Exercise 5
PGPLOT, make, COMPLEX
(28.11.2025)

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1. Task *PGPLOT* (7 P)
Write a little Fortran program that uses `PGENV` and `PGLAB` to show a coordinate system for $x \in [-2; 2]$ and $y \in [-1; 1]$. Also plot a yellow point at $(-1; 0.5)$. (3 P)
Write a `Makefile` for compilation! (4 P)
Important hints: You can find the PGPLOT library in `/home/weber/htodt/PGPLOT/`. You also have to set the `LD_LIBRARY_PATH` to this directory (check with `ldd`!).
Note that the data types in PGPLOT are all of `KIND=4`. A literal constant of `KIND=4` can be created by appending `_4` to the value, e.g., `1.0_4`.

2. Task *Mandelbrot set* (10 P)
The Mandelbrot set is a subset of the complex plane $M \subset \mathbb{C}$ defined by

$$c \in M : ||\{z_n(c)\}|| < \infty, \tag{1}$$

where the members of the sequence $\{z_n\}$ are

$$z_{n+1} = z_n^2 + c \qquad \text{and} \qquad z_0 = 0. \tag{2}$$

Focus on the region around $c = 0 + 0\imath$, e.g.,
$-2 \leq \mathcal{R}e(c) \leq +1$ and $-1 \leq \mathcal{I}m(c) \leq +1$
and calculate the shape of the Mandelbrot set for it by checking Eq. (1) for a subset of points in this region.

a) As a first approach, the graphical output can be easily done in the terminal by mapping each position (column and lines) in the terminal, e.g., 132×42 characters, to a point in the complex plane. The `WRITE` statement should therefore only print one character per call, e.g., an `X` if the point belongs to the Mandelbrot set and a blank (space) " " for the other points. At the of each line in the terminal the `WRITE` statement creates a line break.

b) How many `DO`-loops are needed and how are they nested into each other?

c) Use the data type `COMPLEX` for Eq. (1).