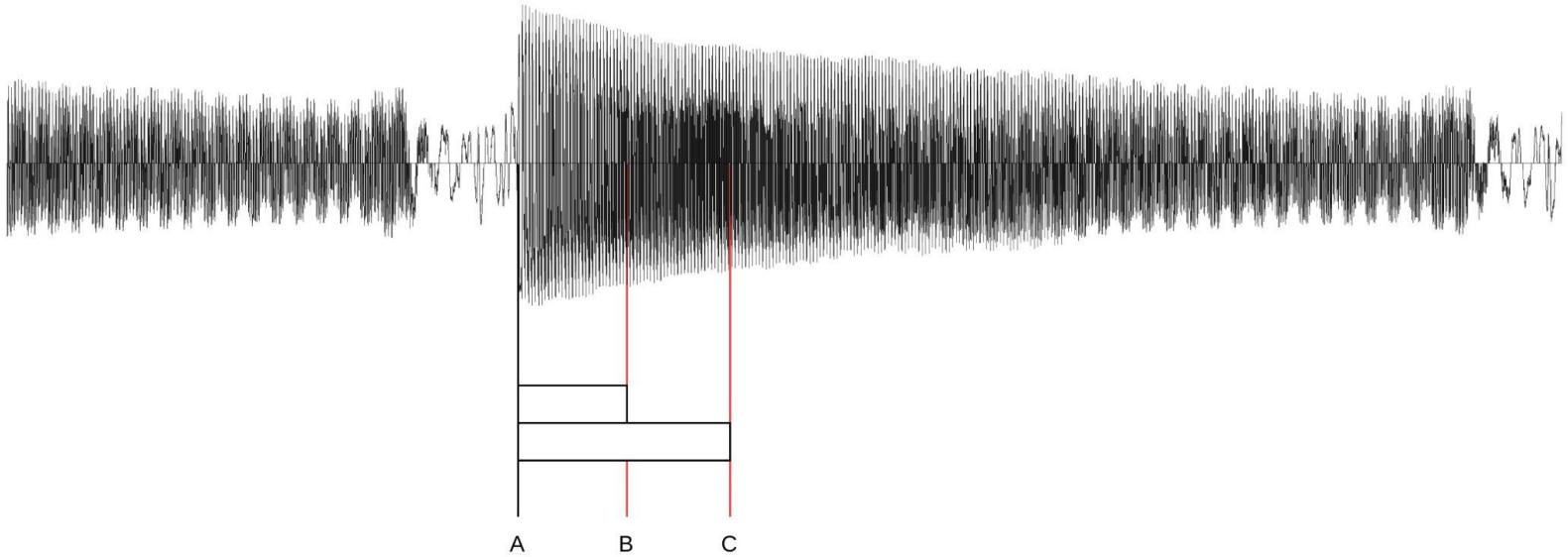

