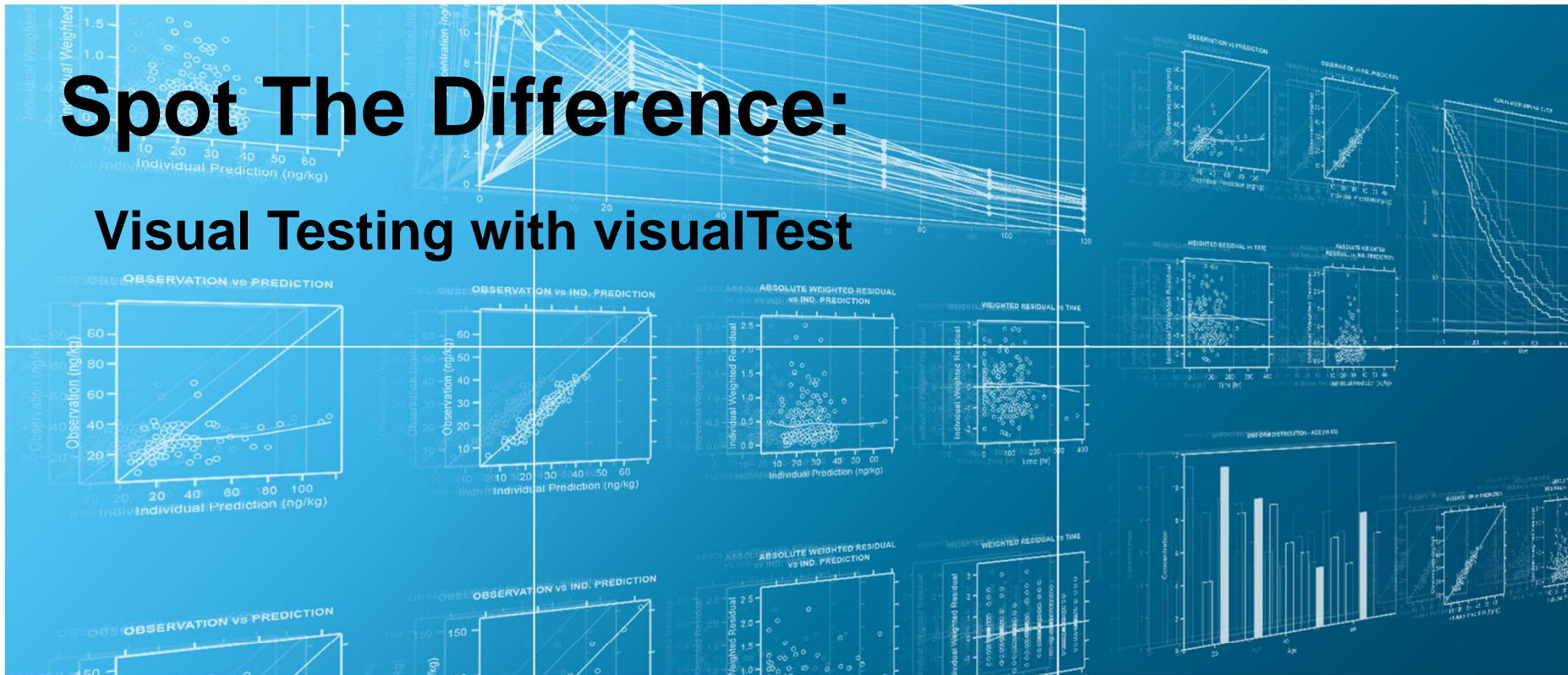
