The Mandelbrot Set

- the "Mandelbrot set" is the set of points C in the complex plane for which the series

$$Z_{n+1} = Z_n^2 + C$$

  with $Z_0=0$ remains bound (i.e. does not diverge).

- for the Mandelbrot set, divergence is given once $|Z_n| > 2$

➢ **exercise:**

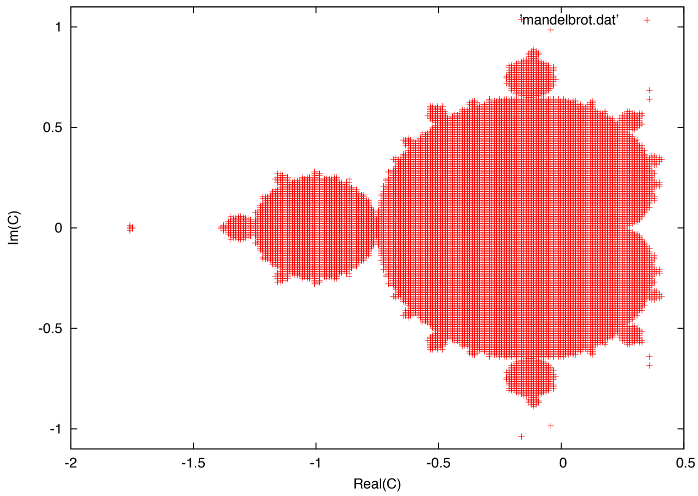
• write an OpenMP parallel code covering the complex plane in the range

$$C_{\min} = (-2, -1.1),\ \ C_{\max} = (+0.5, +1.1)$$

determining the divergence of each point.

• write the non-divergent points into a file, e.g. 'mandelbrot.dat'

• use, for instance, `gnuplot` to generate a plot marking each point C for which the series has not diverged with a cross:



- **tips:**

• let the number of points in each dimension Real(C) and Img(C) be a parameter, e.g.

```
NPOINTS_PER_DIMENSION
```

• use dynamically allocated arrays, e.g.

```
double *c_real, *c_img;
int *notdiverged;
```

• `notdiverged []` should be accessed like a 2-dimensional array storing either 0 or 1 (see →)

• if the series has not diverged after `NMAXITERATIONS=100` consider it non-divergent

• fill the arrays `c_real[]`, and `c_img[]` before a double nested loop checking for divergence

• use a subroutine to check for the divergence of a given point `c_real[i]`, `c_img[j]`

• use a subroutine that takes the arrays `c_real[]`, `c_img[]`, `notdiverged[]` to write the output file

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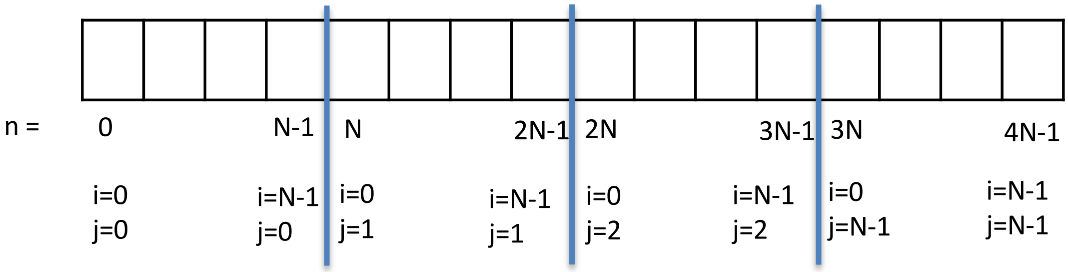
- accessing a 1D array like a 2D array (i.e. with 2 instead of 1 index):

example: NxN array with N=4



n = i + j*N