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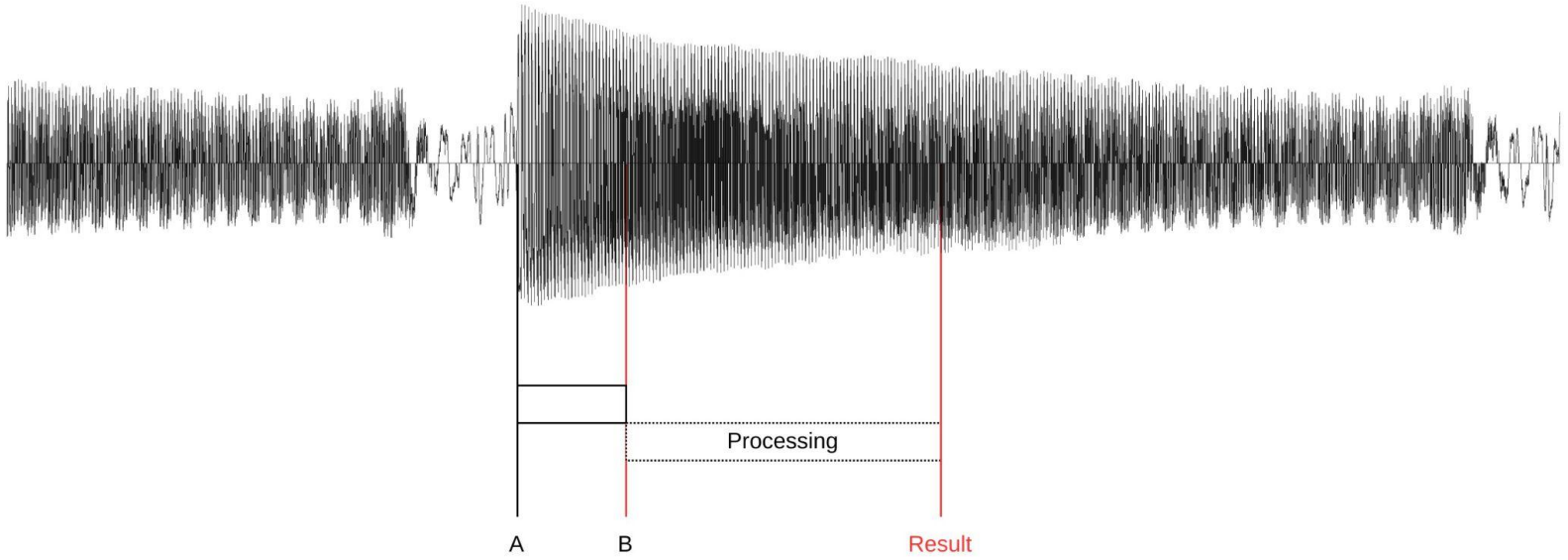
