

# Understanding & Exploring → [ Mandelbrot Algorithms+AI+QRNG Concepts+Hard Problem Concepts based on Python & Haskell ] – A Short Communication.

[ PART A ] – Python

## Medical Image Processing & Electron Microscopy Image Processing Informatics Using Python/LLVM.

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### [I] Inspiration+Introduction :

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5563119>  
<https://www.fordham.edu/info/what-is-mathematics/mandelbrot-set>  
<https://software.intel.com/en-us/intel-c-compiler/application-domains>  
[https://en.wikipedia.org/wiki/Mandelbrot\\_set](https://en.wikipedia.org/wiki/Mandelbrot_set)  
[www.fractal.org/Bewustzijns-Besturings-Model](http://www.fractal.org/Bewustzijns-Besturings-Model) > Fractals-Useful-Beauty

[https://www.researchgate.net/publication/228984695\\_A\\_new\\_visualiza...](https://www.researchgate.net/publication/228984695_A_new_visualiza...)  
[www.engineers-excel.com > Apps > Image\\_Processing > Description](http://www.engineers-excel.com/Apps/Image_Processing/Description)  
[www.satsig.net > seti > mandelbrot-image](http://www.satsig.net/seti/mandelbrot-image)

[Histopathological Image Analysis in Medical Decision Making - https://books.google.co.in > books](https://books.google.co.in/books) Dey, Nilanjan, Ashour, Amira S., Kalia, Harihar – 2018 – Medical IEEE Transactions on **Image Processing**, 17(1) ... Science, 156(3775), 636–638. doi:10.1126science.156.3775.636 PMID:17837158 **Mandelbrot**, B. (1982).

<https://natureofcode.com/book/Chapter-8-Fractals>  
<https://fractal.foundation.org/resources/what-are-fractals>  
<https://www.britannica.com/biography/Benoit-Mandelbrot>  
<https://perso.math.u-pem.fr/~jaffard.stephane/pdf/Mandelbrot> – by P Abry.  
[www.cs.ukzn.ac.za > ~sviriri > Books > Image-Processing > book4](http://www.cs.ukzn.ac.za/~sviriri/Books/Image-Processing/book4)  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6442032>  
<https://www.researchgate.net/scientific-contributions/2074894976-Nirmal-Tej-Kumar>

### [III] Informatics R&D Framework Implementation :

#### Step 1 :

input/s → [ Mandelbrot Algorithms in Python+ImageAI in Python+QRNG Services & Devices in python+Python-LLVM ] →

#### Step 2:

[ Test the Algorithms on (IoT/HPC/Smart Devices/Mongo DB-Python) Platform/s ] →

[ to Probe either a Medical Image or an Electron Microscopy Image ]

#### Step 3:

[ perform Further R&D Analysis ] → output/s.

[ **Figure I – Algorithm I–Exploring Python based Mandelbrot Algorithms+ImageAI+QRNG Services & Devices+LLVM in the Context of Medical Image Processing/Electron Microscopy Image Processing Software R&D.** ]

**\*\* Testing in Progress/Approximate Algorithm Only.**

**\*\* Actual Implementation Will Certainly Vary.**

**\*\* Please Check & Satisfy Yourselves.**

**\*\* Using QRNG “could be little bit tricky”.**

### [III] Information on Imaging Mathematics+Python Software Used in our Software R&D/Other Publications :

[a] <https://www.geeksforgeeks.org/mandelbrot-fractal-set-visualization-in-python/>

[b] <http://imageai.org>

[c] <https://pypi.org/project/qrng>

[d] <https://ozanerhansha.github.io/projects> – qRNG is a cloud based python package that uses IBM’s QISKit API to connect with any one of their 3 publicly available quantum computers to generate random numbers.....

[e] <https://developer.ibm.com/open/projects/qiskit> – **IBM Stuff.....Interesting.....**

[f] <https://www.quantiki.org/wiki/list-qc-simulators>

[g] <https://dataplatfom.cloud.ibm.com/docs/content/streaming-pipelines>

[h] <https://www.semanticscholar.org/author/Nirmal-Kumar/12354503/suggest>

[i] <https://www.idquantique.com> > Random Number Generation – **QRNG Devices/Very useful for simple experiments**

[j] <https://www.idquantique.com> > Random Number Generation > Products

[k] <https://www.idquantique.com/landing-page/quantis-quantum-random-n..>

[l] <https://www.prnewswire.com/news-releases/id-quantique-a-major-step-i...>

[m] <https://qrng.physik.hu-berlin.de> / <https://qrng.physik.hu-berlin.de> > download

**[IV] Some of Our References ((via)) Vixra.org :**

[a] [http://www.vixra.org/author/nirmal\\_tej\\_kumar](http://www.vixra.org/author/nirmal_tej_kumar)

[b] [http://www.vixra.org/author/d\\_n\\_t\\_kumar](http://www.vixra.org/author/d_n_t_kumar)

[c] [http://www.vixra.org/author/n\\_t\\_kumar](http://www.vixra.org/author/n_t_kumar)

[d] <http://www.vixra.org/author/nirmal> ->Cryo-EM Image Processing Paper

**[V] Conclusion/s With Future Perspectives :**

Mandelbrot Fractal Set visualization in Python+AI+QRNG was used to perform Software R&D in the Context of Medical Images/Electron Microscopy Images.To the best of our knowledge,this is one of the pioneering Short Technical Communications in this promising domain.Hope,this will be an inspiration to a wider community of scientific imaging professionals.

