

Introduction to Groups

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*This is a first draft of a worksheet for the beginning of Abstract Algebra
(Needs more work)*

[>

► Outline

1. Investigate the symmetries of a square visually.
2. Investigate the composition of two transformations visually.
3. Investigate the symmetries of a hexagon

▼ Symmetries of a Square

▼ Define and plot a square

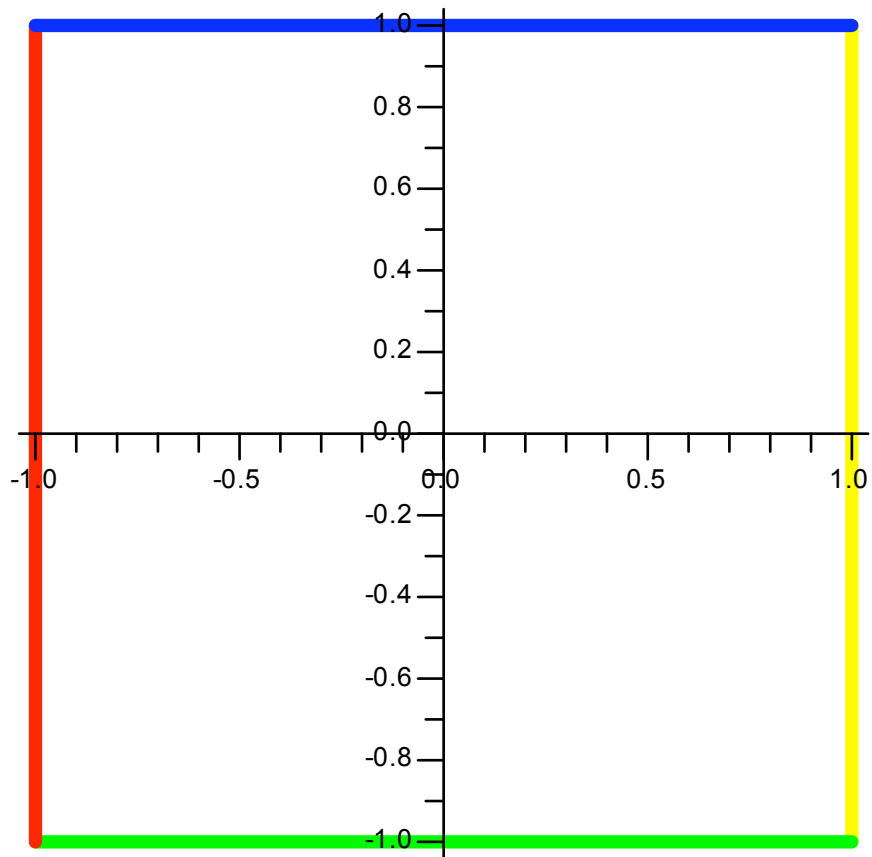
```
> restart : with (plots) : with (plottools) :  
Warning, the name changecoords has been redefined  
Warning, the assigned name arrow now has a global binding
```

The following define the sides of a square.

```
> L1 := line([1, 1], [-1, 1], color = blue, thickness = 5) :  
L2 := line([-1, 1], [-1, -1], color = red, thickness = 5) :  
L3 := line([-1, -1], [1, -1], color = green, thickness = 5) :  
L4 := line([1, -1], [1, 1], color = yellow, thickness = 5) :
```