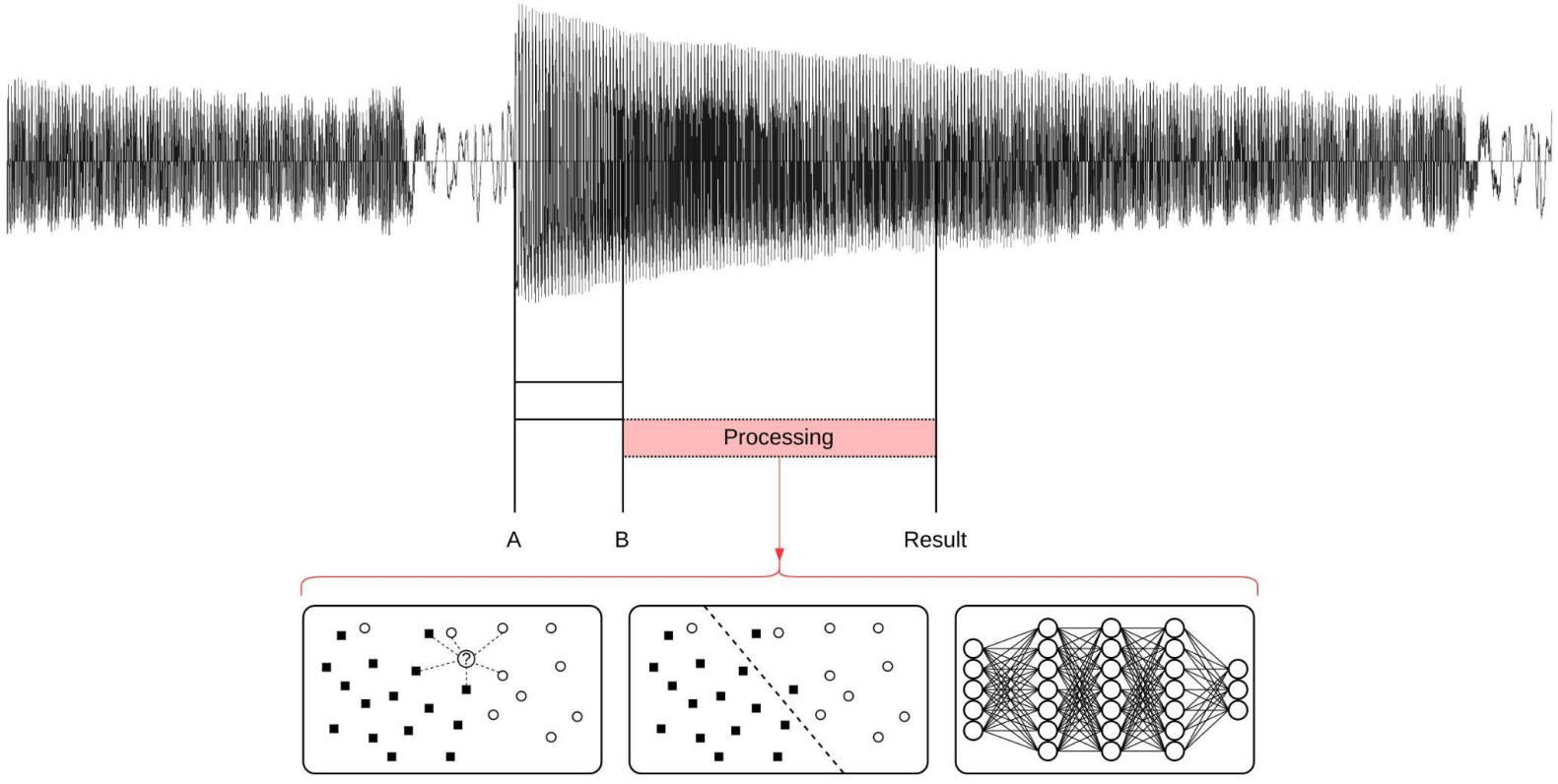


