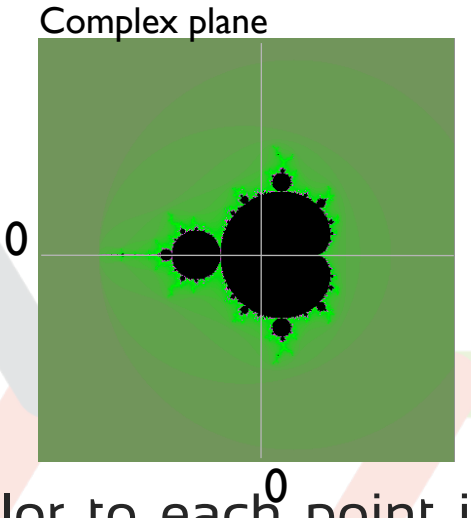
Mandelbrot quest

DIRAC Tutorial

Mandelbrot set

The Mandelbrot set definition

http://en.wikipedia.org/Mandelbrot



The vicinities of the Mandelbrot set area provide an astonishingly rich fractal images

The algorithm consists in assigning a color to each point in the complex plane as a function of a speed of divergence of the Mandelbrot sequence

You certainly have seen some of them but even more are even not discovered yet

In the tutorial we will explore those images while exercising the use of DIRAC tools and grid resources

mandelbrot application

In the quest we will be using the *mandelbrot* application

http://dirac.france-grilles.fr/demo/mandelbrot

The *mandelbrot* application is a simple python script to construct fractal images:

- Builds a fractal image around a chosen C point
- One can vary the size of the image, its precision (zoom level), color scheme
- The output is an image file in BMP format
  - Can be easily visualized in a Web browser

The *mandelbrot* application is available also from a grid DIRAC-USER Storage Element:

LFN:/vo.formation.idgrilles.fr/user/a/atsareg/mandelbrot

mandelbrot application usage

Usage:

```
mandelbrot [options] [<output_file>]
```

Options:

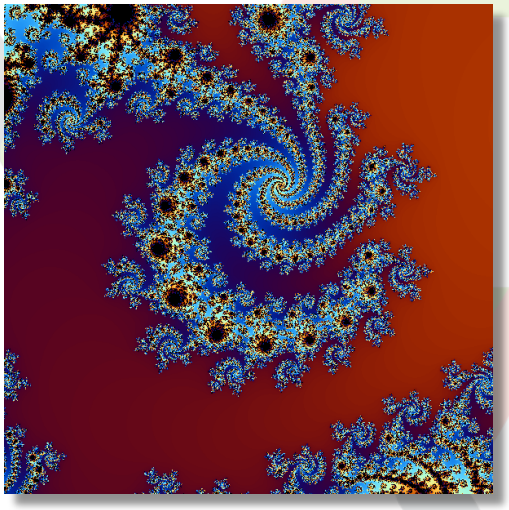
```
-X, --cx - the real part of the C parameter in the center of the image,
           default = -0.5

-Y, --cy - the imaginary part of the C parameter in the center of the image,
           default = 0.0

-P, --precision - the step size of the C parameter increment per pixel
              of the image, default = 0.01

-M,   --max_iterations   -   the   maximum   number   of   the   mandelbrot   algorithm
    iterations, default = 100

-W, --width - image width in pixels, default = 300

-H, --height - image height in pixels, default = 300

-B, --bw - force black and white image, default is a color image

-F, --color_factor - color palette parameter defining how quickly the
              colors are changing, the value should be in the range 0.<x<1.0,
              default = 0.02

-S, --color_phase - a magic color palette parameter, default = 1.0

-D, --color_delta - yet another magic color palette parameter, default = 1.0

-h, --help - print this usage info
```

Mandelbrot Quest

Goal: find a new interesting and beautiful area in the Mandelbrot set vicinity and let everybody admire it !

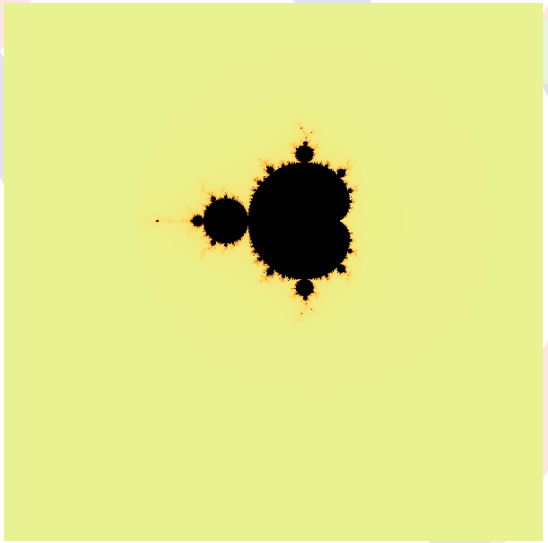
Of course, by doing the whole work with the *mandelbrot* grid jobs

mandelbrot –W 600 –H 600 –X -0.46490 –Y -.56480 –P .000002 –M 500



Mandelbrot quest steps

- Task steps
  1. Find an interesting seed C point
  2. Build a series of images with an increasing zoom level centered around the seed C point from step 1.
  3. Build a movie using the images from step 2. as frames



Mandelbrot quest task: step 1

Run several mandelbrot jobs with varying C and precision

- Use the Job Launchpad Web interface
- Submit a number of mandelbrot jobs with varying contents of the Arguments JDL parameter
  - Hint: put the *mandelbrot* application into the Input Sandbox
- Store the output file in the Output Sandbox
- Get the output file from the Web portal Job Monitor and inspect it in the browser
- Choose the most appealing C point

Remark

- Running mandelbrot locally on your computer is allowed but this is cheating !

Mandelbrot quest task: step 2

Run a series of 300-500 mandelbrot jobs with a fixed C parameter and increaing precision (zoom level)

- Use Parametric Jobs with the Job Launchpad
- Store output files in a grid Storage Element
  - MCIA-irods, DIRAC-USER

Mandelbrot quest task: step 3

- Collect the output image files from Step 2. and build a « Mandelbrot journey » movie
  - Use DIRAC API to write a script to launch a grid job creating the movie
    - Use *convert* Unix program as an Executable to do the work. For example:

```
convert *.bmp movie.gif
```

    - Use image files from Step 2. as Input Data
    - Store the resulting animated gif image as Output Data
  - Alternatively, use DIRAC API to write a script to collect the image files on your local computer to create the movie
    - Download and store image files in one directory
    - Invoke the *convert* program locally to create the mouvie
    - Upload the resulting animated gif file to a grid Storage Element

Drawing the results

- The resulting images and movies will be demonstrated to the tutorial audience and the authors of the best movies will be declared

Winners of the DIRAC Mandelbrot Quest !