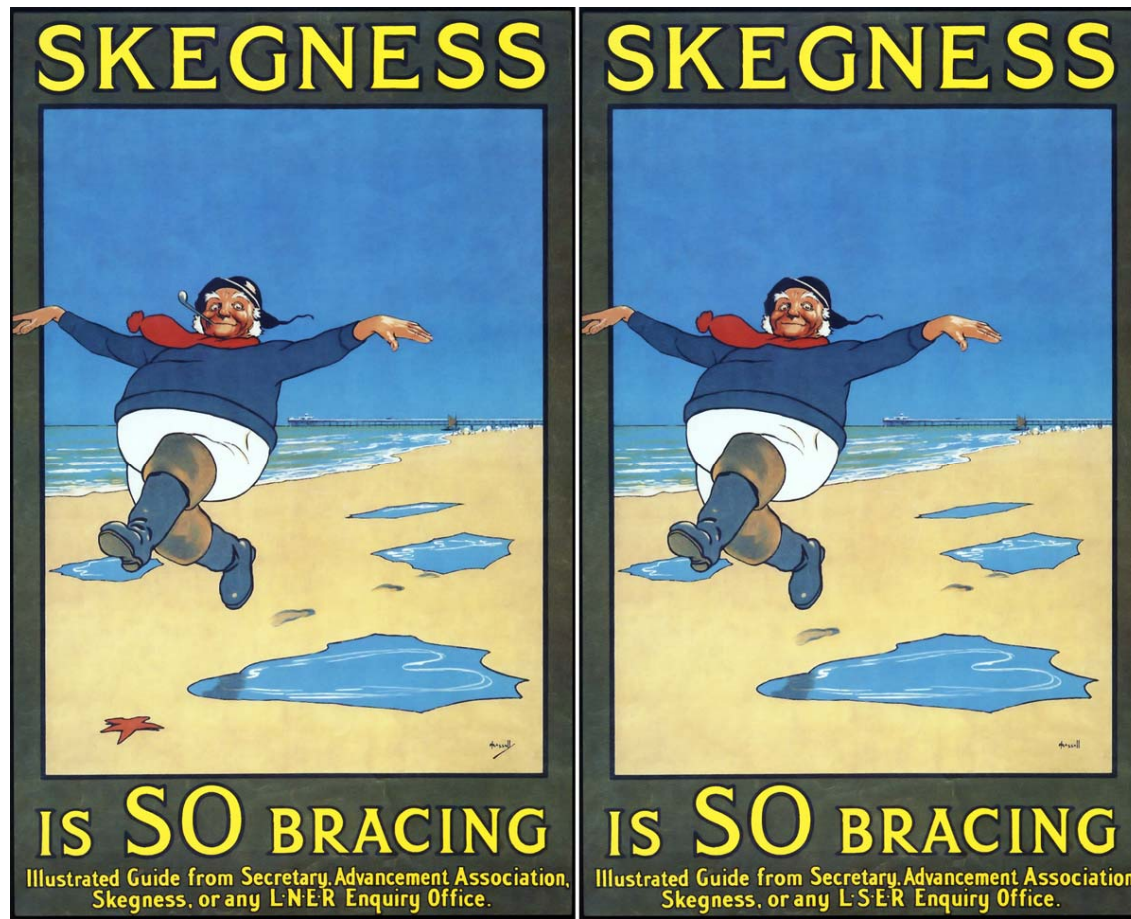


