live editing

Telling mathematical stories with live editing

Ian Thomson
Trinity College, SA
<thomsoia@live.trinity.sa.edu.au>

Using 'live editing' it is possible to write code that can be run a section at a time. This makes it easier to spot and correct errors. It can also be used to create an interactive mathematical story.

The example illustrated in Figure 1 was created using MATLAB software. This particular example is able to take the user on a mathematical journey with historical connections. Using the language of the digital age it tells a tale about the mysterious *Great Geometric Mosaic* (Ayuntamiento de Cordoba, 2016).

The *MATLAB* script comes in two forms: text and code. Text sections can contain titles, headings, pictures, equations and text; whilst the code sections (Figure 2) contain the actual commands. Each section of code can be run one a time by clicking on "Run Section" from the Live Editor menu bar at the top of the screen.

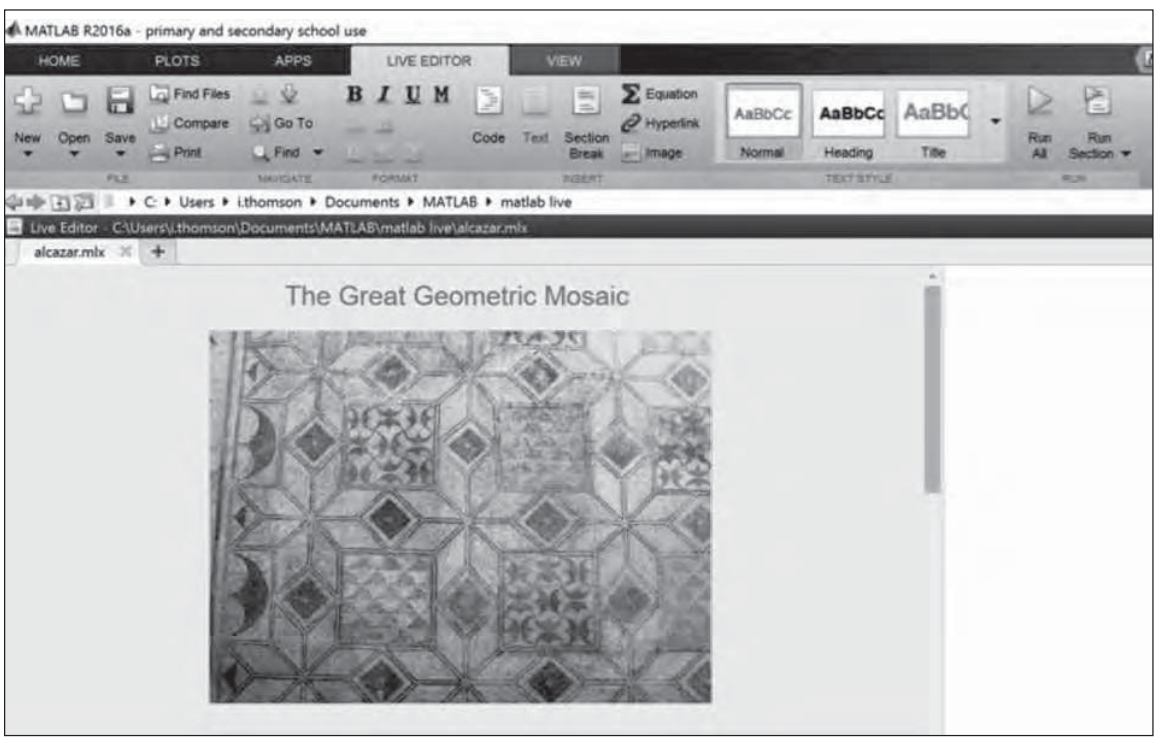

Figure 1. Example of 'live editing' using *MATLAB*.

```
angle=0:0.01:pi;
x1=cos(angle);
y1=sin(angle);
fill(x1,y1,'b')
axis equal off
hold on

x2=0.5*cos(angle)-0.5;
y2=0.5*sin(angle);
fill(x2,y2,'r')

x3=0.5*cos(angle)+0.5;
y3=0.5*sin(angle);
fill(x3,y3,'r')

fill(x1,-y1+2,'b')
fill(x2,-y2+2,'r')
fill(x3,-y3+2,'r')
```

Figure 2. Section of code to be run.

And so, with students seated comfortably, the story begins…

Origins of the Great Geometric Mosaic

The Great Geometric Mosaic is to be found in the Hall of Mosaics in the Alcazar in Cordoba, Spain. It is a Roman mosaic dating back to the 2nd century BCE. This elaborate pattern is part of the mosaic.

The secret behind this pattern is found lower down on the mosaic. Here we can see two semi-circles enclosed within a larger semi-circle. Let's begin by drawing this figure.

Figure 3.

The mathematical journey ensues in the code sections. An array of angles is created from zero to pi in steps of 0.01 radians. The cosines and sines of these angles are assigned to the x and y coordinates of the unit circle. This creates a semi-circle which is then filled in blue colour.

Similarly, two red circles are created which are smaller in size and are translated horizontally, one to the left and the other to the right. This whole process is repeated with some adjustments which create a reflection. The output from each section appears on the right-hand side of the screen (refer Figure 4).