**[ THE END ]**

## [ PART B ] – Haskell

# Exploring a JIT Compiler with Haskell and LLVM in the Context of Medical Image Processing & Electron Microscopy Image Processing Software R&D Using Mandelbrot Algorithms.

### [I] Inspiration+Introduction :

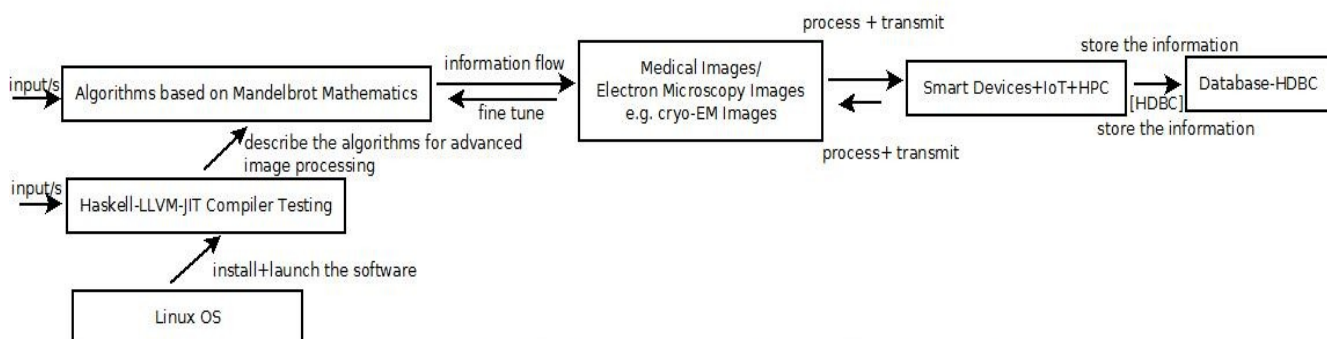
<http://www.stephendiehl.com/llvm/#why-is-this-a-hard-problem> – Implementing a JIT Compiler with Haskell and LLVM ( Stephen Diehl )

[The LLVM Compiler Infrastructure Project](https://llvm.org) – <https://llvm.org>

[Haskell Language](https://www.haskell.org) – <https://www.haskell.org> – The Haskell purely functional programming language home page.

### [III] R&D Informatics Framework Involving the Above Mentioned Software Tools/Mathematics :

Description of our Simple Suggestion Involving the Required Mathematics+Software Used



Algorithm I - R&D Informatics Framework based on Haskell+LLVM+JIT Compiler Techniques for Advanced Image Processing Platform  
Approximate Algorithm Only. Testing in Progress with some Promising Results  
Simple Conclusions - Functional Programming is always useful in demanding Science & Technology Domains like Medical Imaging/cryo-EM Imaging.  
Actual Implementations will certainly vary. Please Check the literature.  
Thanks - Dr.Nirmal

[ Figure I – Algorithm I – R&D Informatics Framework for Advanced Image Processing ]

[ Haskell could easily be interfaced with Java/JVM Environments and QRNG Devices/ML Algorithms ]

### [III] Useful Information & Reading Materials on Mathematics+Software Used/Useful :

[a] [book.realworldhaskell.org](http://book.realworldhaskell.org) > read > using-databases

[b] <https://wiki.haskell.org> > Web > Databases\_and\_Persistence

[c] <https://caiorss.github.io> > haskell > DatabaseHDBC

[d] <https://en.wikipedia.org> > wiki > Mandelbrot\_set

[e] [math.hws.edu](http://math.hws.edu) > eck > mandelbrot

[f] [mathworld.wolfram.com](http://mathworld.wolfram.com) > MandelbrotSet

[g] [www.math.utah.edu](http://www.math.utah.edu) > ~alfeld > math > mandelbrot > mandelbrot

[h] <https://blogs.scientificamerican.com> > roots-of-unity > a-few-of-my-favorit..

**[IV] Acknowledgment/s :**

Special Thanks to all my Mentors+Friends+Collaborators. Non-Profit R&D.

**[V] Conclusion/s With Future Perspectives :**

An Important idea is suggest and presented in the Context of Medical Imaging *cryo-EM Imaging Software R&D Applications* Using Smart Devices/IoT/HPC – Heterogeneous Environments.

**[VI] Important References :**

[a] [vixra.org/pdf/1805.0380v1.pdf](https://vixra.org/pdf/1805.0380v1.pdf). \*\*\*\* --- from the Author.

[b] [vixra.org/pdf/1911.0447v1.pdf](https://vixra.org/pdf/1911.0447v1.pdf) \*\*\*\* --- from the Author.

**[ THE END ]**