Spot The Difference: Visual Testing with visualTest



Chris Campbell, PhD



Spot The Difference

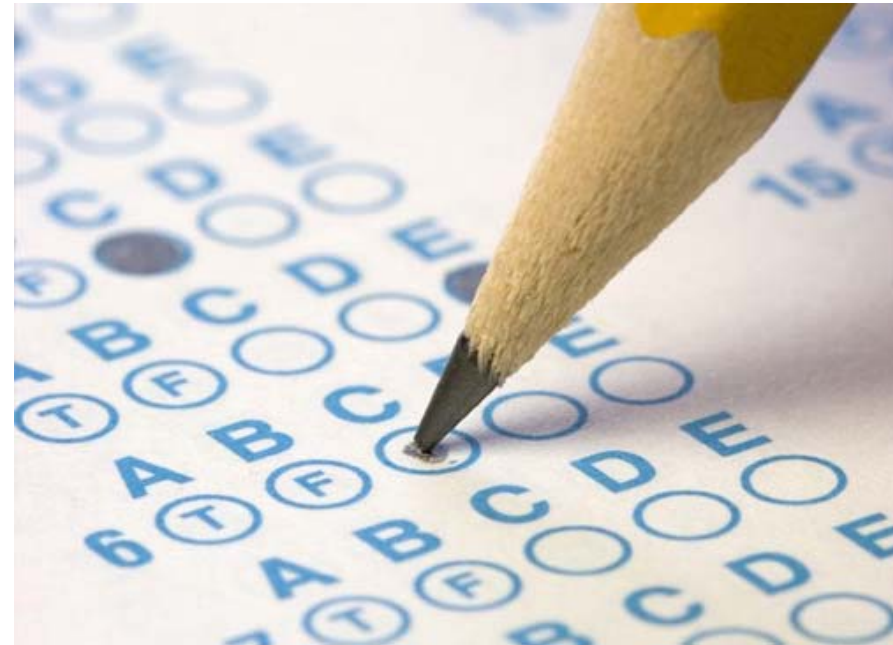


Visualization is important

- Understanding trends
- Identifying problems
- Communicating findings

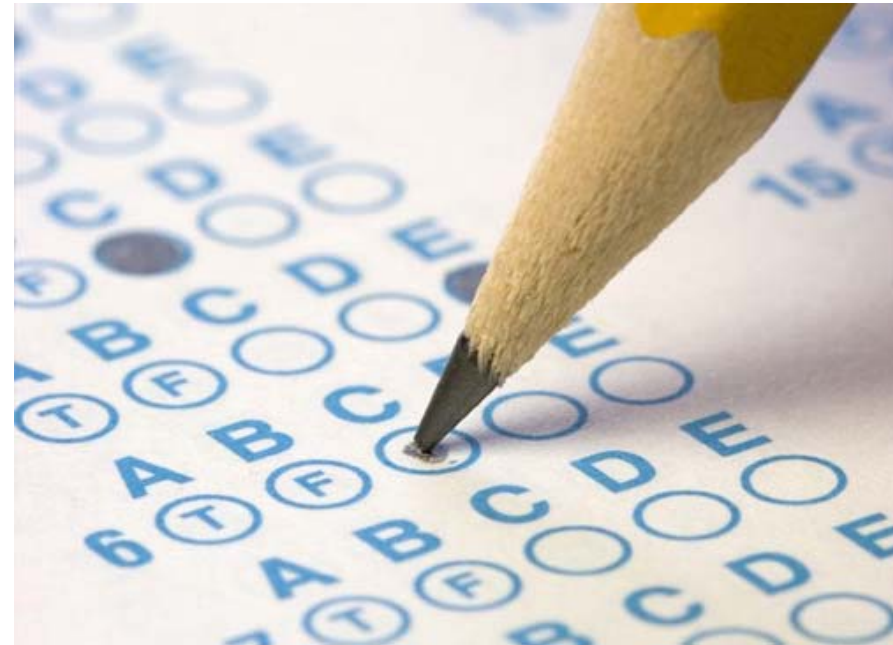
Testing code is important

- Expected successful use cases
- Expected failure use cases



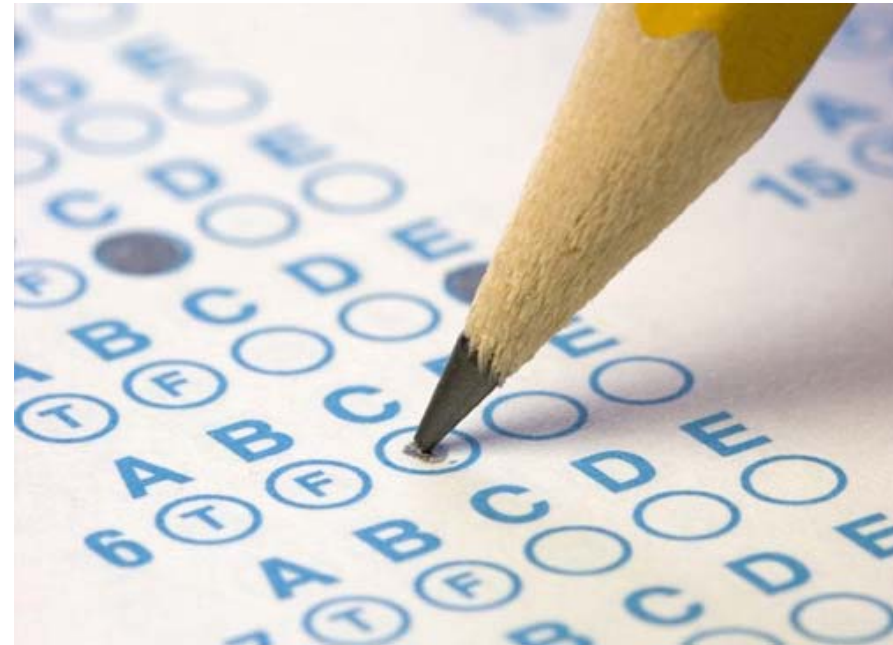
What has changed?