Next we display the square.

```
> display(L1, L2, L3, L4);
```



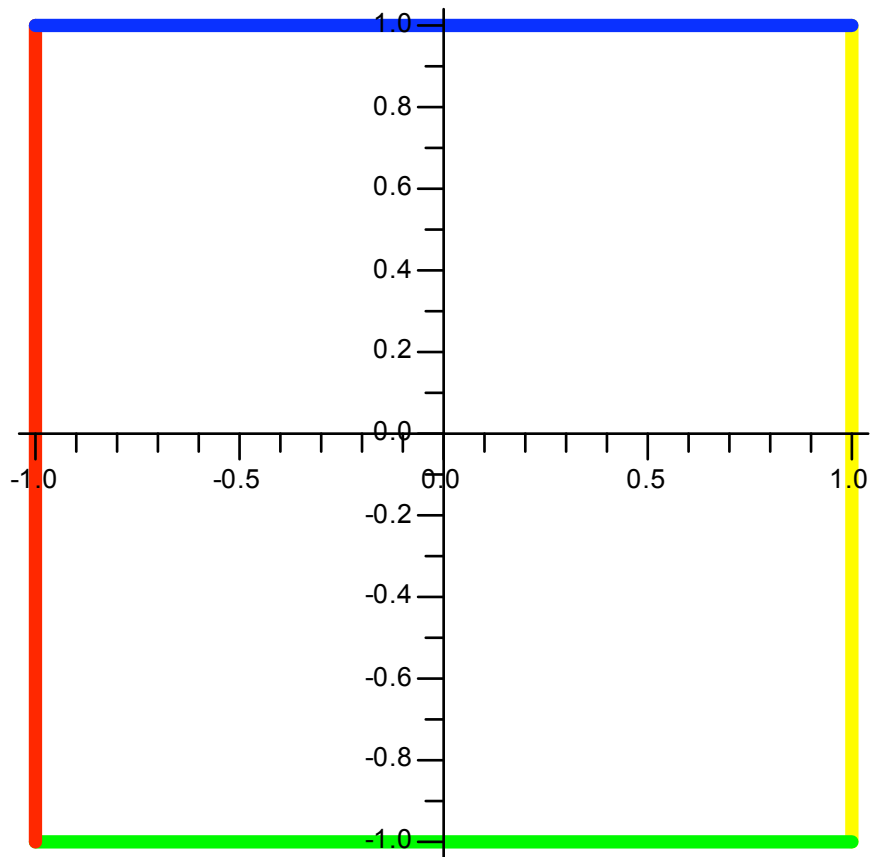
```
[>
```

```
[> square := display(L1, L2, L3, L4) :
```

```
[>
```

▼ Rotations

```
[> R0 := rotate(square, 0, [0, 0]) :  
display(R0);
```



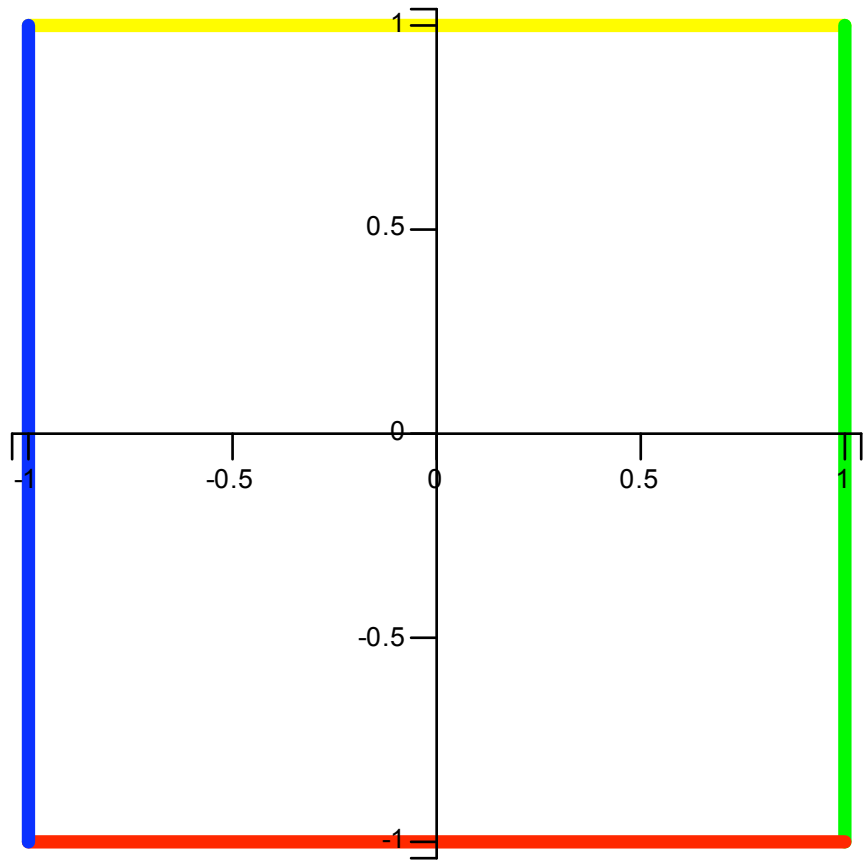
```
> plot  
Warning, inserted missing semicolon at end of statement  
plot
```

