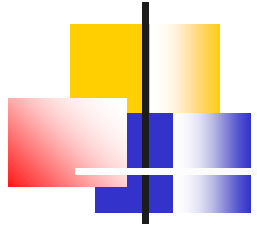




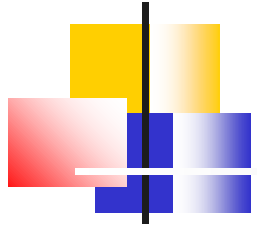
Mandelbrot Set with jeforth

**Silicon Valley
Forth Interest Group
Chen-Hanson Ting
April 24, 2021**



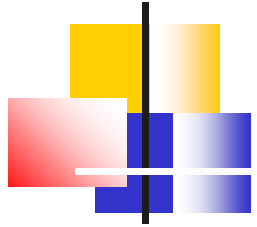
Mandelbrot Set

- **I coded the fractals of Mandelbrot Set on a PC with F83 and then with F-PC.**
- **It was slow, and the keyboard interface was clumsy.**
- **Things changed with JavaScript which has a fast virtual machine and a convenient GUI (Graphic User Interface).**



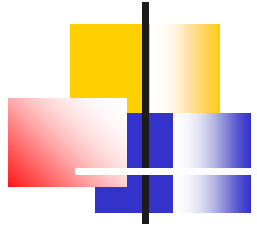
Mandelbrot Set

- **I modified the Mandelbrot Set code from:**
<http://rembound.com/articles/drawing-mandelbrot-fractals-with-html5-canvas-and-javascript>
- **Moved the code into jeforth623.**
- **Explored the mouse interface.**



Mandel.html

- **Input box, output box and the canvas are layered on one another.**
- **Input box in white letters.**
- **Output box in yellow letters.**
- **Canvas layer on the top shows image and responds to mouse clicks.**



Mandel.html

- **Double click mandel.html and you get the start-up screen.**
- **To the left, jeforth6.23 signs on in yellow letters.**
- **The input layer shows how the mouse and wheel control the display.**

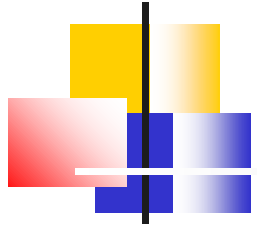


Start-up Screen

The screenshot shows a web browser window with three tabs: 'javascript else if - Google Search', 'JavaScript if else else if', and 'Mandelbrot Set'. The address bar shows the file path 'C:/F%23/jeforth/mandelbrot/mandel/mandel.html'. The browser's toolbar includes navigation buttons, a star icon, and several extension icons. Below the toolbar, there are search engines and other website shortcuts. The main content area is black with yellow text 'jeforth 6.23' at the top left. Below this, the following text is displayed:

```
Left Click
Center
Wheel Fore:
Expand
Wheel Back:
Shrink
Right Click:
Reset
```

At the bottom of the browser window, there is a download bar showing a file named 'jgames_gb.zip' with an upward arrow icon. To the right of the download bar is a 'Show all' button with a close icon.



Mandelbrot Set

- **Click the cursor in the middle of display and an initial Mandelbrot Set is painted on the canvas.**
- **The (x,y) coordinates and zoom factor are shown in the top-left corner with yellow letters.**

Initial Mandelbrot Set

javascript else if - Google Search x JavaScript if else else if x Mandelbrot Set x +