- Expected new functionality?
- Regressions?
- Dependencies?



What has changed?

- Difficult or impossible to know without tests





Difficulties in testing graphics

- How to quantify rendered 3D output?
- What is platform for render?
- What format is the rendered output?



How to quantify rendered output?

- File size?
- File identity (md5checksum)?
- Pixel values?
- Image summary?

What is platform for render?

- Many of our customers code on Windows and execute analysis on Unix
- But what about the file contents?

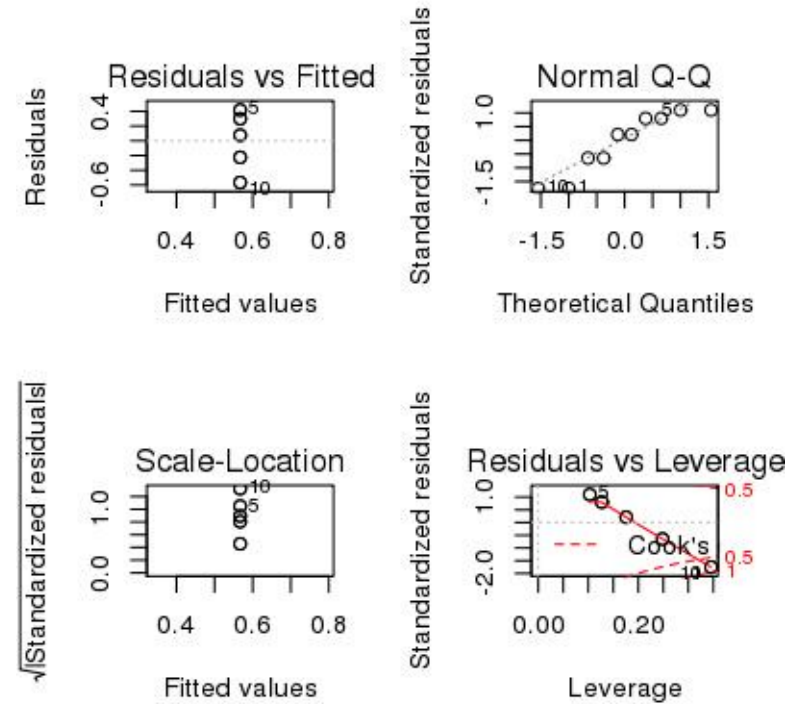
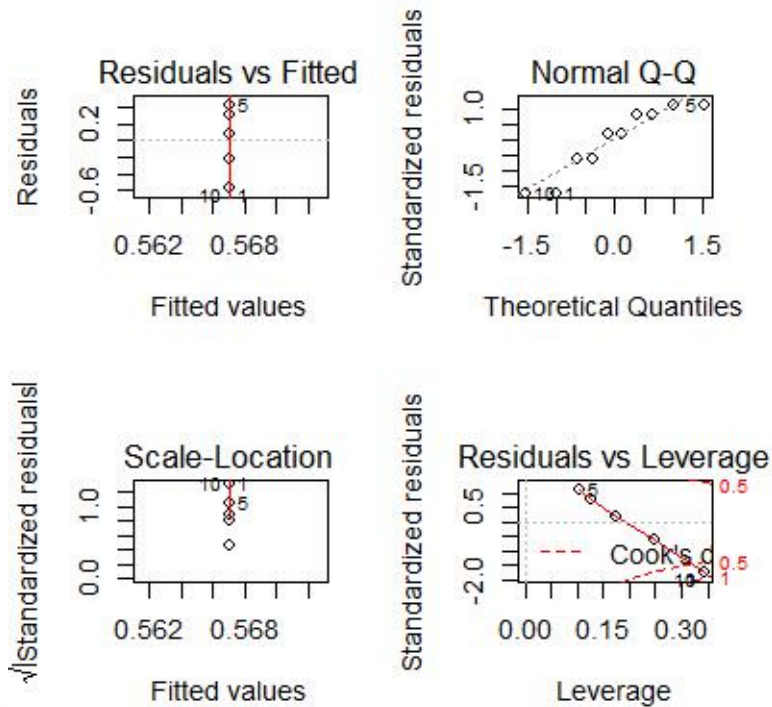


