Proof 2.2 — Zoom Window Centring

Let the window span be: $\mathbf{x_{min},x_{max},y_{min},y_{max}}$ and the click at pixel **(ex,ey).**

Step 1: Fractional position of click (Ratio — independent of coordinate system)

We can obtain fractions in two equivalent ways:

1a. Screen ratio first (pixel → fraction):

$$\mathbf{f_x=e_x/SCREEN\_WIDTH}$$

$$\mathbf{f_y=e_y/SCREEN\_HEIGHT}$$

So $f_x,f_y \in [0,1]$:

- $f_x=0$→ left edge,
- $f_x=1$ → right edge,
- $f_y=0$→ top edge,
- $f_y=1$→ bottom edge.

Then convert to complex coordinates of click:

$$\mathbf{x_c=x_{min}+f_x{*}(x_{max}-x_{min})}$$

$$\mathbf{y_c=y_{min}+f_y\cdot(y_{max}-y_{min})}$$

1b. Complex coordinate first (pixel → complex → fraction):

Convert click pixel to complex coordinate directly:

$$\mathbf{x_c=x_{min}+(e_x/SCREEN\_WIDTH)\ {*}(x_{max}-x_{min})}$$

$$\mathbf{y_c=y_{min}+(e_y/SCREEN\_HEIGHT){*}\ (y_{max}-y_{min})}$$

Then normalize to fractions:

$$\mathbf{f_x=(x_c-x_{min})/(x_{max}-x_{min})}$$

$$\mathbf{f_y=(y_c-y_{min})/(y_{max}-y_{min})}$$

Both paths (1a and 1b) give the same **(fx,fy)**and same centre **(xc,yc).**

Step 2: Choice of scale factor

Zoom depends on mouse button:

s=ZOOM_FACTOR, if left button (zoom in)

s=1/ ZOOM_FACTOR if right button (zoom out)

Step 3: New window size after zoom

$$newWidth=(x_{max}-x_{min})\cdot s$$

$$newHeight=(y_{max}-y_{min})\cdot s$$

Step 4: Keep click at same fraction

$$x_{new}=x_{min}+f_x*newWidth$$

$$y_{new}=y_{min}+f_y*newHeight$$

Step 5: Re-arrange to find new bounds

$$x_{min}=x_{new}-f_x*newWidth$$

$$y_{min}=y_{new}-f_y*newHeight$$

The click must remain at same relative fraction: so $x_{new}=x_c$ **and** $y_{new}=y_c$

Thus:

$$x_{min}=x_c-f_x*newWidth$$

$$y_{min}=y_c-f_y*newHeight$$

$$x_{max}=x_{min}+newWidth$$

$$y_{max}=y_{min}+newHeight$$

We have used 1a in our code because it has less computation.