# Fourier transforms

- Will do more of this next week, at the moment I want to introduce the concept in a hands-on way.

- Go to the app store or iOS store and look for / download a free *spectrum analyzer* app.

- Once it's installed, turn it on and try whistling or singing to it. What do you see? What is going on here?

Fourier transforms

- Whistling should produce a sharp peak as shown on the right.

- What happens when you change the pitch / note of your whistle?

- Now that we can individually control each "note" what could we do with this?
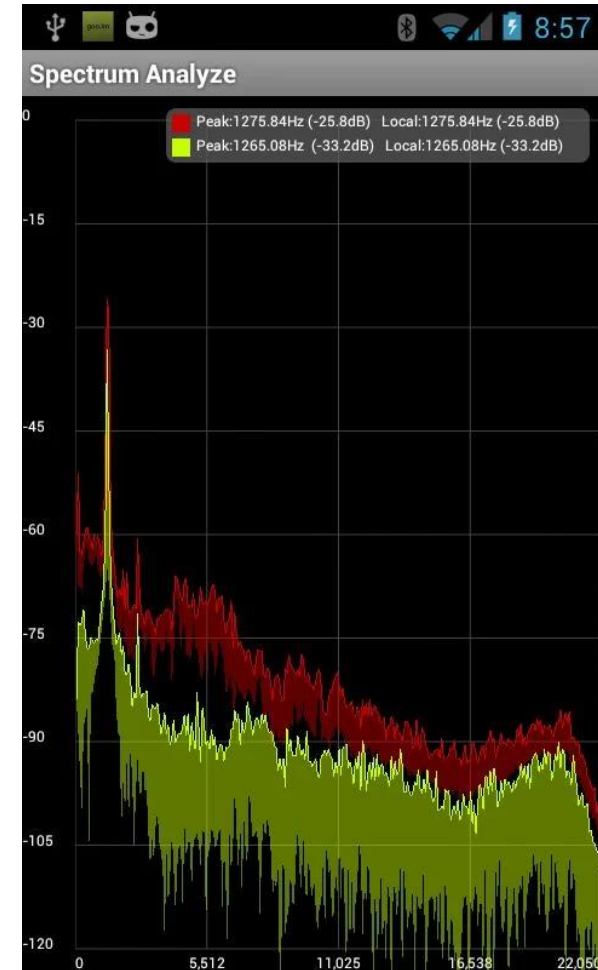
Visualizing Chaos

- Chaotic systems, like nonlinear systems and fractals, often appear as nonsense when we just plot the x and $f(x)$ values for a particular set of coefficients.

- Computation makes it possible to try out *all* of the possible coefficients and visualize it all at once. This gives us some idea of the behavior of the system.

- A fun video which demonstrates chaos in the Mandelbrot Set: https://www.youtube.com/watch?v=9gk_8mQuerg

Exercise

- In class you dealt with the logistic map $x_{n+1} = rx_n(1 - x_n)$
- Write a function which plots x with inputs for: r, number of points, and x_0 (initial value).
- Try out different values for the inputs and see what you get.

Exercise

- We can see that an important quantity in chaotic systems such as this is the number of values x oscillates between (called *fixed points*).

- Visualize these fixed points by generating the plot seen in class, plot a cluster of values for each possible r value to see how the fixed point itself changes with r, and how the number of fixed points change.

Groups for group project

Group 1

214425862	' Torubka'	' Matthew'
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Group 2

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Group 3

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213528344	' Werheid'	' Zachary'
213745013	' Tsang'	' Matthew'
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Group 4

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Group 5

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213448899	' Atamanchuk'	' Jessie'
213709647	' Hasaj'	' Semi'
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Group 6

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213444864	' Klincans'	' Matthew'
213274733	' David'	' Nirose'
213855036	' Chen'	' Zihao'
N/A	Anozie (A.)'	N/A
N/A	Islam (T.)'	N/A

Find your group members and start brainstorming!
Note: 3 names are missing from this list, will be filled in once discovered.

Arduino Programming

- Everyone in your group should feel comfortable programming the Arduino

- It's important to see how knowledge of one language can translate to another

- Arduino's are programmed in C, with built in *libraries*

- **Exercise:** Take a look at the Arduino code on the following slide. List all of the things that are familiar, and all of the things that are different from your experience with MATLAB

Exercise

```
/*

Prints whether or not the voltage on
Analog pin A0 is

above or below a set threshold "a"

*/


const float a = 1.2; // Threshold[Volts]

const float convFactor = 5.0 / 1024.0;


void setup() {
Serial.begin(9600)

}
```

```
void loop() {

int val = analogRead(A0);

float b = val * convFactor;

bool isgreater = b > a;


if (isgreater) {

  Serial.println("Voltage above");

} else {

  Serial.println("Voltage below");

}

delay(100);

}
```

Arduino Library Functions

- You will need to find functions in the Arduino library to get the Arduino to read and write information the way you want it to

- Some important Arduino functions are:
    1. `setup()`
    2. `loop()`
    3. `digitalWrite()`
    4. `pinMode()`
    5. `delay()`
    6. `Serial.begin()`
    7. `Serial.println()`
    8. `Serial.read()`

- To find the functions you need, look on the Arduino website or at some example codes in the Arduino IDE under File → Examples

Exercise (Optional)

- Write an Arduino program which averages the last ten values read on two analog pins and calculates the difference between the two averages. If the difference is positive turn the Arduino's onboard LED ON, if the difference is negative turn it OFF.