Windows versus Unix

Identical script

Windows

Unix



Windows versus Unix

Different render

```
> file.info("windows/VR-616_plot-lm01.jpg") ["size"]
      size
windows/VR-616_plot-lm01.jpg 29381
> file.info("unix/VR-616_plot-lm01.jpg") ["size"]
      size
unix/VR-616_plot-lm01.jpg 25035
```

Windows versus Unix

Files not the same

```
> md5sum("windows/VR-616_plot-lm01.jpg")
    windows/VR-616_plot-lm01.jpg
"461268e4edb5f1872c913394511df7aa"
> md5sum("unix/VR-616_plot-lm01.jpg")
    unix/VR-616_plot-lm01.jpg
"ff974c8678648d7611f99efc035c9772"
```

Windows versus Unix

Pixels not the same

```
> require(jpeg)
> grWin <- readJPEG("windows/VR-616_plot-lm01.jpg")
> grUnx <- readJPEG("unix/VR-616_plot-lm01.jpg")
```

Windows versus Unix

Pixels not the same

```
> round(grWin[52:54, 52:54, 1], 3)
      [,1] [,2] [,3]
[1,] 0.859 0.957 1.000
[2,] 0.957 1.000 1.000
[3,] 0.004 0.122 0.122
> round(grUnx[52:54, 52:54, 1], 3)
      [,1] [,2] [,3]
[1,] 1.000      1 1.000
[2,] 0.945      1 0.992
[3,] 1.000      1 0.988
```

What is platform for render?

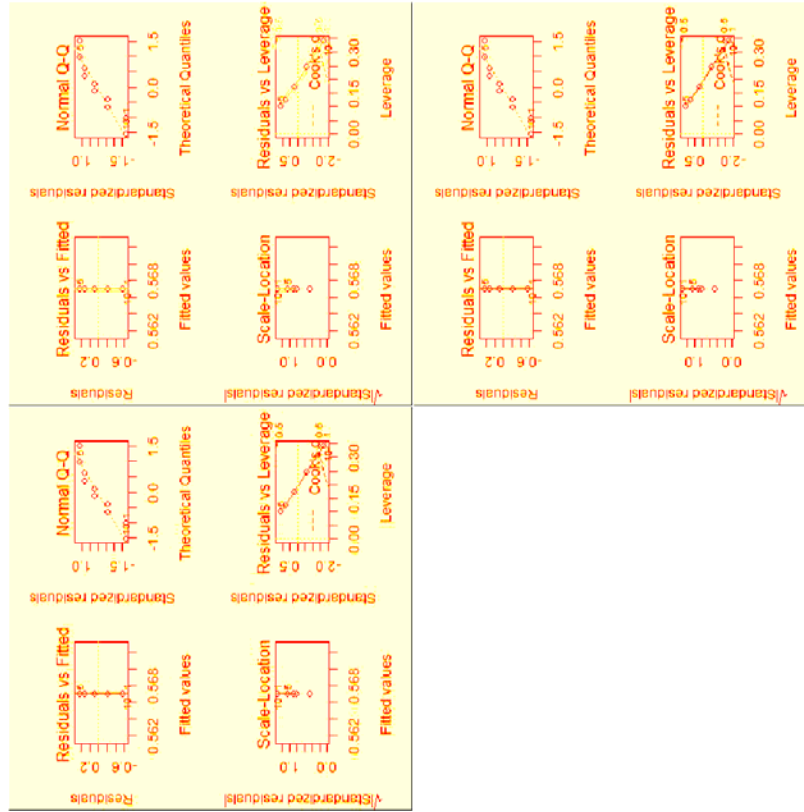
- File size different
- File md5checksum different
- Pixel values different
- Image summary?