Real-time challenges



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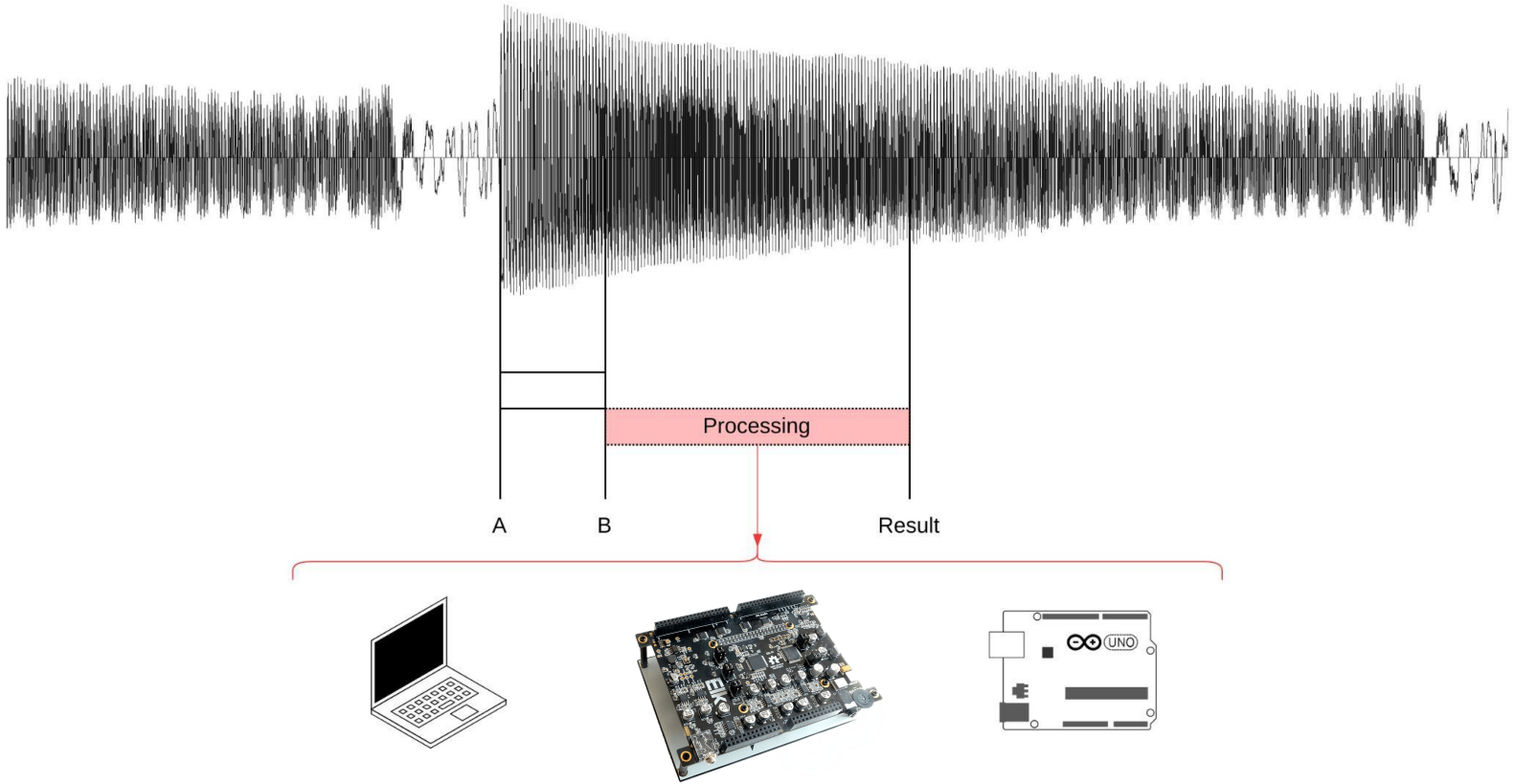
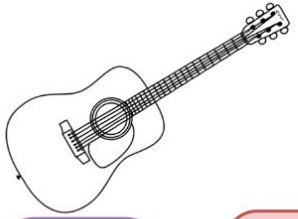
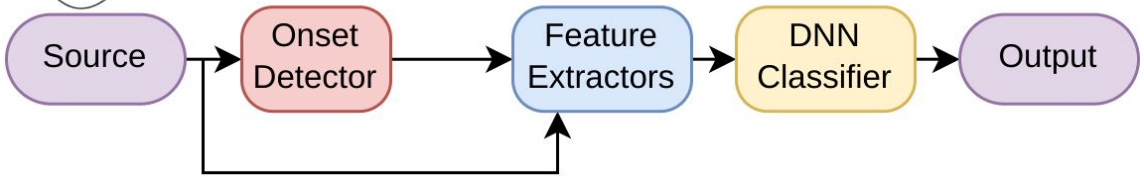