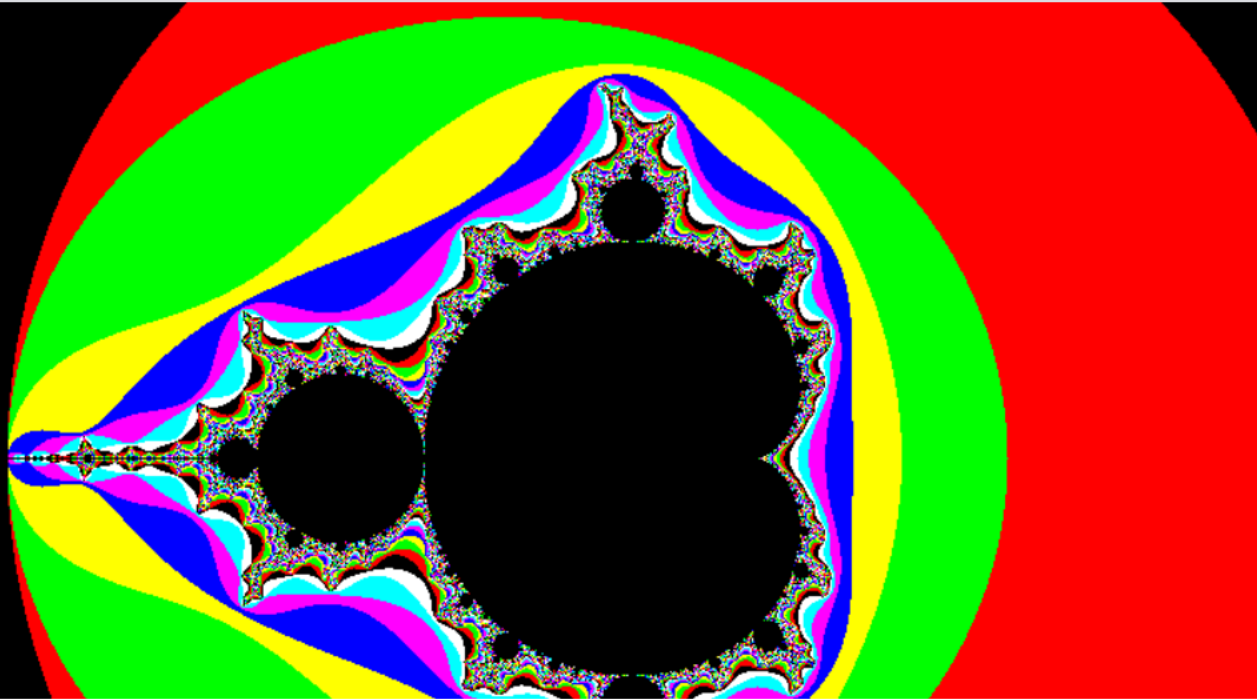
File | C:/F%23/jeforth/mandelbrot/mandel/mandel.html

Apps Google Index to Texts & Tr... YouTube - Broadca... 大纪元新闻网 - 海... 首页-中国天气网 长江水文网

Reading list

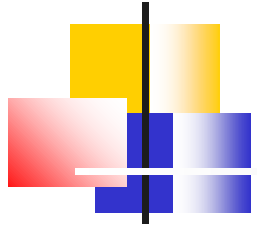
x=-0.245
y=-0.115
z=200

Left Click
Center
Wheel Fore:
Expand
Wheel Back:
Shrink
Right Click:
Reset



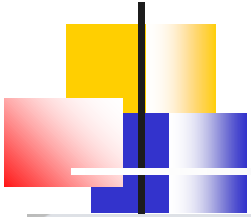
jgames_gb.zip

Show all x



Navigate the Set

- **Clicking left mouse button anywhere on the screen moves the clicked position to center.**
- **Wheel-Fore expands display.**
- **Wheel-Back shrinks display.**
- **Clicking right button resets the display to its original size.**



Mandelbrot Set

Browser tabs: javascript else if - Google Search, JavaScript if else else if, Mandelbrot Set

Address bar: File | C:/F%23/jeforth/mandelbrot/mandel/mandel.html

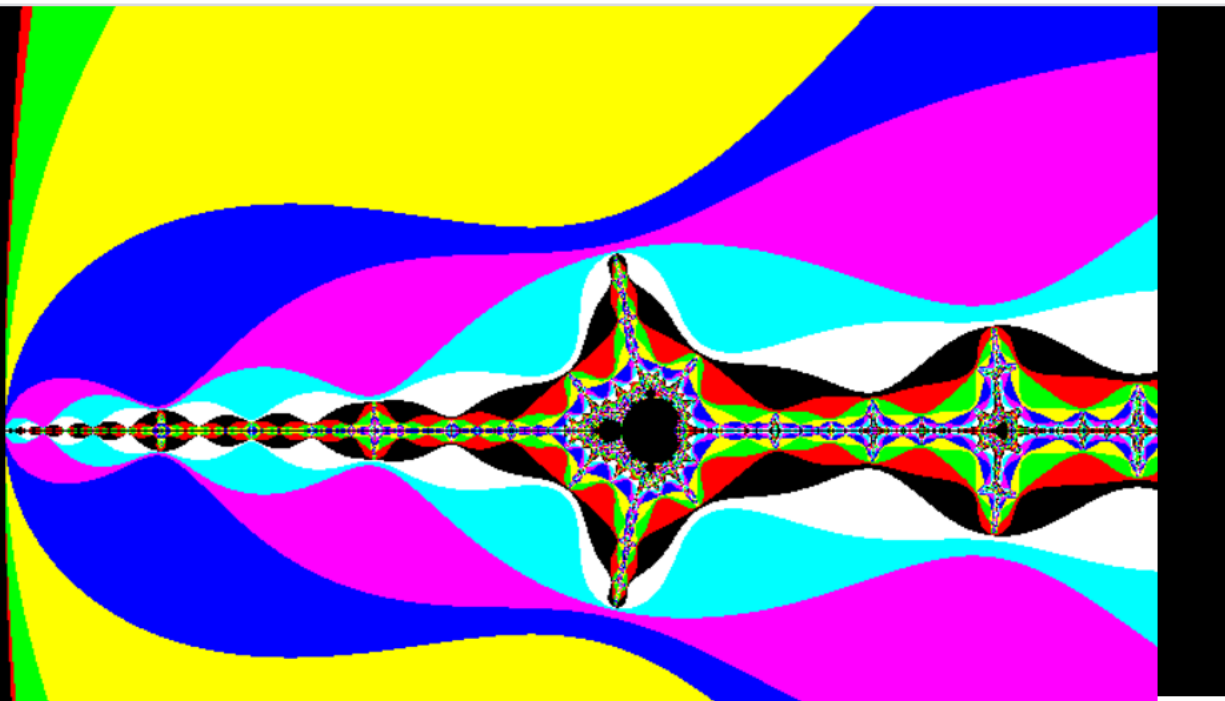
Navigation icons: back, forward, refresh, home, star, print, search, extensions, profile, menu

