Normal Samples

If we want 10 samples from a Gaussian or normal random process with variance 4 can use rnorm(10,sd=2). Remember the standard deviation (sd) is the square root of the variance.

```
set.seed(2)
x <- rnorm(10,sd=2)
x
```

```
##  [1] -1.7938291  0.3696984  3.1756907 -2.2607513 -0.1605035  0.2648406
##  [7]  1.4159095 -0.4793960  3.9689479 -0.2775740
```

```
var(x)
```

```
## [1] 3.880803
```

The var() function produces an estimate of the variance, if we want a better estimate we need more samples.

```
var(rnorm(1000,sd=2))
```

```
## [1] 4.105966
```

Complex Normal Samples

If we are using base R and want complex normal (CN) samples, we need to write our own function. When the signal processing literature refers to CN they are usually referring to circularly-symmetric CN. Circularly-symmetric means the samples are independent and their mean is 0.

The function produces N CN samples with variance v. The real and imaginary parts are independent, because they are produced by different calls to rnorm(). Let x,y be independent. The var(ax) = a^2var(x) and var(x+y)=var(x)+var(y). So, if we want a variance of 1 would have to start a variance of sqrt(1/2).

```
makeCN <- function(N,v=1) {(sqrt(v/2))*rnorm(N) + (sqrt(v/2))*1i*rnorm(N)}
makeCN(10)
```

```
##  [1]  0.0023376-0.2079938i  0.7613032+0.6053620i  0.3946671-0.4049715i
##  [4]  0.4892950-0.1207824i  0.4651165-0.2871364i -0.2312504+0.9408834i
##  [7] -0.2153405-0.9648887i -1.0994866+1.0119199i  1.0396552+0.7824796i
## [10]  0.1147878+0.9059002i
```

If we want to check the variance, we can't use var() directly.

```
var(makeCN(10))
```

```
## Warning in var(makeCN(10)): imaginary parts discarded in coercion
```

```
## [1] 0.6039204
```

But the real and imaginary parts are independent, so we can calculate the variance separately.

```
z <- makeCN(10)
var(Re(z)) + var(Im(z))
```

```
## [1] 0.5623849
```

To make this easier, we can create a function to find the variance.

```
varComplex <- function(z) var(Re(z)) + var(Im(z))
```

To get a good estimate we need a-lot of samples.

```
varComplex(makeCN(1000))
```

```
## [1] 1.016615
```

Let’s set the variance to 2 and then estimate the variance of the samples.

```
varComplex(makeCN(1000,v=2))
```

```
## [1] 1.925119
```

Success!