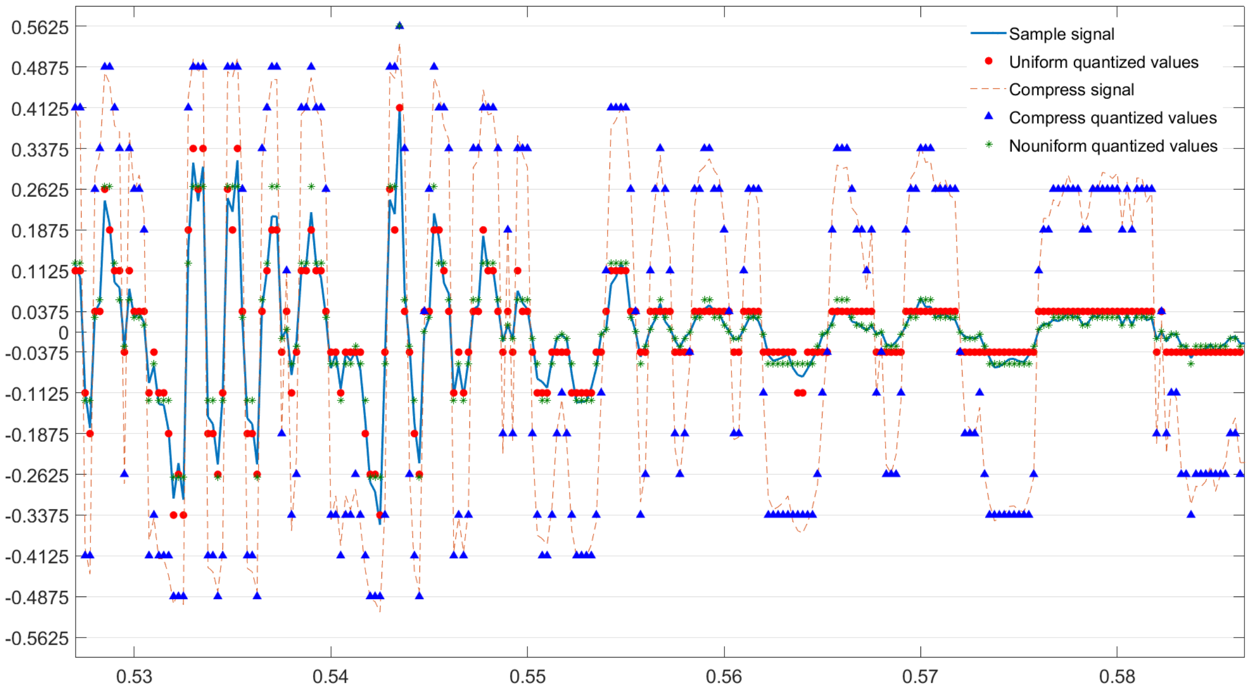
Project 1: A-Law and mu-Law Companding

1. Load a speech file with sample rate $F_s = 4000$.

   Fs = 4000;

   [mSpeech,Fs] = audioread("MaleSpeech-16-4-mono-20secs.wav");

2. Quantize the sample signal 'mSpeech' with $L = 16$, $q = V\_p/(L-1)$, called s_{q2} signal.
3. Plot 'mSpeech' and s_{q2}.
4. Calculate the quantizer error variance $\sigma^2_{s_{q2}}$ and the ratio of average signal power to average quantization noise power $(S/N)_{s_{q2}}$ by the numerical method.
5. Compress the sample signal 'mSpeech', called s_{c5}, with μ-law and A-law
6. Quantize the compressed signal s_{c5} with the same parameters as Step 2, called s_{q6}.
7. Expand the quantized signal s_{q6} in Step 5, called s_{e7}.
8. Plot s_{c4}, s_{q5}, s_{e6} in the same figure with mSpeech and s_{q2}.
9. Calculate $\sigma^2_{s_{e6}}$ and $(S/N)_{s_{e6}}$ by the numerical method and compare with the values in Step 4.



Code tham khảo

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clear;

% 1. Load speech signal
Fs = 4000;
[mSpeech,Fs] = audioread("MaleSpeech-16-4-mono-20secs.wav");
% sound(mSpeech,Fs)

% Consider the speech signal in 1.5s
t = 0:1/Fs:1.5;
plot(t,mSpeech(1:length(t)),'LineWidth',2);
hold on

% 2. Quantize the sample signal
L = 16; %the number of quantization levels
V_p = 0.5625; %the peak voltage of signal
% Determine the single quantile interval ?-wide
q = ????; % Use the exact equation

s_q_2 = quan_uni(mSpeech(1:length(t)),q); % Uniform quantization

% Plot the sample signal and the quantization signal
plot(t,s_q_2,'ro','MarkerSize',6,'MarkerEdgeColor','r','MarkerFace
Color','r');

% 3. Calculate the average quantization noise power,...
% the average power of the sample signal and SNR

e_uni = mSpeech(1:length(t)) - s_q_2; % error between sample
signal and quantized signal

pow_noise_uni = 0;
pow_sig = 0;
for i = 1:length(t)
    pow_noise_uni = pow_noise_uni + e_uni(i)^2;
    pow_sig = pow_sig + mSpeech(i)^2;
end

pow_noise_uni = ???;
pow_sig = ???;
SNR_a_uni = pow_sig/pow_noise_uni = ???;
```

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%--------compression-------------
% 5. Compress the sample signal 'mSpeech'
mu = ???; % or A = ???; use the standard value
y_max = V_p;
x_max = V_p;

% Replace the compress equation for u-law and A-law
% with x is the 'mSpeech' signal
s_c_5 = ...;

% Plot the compress signal;
plot(t,s_c_5);

% 6. Quantize the compress signal and plot the quantized signal
s_q_6 = quan_uni(s_c_5,q);

plot(t,s_q_6,'b^','MarkerSize',6,'MarkerEdgeColor','b','MarkerFace
Color','b');

% 7. Expand the quantized signal
s_e_7 = ...;

plot(t,s_e_7,'g*','MarkerSize',6,'MarkerEdgeColor','g','MarkerFace
Color','g');
legend('Sample signal','Uniform quantized values','Compress
signal',...
    'Compress quantized values','Nouniform quantized values');

% 9. Calculate the average quantization noise power,...
% the average power of the analog signal and SNR
e_com = mSpeech(1:length(t)) - s_e_7;

pow_noise_com = ???;
SNR_a_com = pow_sig/pow_noise_com = ???;


function quan_sig = quan_uni(sig,q)

    for i = 1:length(sig)
        quan_sig(i) = quant(sig(i),q);
        d = sig(i) - quan_sig(i);
        if d == 0
            quan_sig(i) = quan_sig(i) + q/2;
        elseif (d > 0) && (abs(d) < q/2)
            quan_sig(i) = quan_sig(i) + q/2;
        elseif (d > 0) && (abs(d) >= q/2)
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            quan_sig(i) = quan_sig(i) - q/2;
        elseif (d < 0) && (abs(d) < q/2)
            quan_sig(i) = quan_sig(i) - q/2;
        elseif (d < 0) && (abs(d) >= q/2)
            quan_sig(i) = quan_sig(i) + q/2;
        end
    end
end
```