Bookmarks: Apps, Google, Index to Texts & Tr..., YouTube - Broadca..., 大纪元新闻网 - 海..., 首页-中国天气网, 长江水文网

Utility icons: Reading list

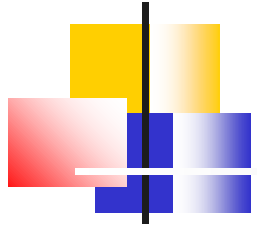
x=-1.8175
y=-0.0025
z=1600

Left Click
Center
Wheel Fore:
Expand
Wheel Back:
Shrink
Right Click:
Reset



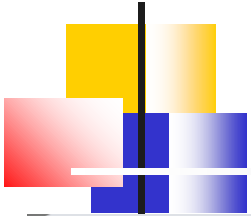
jgames_gb.zip ^

Show all x



Coloring the Set

- **Number of iterations to divergence determines the color of a pixel.**
- **Three least significant digits of iteration determine the color:**
 - **Bit 0 for red**
 - **Bit 1 for green**
 - **Bit 2 for blue**



Mandelbrot Set

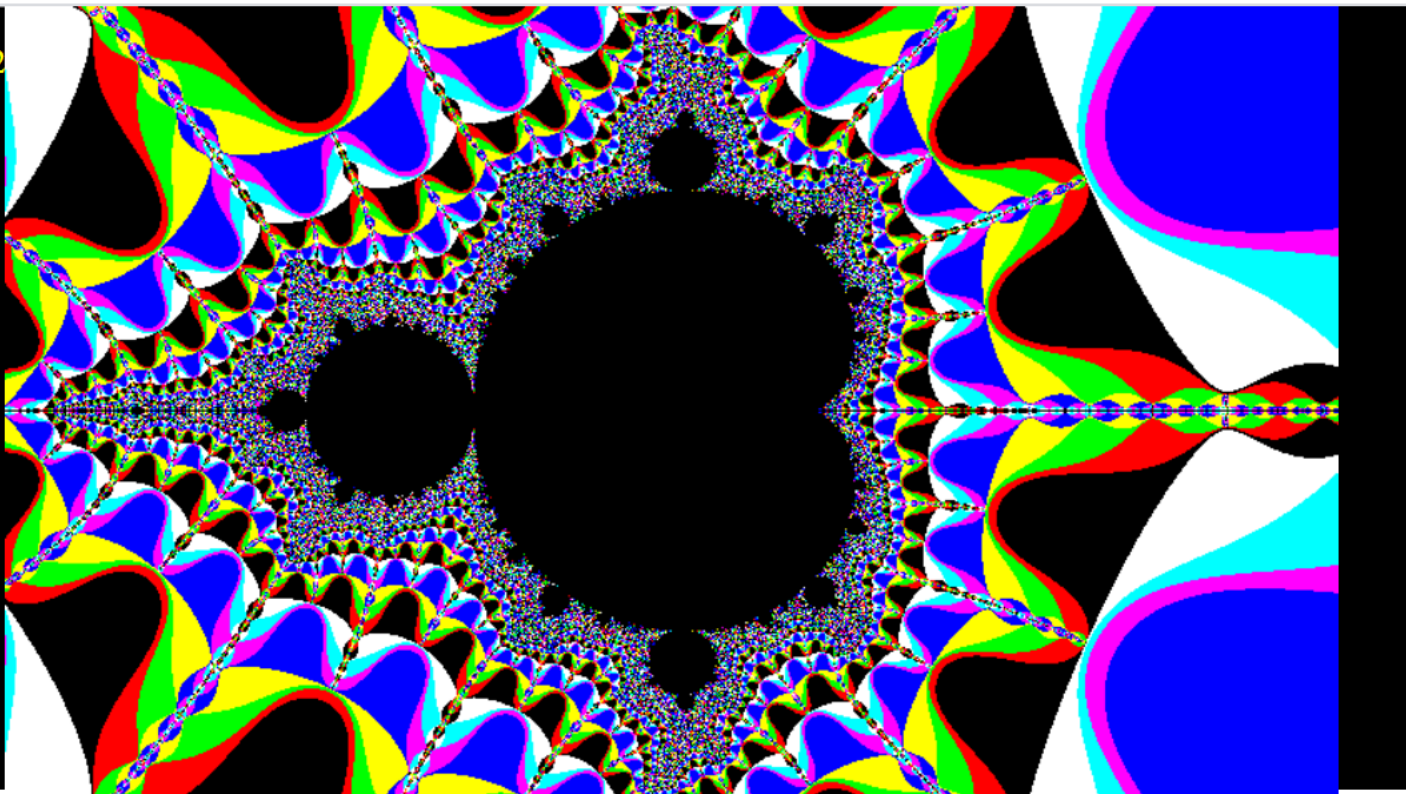
Browser tabs: javascript transparency - Google, HTML DOM Style opacity Proj, Mandelbrot Set, Mandelbrot Set