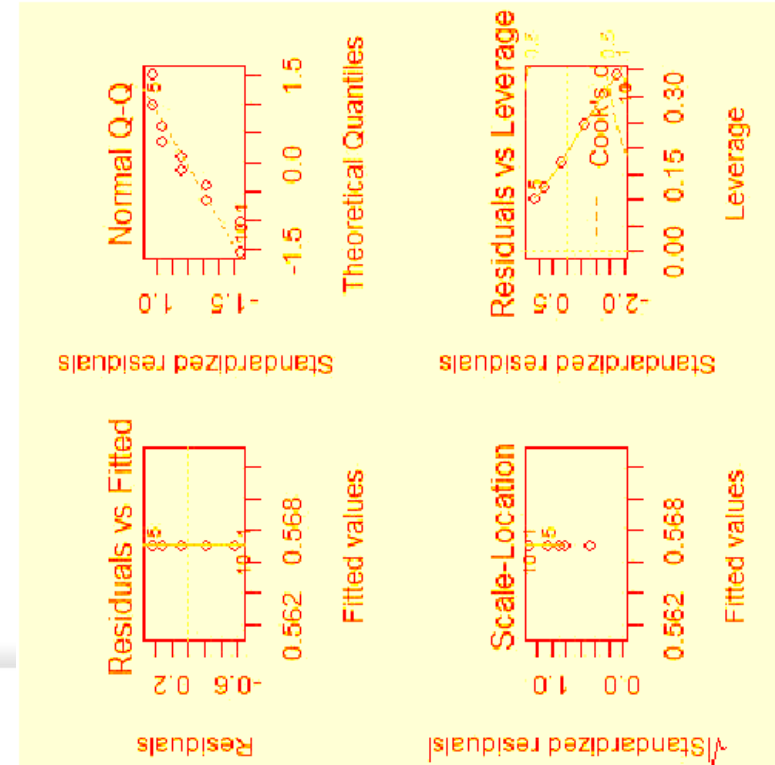
Image summary

- RGB array to 2D matrix
- Fourier transform matrix
- Sum 2D matrix to 1D vector
- Compare vectors

RGB array to 2D matrix

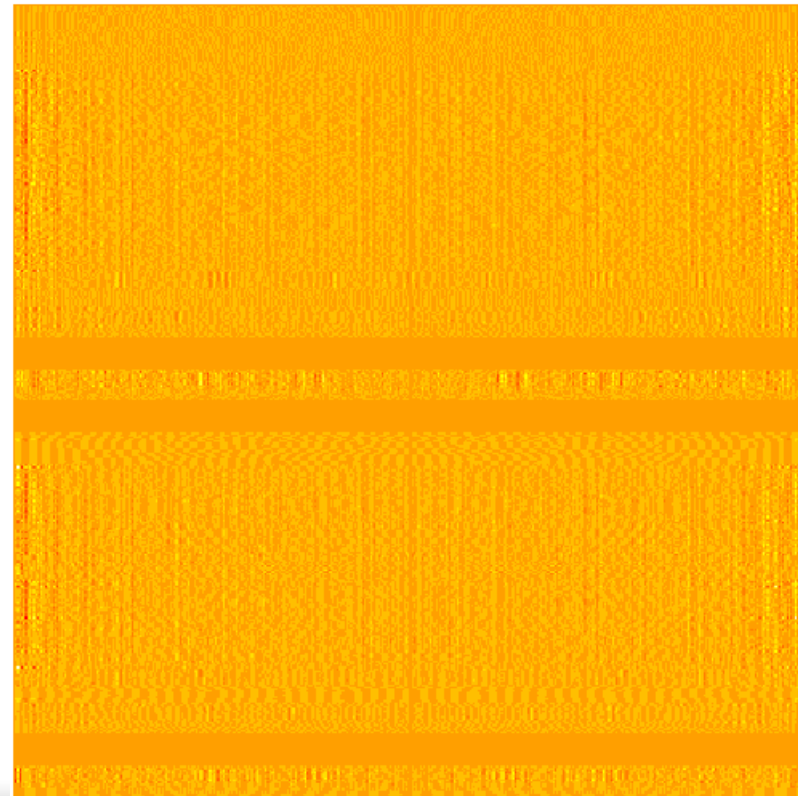


```
> matWin <- rgb2Value(grWin)
> image(matWin)
```