With RTOS Elk Audio OS [4]

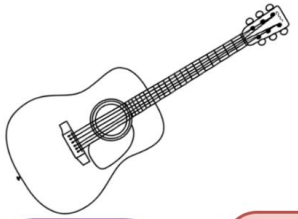


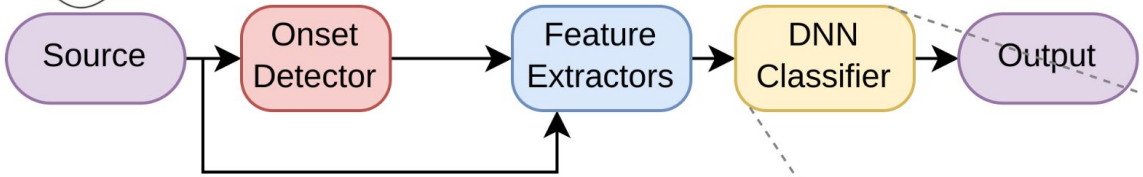
Separate Pipeline approach [1]

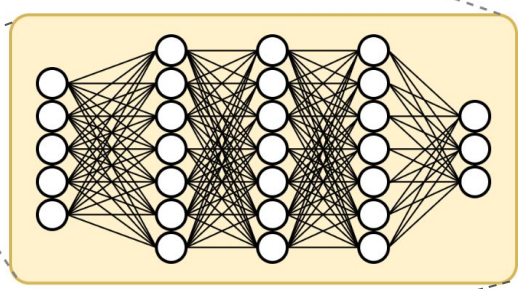
on percussive acoustic techniques



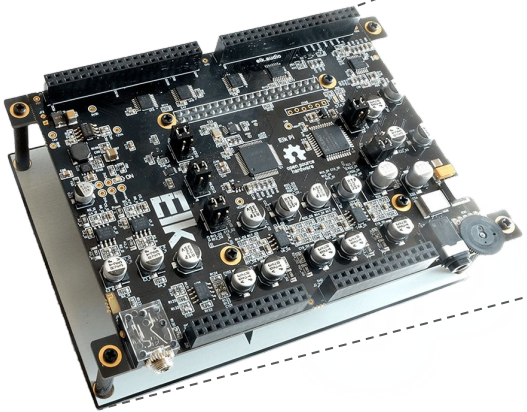
Separate Pipeline approach [1]







TensorFlow Lite



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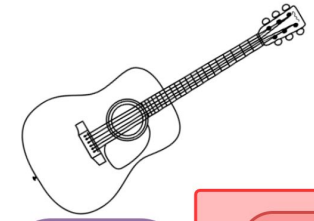
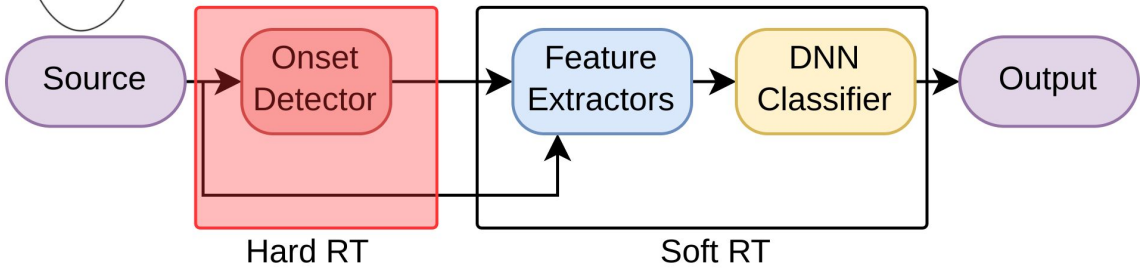
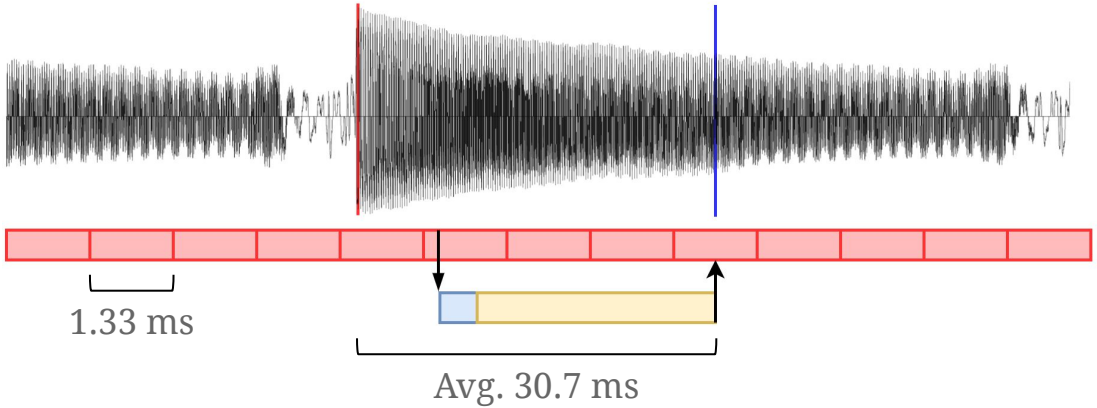