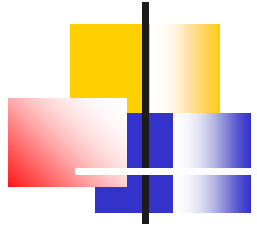
Address bar: File | C:/F%23/jeforth/mandelbrot/mandel/mandel.html

Navigation: Back, Forward, Refresh, Home, Star, S, G, Add-ons, Profile, Menu

Search/Links: Apps, Google, Index to Texts & Tr..., YouTube - Broadca..., 大纪元新闻网 - 海..., 首页-中国天气网, 长江水文网, Reading list

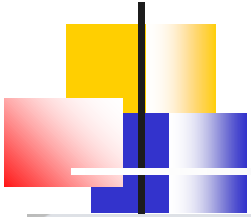
x=-1.9409570312
y=0.0000390625
z=204800





Mandel.html

- **The (x,y) coordinates and the zoom factor are always shown on the left with yellow letters.**
- **Input box shows mouse instructions.**
- **Input box still accepts Forth commands, and output box shows responses from jeforth.**



Mandelbrot Set

Browser tabs: javascript else if - Google Search, JavaScript if else else if, Mandelbrot Set

Address bar: File | C:/F%23/jeforth/mandelbrot/mandel/mandel.html

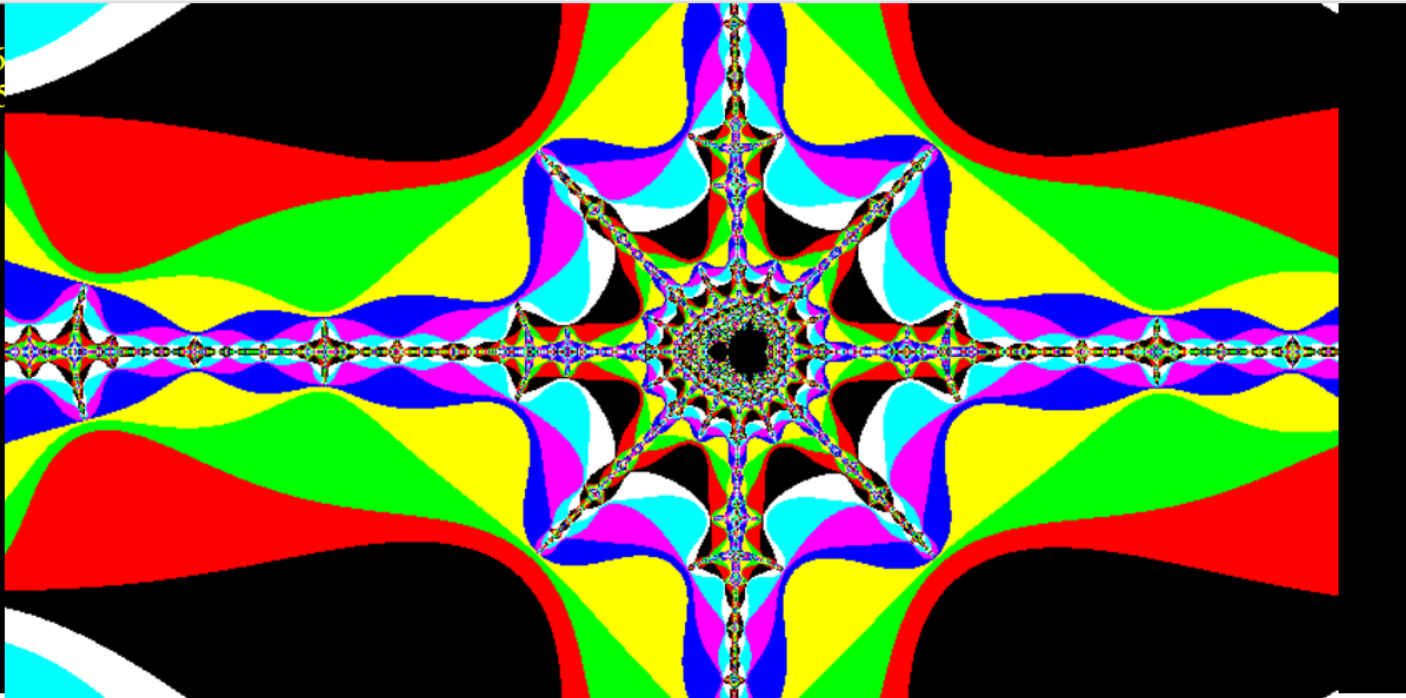
Navigation icons: back, forward, refresh, home, star, print, search, extensions, profile, menu

Bookmarks: Apps, Google, Index to Texts & Tr..., YouTube - Broadca..., 大纪元新闻网 - 海..., 首页-中国天气网, 长江水文网

Utility icons: Reading list

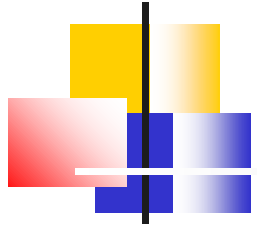