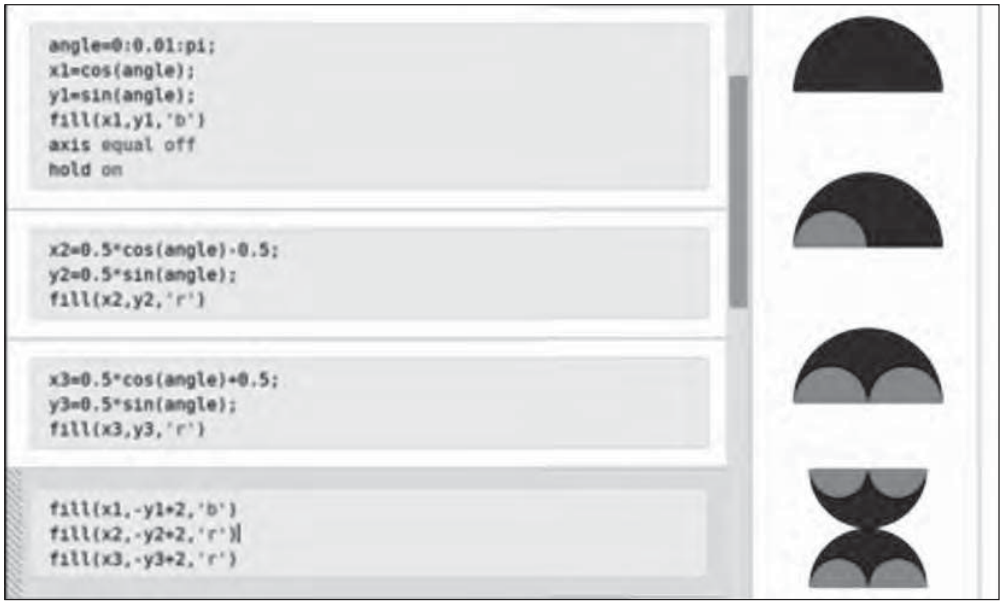

Figure 4.

A three by three grid is then established and a figure is created which is made up of nine copies of the previous figure. The odd numbered figures are rotated through ninety degrees. The background colour is set to red.

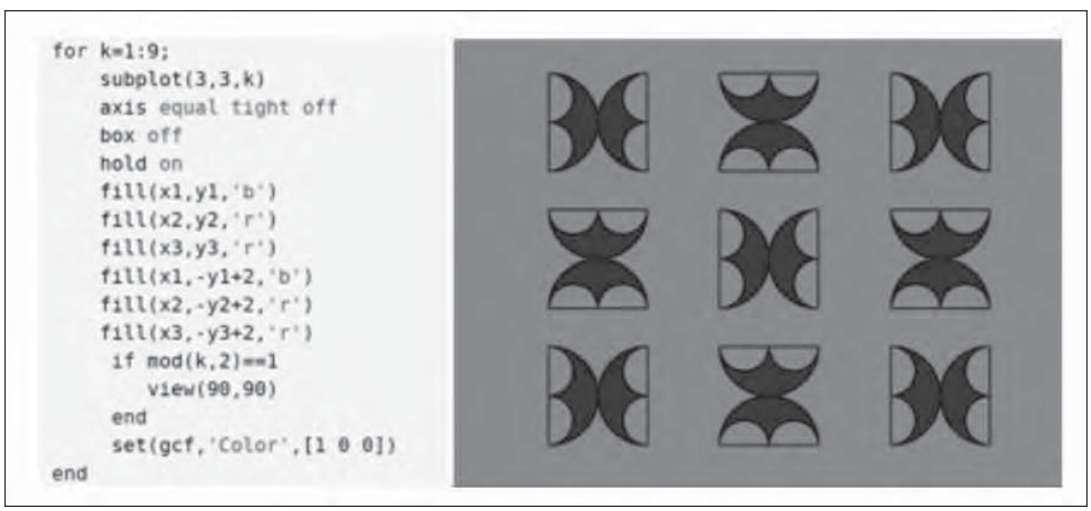

Figure 5.

Double-clicking on this figure takes the student into the Figure window where some final touches can be made. After a little clicking and dragging the secret of the Alcazar is finally revealed!