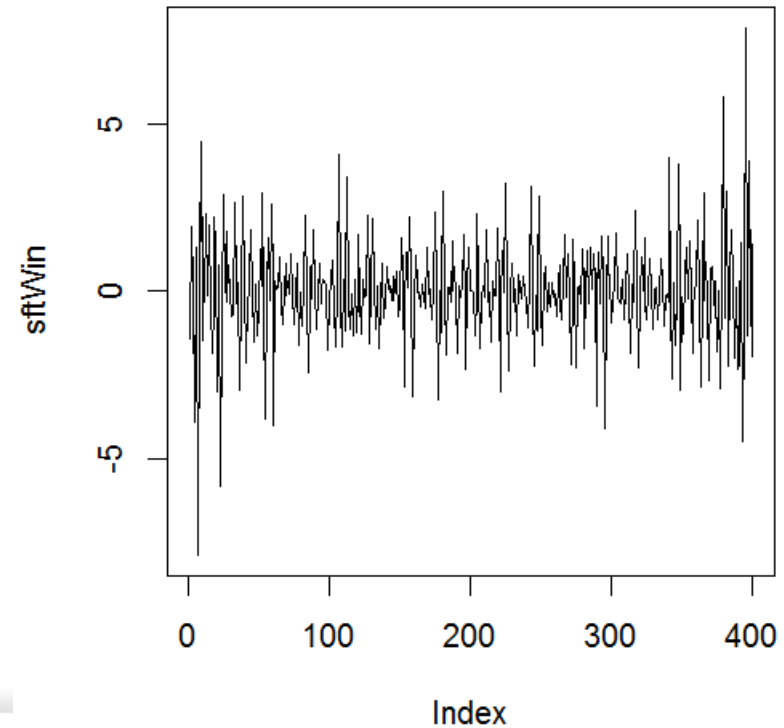
Fourier transform matrix

```
> ftWin <- mvfft(matWin)
> image(Im(ftWin))
```



Sum 2D matrix to 1D vector

```
> sftWin <- apply(Im(ftWin)
+   MARGIN = 1, sum)
> plot(sftWin)
```