x=-1.8101208496
y=0.00010131835
z=409600

Left Click
Center
Wheel Fore:
Expand
Wheel Back:
Shrink
Right Click:
Reset



jgames_gb.zip ^

Show all x

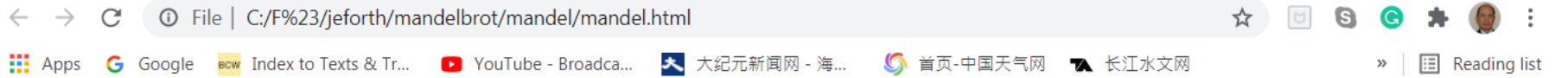


Zoom Factor

- **When the zoom factor reaches 107,371,182,400 you can see that fractal patterns are distorted due to round-off errors in multiplication.**
- **Time to right click the mouse to return to the original display.**



Mandelbrot Set

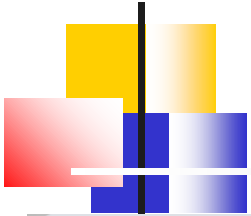


$x=-1.8105345412$
 $y=5.00932628710$
 $z=140737488355$

Left Click
Center
Wheel Fore:
Expand
Wheel Back:
Shrink
Right Click:
Reset

jgames_gb.zip ^

Show all x



Mandelbrot Set



x=-0.12
y=-0.005
z=200

Left Click
Center
Wheel Fore:
Expand
Wheel Back:
Shrink
Right Click:
Reset

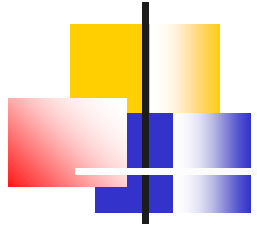


jgames_gb.zip



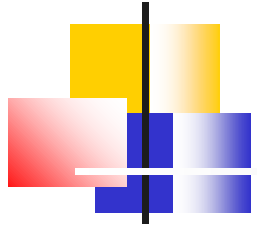
Show all





Conclusions

- **Using the mouse alone to navigate the display is the ideal GUI (Graphic User Interface).**
- **JavaScript and Forth are so fast that the user will not be aware of their existence.**
- **That's how computers should work.**



Thank You!