

# Data Generation: Modulation Classification

EE18BTECH11014

Krishna Srikar Durbha

## Signal and Channel Parameters

```
% No.of Samples
N = 10000;

% SNR(in dBW)
SNR = [5,10,15,20,25,30];

% Channel Length for Rayleigh Fading
L = [2,3];

% Modulation Schemes
modulationTypes = categorical(["QPSK", "16-QAM", "64-QAM"]);

% Channels
channelTypes = categorical(["AWGN", "Rayleigh"]);

% Normalise Data
Norm = false;

% Ignoring Warnings
warning('off','all');
```

## Data Generation

### Generating Signal

```
numModulationTypes = length(modulationTypes);
numChannelTypes = length(channelTypes);
for i = 1:numChannelTypes
    for j = 1:numModulationTypes
        if channelTypes(i) == "Rayleigh"
            DataGeneration(N*50,modulationTypes(j),channelTypes(i),SNR,L,Norm)
        elseif channelTypes(i) == "AWGN"
            DataGeneration(N,modulationTypes(j),channelTypes(i),SNR,L,Norm)
        end
        fprintf('-----\n');
    end
end
```

```
Saved AWGN QPSK Data
-----
Saved AWGN 16-QAM Data
-----
Saved AWGN 64-QAM Data
-----
Saved Rayleigh QPSK Data
-----
Saved Rayleigh 16-QAM Data
```

## Functions

### Bit Error Rate Calculation for a Signal

```
function DataGeneration(N,Modulation,Channel,SNR,L,Normalise)

S = size(SNR,2);
C = size(L,2);

% For AWGN Channel
if Channel == "AWGN"
    % File Path
    dataDirectory = fullfile("../Data/" + string(Channel) + "/" + string(Modulation));
    mkdir(dataDirectory);

    for i = 1:S
        % Generating Modulated Data
        [tx,txModulated,SignalEnergy] = TransmissionData(N,Modulation,Normalise);

        snr = SNR(i);
        snrW = 10^(snr/10);
        % disp("SNR(in dB):" + string(SNR(i)) + " SNR:" + string(snr))

        % Transmission: Adding Noise
        rx = txModulated + (randn(N,1)+1i*randn(N,1))*sqrt(1/2)*sqrt(SignalEnergy/snrW);
        % disp(string(Channel) + " " + string(Modulation) + " " + string(snr))

        % Saving File
        fileName = fullfile(dataDirectory,sprintf("%sdB-SNR",string(snr)));
        save(fileName,"tx","txModulated","rx","snr");
    end
end

% For Rayleigh Channel
if Channel == "Rayleigh"
    % Channel Lengths
    for l = 1:C
        % ChannelModel: Modelling Channel
        ChannelLength = L(l);
        if ChannelLength == 2
            ChannelCoeff = [sqrt(0.8), sqrt(0.2)];
            ChannelModel = ChannelCoeff.*(randn(1,ChannelLength)+1i*randn(1,ChannelLength));
        elseif ChannelLength == 3
            ChannelCoeff = [sqrt(0.75), sqrt(0.2), sqrt(0.05)];
            ChannelModel = ChannelCoeff.*(randn(1,ChannelLength)+1i*randn(1,ChannelLength));
        end

        % File Path
        dataDirectory = fullfile("../Data/" + string(Channel) + "/" + string(ChannelLength));
        mkdir(dataDirectory);
    end
end
```

```

        mkdir(dataDirectory);

        for i = 1:S
            % Generating Modulated Data
            [tx,txModulated,SignalEnergy] = TransmissionData(N,Modulation,Normalise)

            snr = SNR(i);
            snrW = 10^(snr/10);
            % disp("SNR(in dB):" + string(SNR(i)) + " SNR:" + string(snr))

            % Transmisssion: Fading Effect of Channel and Adding Noise
            rx = conv(txModulated,ChannelModel,'same') + (randn(N,1)+1i*randn(N,1));
            % disp(string(Channel) + " " + string(Modulation) + " " + string(snr))

            % Saving File
            fileName = fullfile(dataDirectory,sprintf("%sdB-SNR",string(snr)));
            save(fileName,"tx","txModulated","rx","snr","ChannelLength");
        end
    end
end
disp("Saved " + string(Channel) + " " + string(Modulation) + " Data")
end

```

## Transmission Data Generation

```

function [tx,txModulated,SignalEnergy] = TransmissionData(N,Modulation,Normalise)
    % Generating Transmitter Signal
    if Modulation == "QPSK"
        tx = randi([0 3], N, 1);
    elseif Modulation == "16-QAM"
        tx = randi([0 15], N, 1);
    elseif Modulation == "64-QAM"
        tx = randi([0 63], N, 1);
    end

    % Modulation: Modulating Data and Scatter Plotting it
    if Modulation == "QPSK"
        qpskmod = comm.QPSKModulator();
        txModulated = qpskmod(tx);
        %scatterplot(txModulated);
        %grid on;
    elseif Modulation == "16-QAM"
        txModulated = qammod(tx,16);
        %scatterplot(txModulated);
        %grid on;
    elseif Modulation == "64-QAM"
        txModulated = qammod(tx,64);
        %scatterplot(txModulated);
        %grid on;
    end

    % Normalising Data
    % This makes Power of Signal = 1

```

```
if Normalise == true
    SignalEnergy = sqrt(mean(abs(txModulated).^2));
    txModulated = txModulated/SignalEnergy;
end

SignalEnergy = sqrt(mean(abs(txModulated).^2));
% disp("Energy of Signal = " + string(SignalEnergy));
end
```