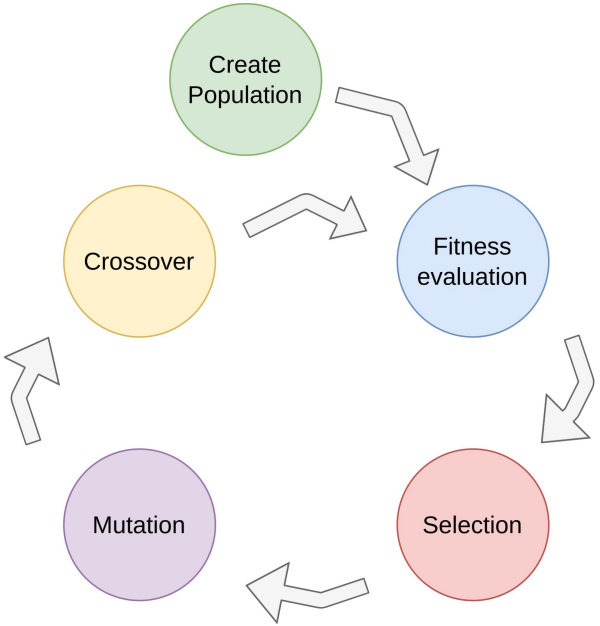


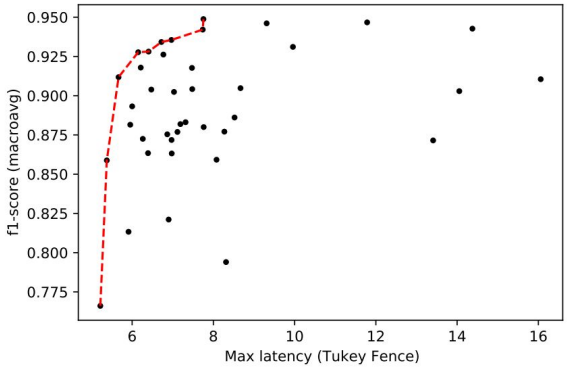


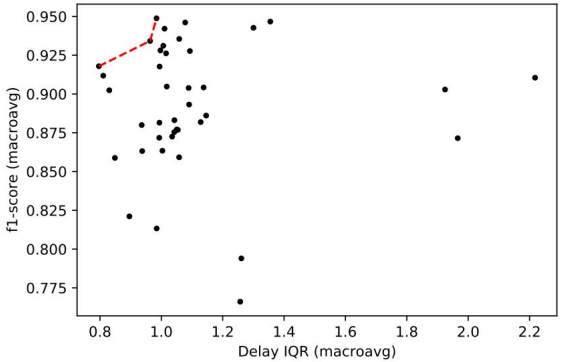
Avg. Latency: **30.7 ms**

Accuracy: **99.1%**

Onset Detection Parameter Optimization [2]







Comparison: Embedded Inference Engines [3]

On CPU

1. TensorFlow Lite
2. PyTorch TORCHSCRIPT
3. ONNX RUNTIME
4. RTNeural Public
   Real-time neural network inferencing
   C++ 182 12

Findings:

a. General inference engines **can be used for real-time audio** (no need of specialized solutions),

b. Trained models **can be converted** to each engine-format.

c. **TFLite**, **ONNX-rt** and **RTneural** are the **quickest**. Torch/Torchscript is considerably slower,

d. RTNeural is extremely lightweight, but it supports a very limited set of “Neural operators”.

e. **TFLite** and **ONNX** are most well documented and easy to use libraries.

References

[1] D. Stefani and L. Turchet, “**On the challenges of embedded real-time music information retrieval**,” in Int. Conf. on Digital Audio Effects (DAFx20in22), 2022 (accepted).

[2] D. Stefani and L. Turchet, “**Bio-Inspired Optimization of Parametric Onset Detectors**,” in Proc. 24th Int. Conf. on Digital Audio Effects (DAFx20in21), vol. 2, pp. 268–275, Sept. 2021.

[3] D. Stefani, S. Peroni, and L. Turchet, “**A comparison of deep learning inference engines for embedded real-time audio classification**,” in Int. Conf. on Digital Audio Effects (DAFx20in22), 2022 (accepted).

[4] L. Turchet and C. Fischione, “**Elk Audio OS: an open source operating system for the Internet of Musical Things**,” ACM Transactions on the Internet of Things, vol. 2, no. 2, pp. 1–18, 2021.

[5] L. Turchet, “**Smart Musical Instruments: vision, design principles, and future directions**,” IEEE Access, vol. 7, pp. 8944–8963, 2019.