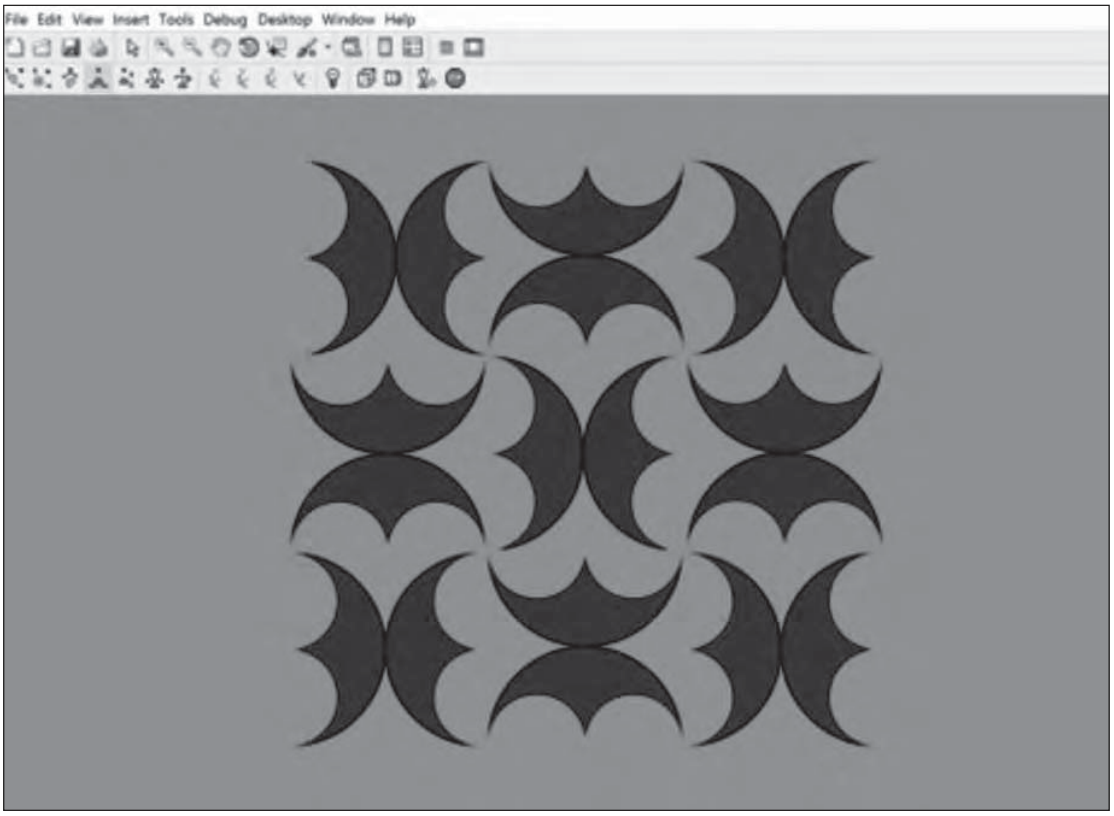

Figure 6.

So, how did this story unfold? It was, to begin with, a mysterious tale of the ancients. It took us on a mathemagical adventure. It often resembled an interactive pop-up book with colourful pictures. But importantly, through the use of live editing, code was visible throughout the story. Like a "glass computer", live editing allowed the working of the code to be seen plainly. It could be unpacked, pondered over, edited and improved if so desired. Live editing is undoubtedly a powerful medium for introducing coding into the mathematical stories that we tell in the classroom.

References

Ayuntamiento de Cordoba (2016). *Hall of Mosaics*. Retrieved 21 November 2016 from http://www.alcazardelosreyescristianos.cordoba.es/?id=623&lang=3

MathWorks (2016). *MATLAB Live Editor*. Retrieved 21 November 2016 from https://au.mathworks.com/products/matlab/live-editor/

From Helen Prochazka's

Scrapbook

The Industrial Revolution

In the 17th century, it was still possible to be educated all the way to university level without studying any mathematics at all.

During the 18th and 19th centuries, the Industrial Revolution spread steadily through Europe, and large numbers of people moved from the countryside to cities. Increased numeracy skills, such as handling money and telling the time, were necessary for this new urban lifestyle.

There was a growing demand for engineers, and mathematical research was now centred on higher education institutions rather than royal courts. In 1794, the Ecole Polytechnique opened its doors in Paris. It offered a practical education that built on the technological advances that started during the French Revolution. Later, under Napoleon's rule, it became a military academy.

Germany took a rather different academic approach. It supported the development of mathematics created for its own sake rather than for practical purposes, its focus detached from the requirements of the state or the military.

Mathematics became increasingly important within the new public education systems. By the start of the 20th century, mathematics was part of the core curriculum in all developed countries.

Bits and bytes

Binary code is the foundation of modern digital technology. Information is translated into this notation, which can then be read by computers, mp3 players, and other digital devices.

A bit (b) is the basic unit of digital data and a byte (B) is made up of 8 bits.

1 byte = 8 bits

Each numeral or character is written as a string of binary code that is 1 byte long. This string of eight numbers consists only of the digits '1' and '0'.

The coded data is stored by a physical system such as a flip-flop circuit, which exists in two possible physical states such as 'on' or 'off'. The digit '0' corresponds to one of the states, while the digit '1' corresponds to the other.

Below is a word statement followed by its binary code translation.

"The first iPod was released in November 2001."

01010100 01101000 01100101 00100000 01100110 01101001 01110010 01110011 01110100 00100000 01101001 01010000 01101111 01100100 00100000 01110111 01100001 01110011 00100000 01110010 01100101 01101100 01100101 01100001 01110011 01100101 01100100 00100000 01101001 01101110 00100000 01001110 01101111 01110110 01100101 01101101 01100010 01100101 01110010 00100000 00110010 00110000 00110000 00110001 00101110