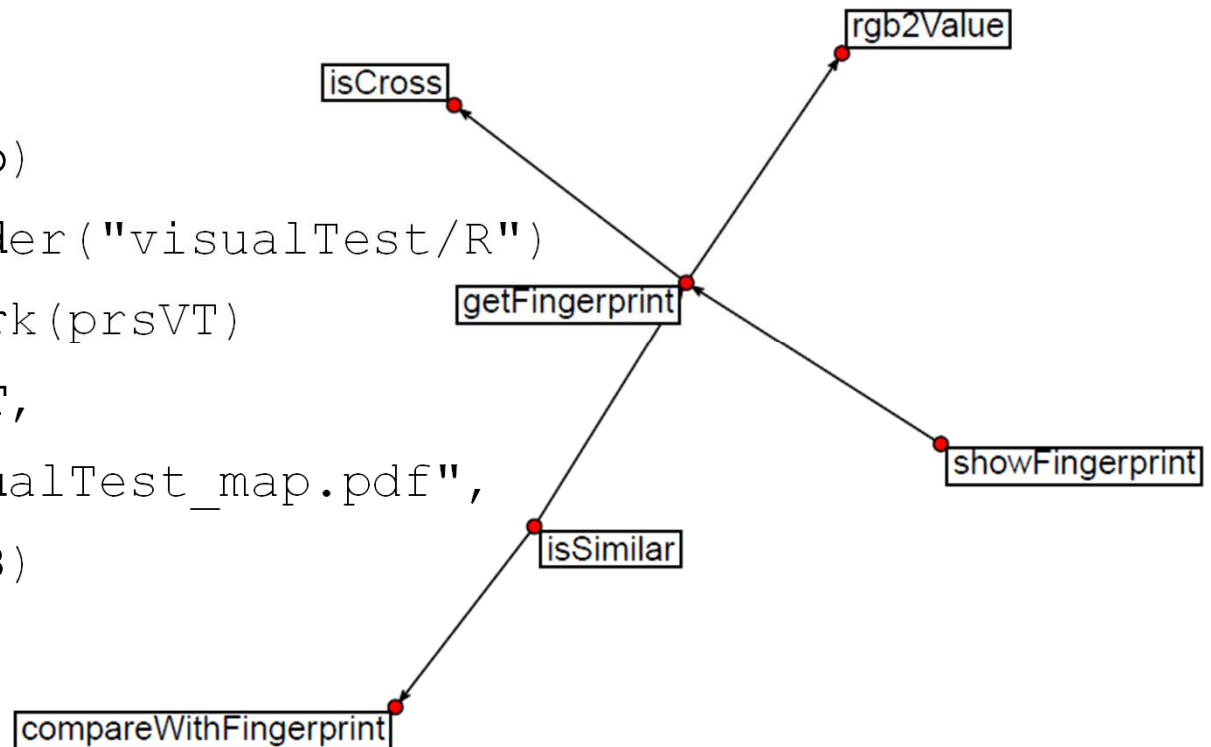


Sum 2D matrix to 1D vector - fingerprint

```
> diff(which(isCross(x = sftWin)))  
[1] 8 4 9 16 10 12 7 9 4 13 7 9 16 12  
[15] 3 10 3 6 6 5 3 11 9 3 3 10 10 4  
[29] 4 7 5 3 10 4 12 15 11 5 14 8 5 6  
[43] 14 8 17 9 6 5  
  
> getFingerprint("windows/VR-616_plot-lm01.jpg")  
[1] 8 4 9 16 10 12 7 9 4 13 7 9 16 12  
[15] 3 10 3 6 6 5 3 11 9 3 3 10 10 4  
[29] 4 7 5 3 10 4 12 15 11 5 14 8 5 6  
[43] 14 8 17 9 6 5
```

visualTest

```
> require(functionMap)
> prsVT <- parseRfolder("visualTest/R")
> nVT <- createNetwork(prsVT)
> plotFunctionMap(nVT,
+   pdffile = "visualTest_map.pdf",
+   label.cex = 0.8)
```



isSimilar

```
> file.info("jollyfisherman-spotL.png") ["size"]
      size
jollyfisherman-spotL.png 1261055
> file.info("jollyfisherman-spotR.png") ["size"]
      size
jollyfisherman-spotR.png 1254452
```



isSimilar

```
> require(visualTest)
> isSimilar(file = "jollyfisherman-spotL.png",
+           fingerprint = "jollyfisherman-spotR.png")
[1] FALSE
> isSimilar(file = "jollyfisherman-spotL.png",
+           fingerprint = "jollyfisherman-spotR.png",
+           threshold = 1)
[1] TRUE
```

isSimilar

```
> file.info("jollyfisherman-spotL.png") ["size"]
      size
jollyfisherman-spotL.png 1261055
> file.info("happysandboy.png") ["size"]
      size
happysandboy.png 1182397
```



isSimilar

```
> isSimilar(file = "jollyfisherman-spotL.png",  
+           fingerprint = "happysandboy.png")  
[1] FALSE  
  
> isSimilar(file = "jollyfisherman-spotL.png",  
+           fingerprint = "happysandboy.png",  
+           threshold = 16)  
[1] TRUE
```



visualTest

- Summarizes image as fingerprint
- Fuzzy comparisons of similar images