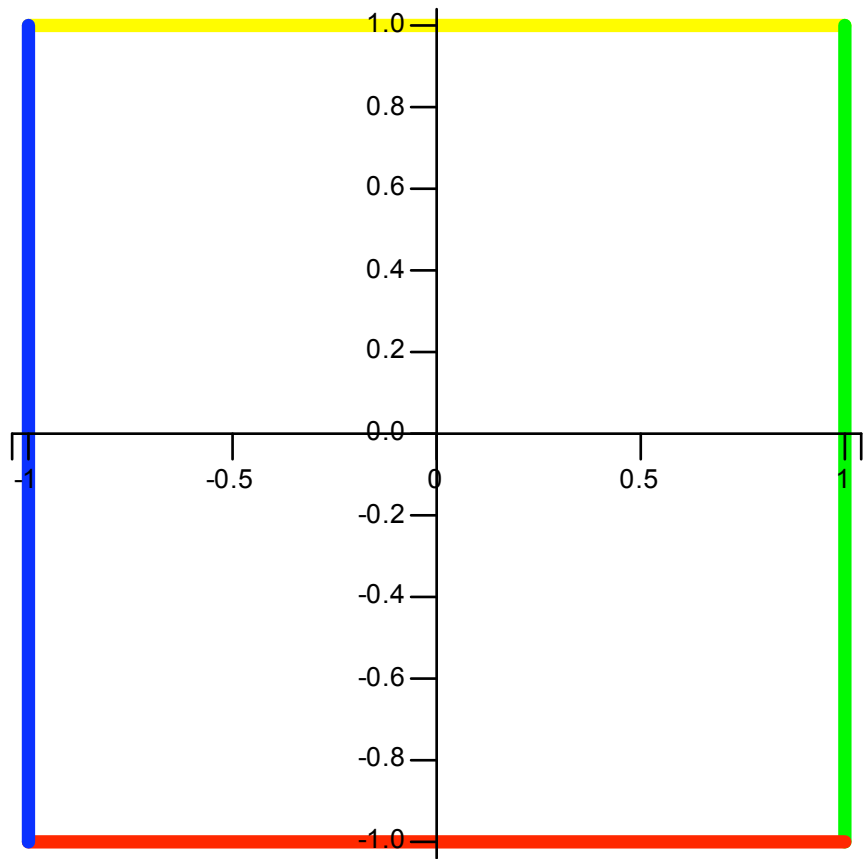
(2.2.1)

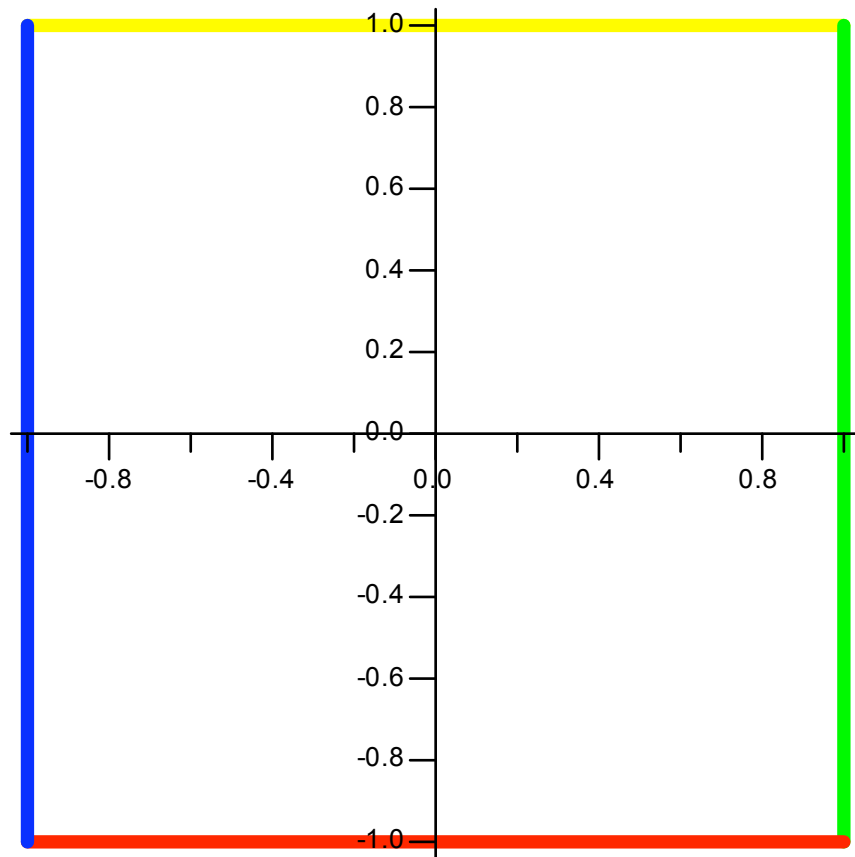
```
> R90 := rotate(square, Pi/2, [0,0]):  
display(R90, tickmarks=[10,10]);
```



```
>  
>  
> R90 := rotate(square,Pi/2,[0,0]):  
display(R90, tickmarks=[[-1,-.5,0,.5,1],[-1,-.5,0,.5,1]]);  
display(R90, tickmarks=[[-1,-.5,0,.5,1],10]);  
display(R90, tickmarks=[10,10]);
```

