Software for Science, power monitoring
The algorithm

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Abstract

In this paper we will explore what algorithm we should pick to test on our platform. The algorithm should be relevant to radio astronomy and provide an interesting study case.

Contents

1 Algorithms in radio astronomy

At first we wanted to know what algorithms were relevant to our project, since we are doing this project for Astron[1], the algorithm we are going to use should have some relevance in radio astronomy. After some searching we came up with a few algorithms that are used in that field.

- Machine learning (Artificial intelligence)

- Auto tuning

- CLEAN (image deconvolution)

- FFT (Fast Fourier Transform)

1.1 Machine learning

Machine learning can be used in a variety of ways, and thus it also has possible applications in radio astronomy. In a paper by Cornelis Johannes Wolfaardt[2] the possibility to use machine learning to automatically classify cases of radio frequency interference is explored.

Or in another paper by E.M. Howard[3] the problem of large amounts of data that needs processing is tackled. Datasets being produced by new telescopes like the SKA[1] are reaching terabytes of data and in the future will get up to petabytes. Analysing all that data would be a huge task for humans, machine learning might be a solution there.

1.2 Auto tuning

We found a rather interesting paper that explores using autotuning and many core accelerators to improve efficiency of other algorithms[4]. Autotuning is in essence a technique to set your parameters to their best possible configuration. And therefore can be used to set the parameters of an algorithm. In this paper they find that using autotune in combination with many core accelerators can lead to a significant boost in performance.

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[1]Square Kilometre Array

1.3 CLEAN

The clean algorithm is an image deconvolution algorithm first described by J.A. Högbom in 1974.[5] Images in radio astronomy are often spread out a bit making single points look like blurs. The clean algorithm fixes this by taking the brightest point and subtracting a small portion of that brightness over the entire image. It does this repeatedly until the image looks "clean".(simplified explanation)

1.4 Fast Fourier Transform

The Fast Fourier Transform(FFT) is a mathematical transformation to a signal showing the frequencies most present in a certain signal. It it used for e.g. pulsar detection, image processing, analysing the frequency spectrum and more. The FFT is one of the most fundamental algorithms for data processing in radio astronomy.

2 Our choice

We have decided to go for the Fast Fourier Transformation, since most of the other algorithms use images that are usually already processed by an FFT. The CLEAN algorithm uses FFT images, and the machine learning in turn uses cleaned images. The FFT will provide an interesting study case, as it is relevant in radio astronomy, and still feasible to set up on our platform within the limited duration of this project.

References

[1] "Astron, netherlands institute for radio astronomy."

[2] C. J. Wolfaardt, "Machine learning approach to radio frequency interference(rfi) classification in radio astronomy."

[3] E. M. Howard, "Machine learning algorithms in astronomy."

[4] A. Sclocco, "Accelerating radio astronomy with auto-tuning."

[5] J. A. Högbom, "Aperture synthesis with a non-regular distribution of interferometer baselines."