Discrete Fourier Transform

In [ ]:

```
function dft(x)
    N = length(x)
    X = complex(zeros(1, N))
    for k = 1:N
        for n = 1:N
            X[k] += x[n] * exp(-2*pi*im*(k-1)*(n-1)/N)
        end
    end
    return X'
end
```

```
dft (generic function with 1 method)
```

In [ ]:

```
dft([1, 2, 3, 4])
```

```
4×1 adjoint(::Matrix{ComplexF64}) with eltype ComplexF64:
                10.0 - 0.0im
 -2.0000000000000004 - 1.9999999999999996im
                -2.0 + 9.797174393178826e-16im
 -1.9999999999999982 + 2.000000000000001im
```

Fast Fourier Transform

In [ ]:

```
function fft(x)
    N = length(x)
    if N <= 1
        return x
    end

    X_even = fft(x[1:2:end])
    X_odd = fft(x[2:2:end])

    terms = @. exp(-2 * pi * im * (0:(N/2 - 1)) / N)

    X = [X_even .+ terms .* X_odd; X_even .- terms .* X_odd]

    return X
end
```

```
fft (generic function with 2 methods)
```

In [ ]:

```
fft([1, 2, 3, 4])
```

```
4-element Vector{ComplexF64}:
                10.0 - 0.0im
                -2.0 + 2.0im
                -2.0 + 0.0im
 -1.9999999999999998 - 2.0im
```

Benchmarking

In [ ]:

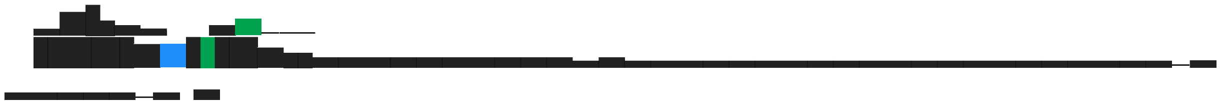
```julia
using StatsBase
using BenchmarkTools

testVals = 100*rand(Complex{Float64}, 10000);
```

In [ ]:

```julia
@benchmark dft(x) setup = (x = StatsBase.sample(testVals, 256, replace=true))
```

```
BenchmarkTools.Trial: 4269 samples with 1 evaluation.
 Range (min … max):  1.056 ms …   8.102 ms  ┊ GC (min … max): 0.00% … 0.00%
 Time  (median):     1.131 ms               ┊ GC (median):    0.00%
 Time  (mean ± σ):   1.158 ms ± 191.718 μs  ┊ GC (mean ± σ):  0.00% ± 0.00%
```



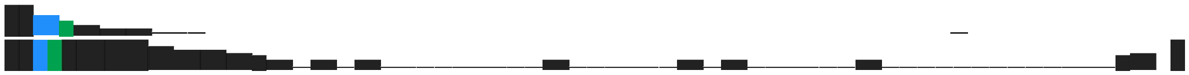
```
  1.06 ms         Histogram: frequency by time        1.63 ms <

 Memory estimate: 6.27 KiB, allocs estimate: 3.
```

In [ ]:

```julia
@benchmark fft(x) setup = (x = StatsBase.sample(testVals, 256, replace=true))
```

```
BenchmarkTools.Trial: 6469 samples with 1 evaluation.
 Range (min … max):  592.900 μs …   8.931 ms  ┊ GC (min … max): 0.00% … 91.92%
 Time  (median):     691.000 μs               ┊ GC (median):    0.00%
 Time  (mean ± σ):   760.545 μs ± 496.213 μs  ┊ GC (mean ± σ):  6.51% ±  8.96%
```



```
  593 μs        Histogram: log(frequency) by time       4.51 ms <

 Memory estimate: 590.16 KiB, allocs estimate: 8432.
```

Comparing median times

In [ ]:

```julia
691e-6 / 1.131e-3
```

```
0.6109637488947833
```

Fast Fourier Transform is consistently faster, taking approximately 39% lesser time, albeit using higher processing power.