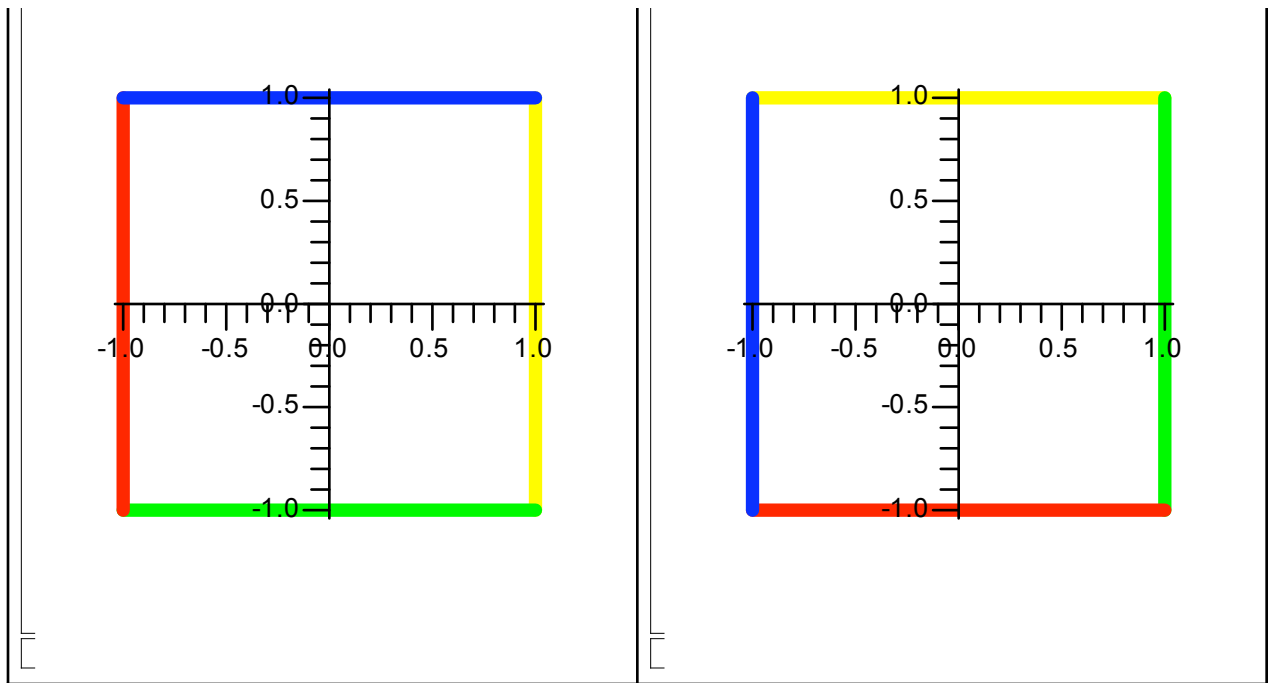






```
display(square);
```

```
display(R90);
```



```
[> R180 := rotate(square,Pi,[0,0]):
display(R180);
[>
```

```
[> R270 := rotate(square,3*Pi/2,[0,0]):
display(R270);
[>
```

► Reflections

► Composition of Transformations

```
[> R90H := rotate(H,Pi/2,[0,0]):
display(R90H);
[>
```

```
> R90V := rotate(V,Pi/2,[0,0]):  
display(R90V);  
>
```

```
> R90MD := rotate(MD,Pi/2,[0,0]):  
display(R90MD);  
>
```

```
> R90SD := rotate(SD,Pi/2,[0,0]):  
display(R90SD);  
>
```

```
> HR90 := reflect(R90,[[ -1,0],[1,0]]):  
display(HR90);  
>
```

▼ Assignment: Symmetries of a Regular Hexagon

▶ Define and plot a regular hexagon

▶ Rotations

▶ Reflections

▶ *Rotations*

1. *What is the angle measure of each rotation?*

▼ Reflections (later)