```
%Code to apply Shannon Fano coding to a grayscale image
clc;
clear all;
close all;
I=imread("VK.jpg");
if size(I,3)==3
I=rgb2gray(I);
end
figure
imshow(I);
counts=imhist(I); %Finding frequency of each gray level intensity.
p=counts/sum(counts);
symbols=find(p>0)-1;
p=p(p>0); %Removing all zero probability gray levels.
[p_sorted,idx]=sort(p,'descend');
symbols_sorted=symbols(idx);
codes=strings(1,length(symbols_sorted));
%Creating an empty string array to store Shannon-Fano binary codes.
codes=shannon_fano(symbols_sorted,p_sorted,codes,1,length(p_sorted));
%Calling the recursive function that generates Shannon-Fano codes.
disp("Top 20 Shannon-Fano Codes for Image Symbols:");
disp("GrayLevel Probability Code");
disp("--------------------------------------");
for i=1:min(20,length(symbols_sorted))
fprintf("%3d %.6f %s\n", ...
symbols_sorted(i),p_sorted(i),codes(i));
end
%Displaying only the most frequent gray levels and their corresponding codes.
Lavg=0;
for i=1:length(p_sorted)
Lavg=Lavg+p_sorted(i)*strlength(codes(i));
end
%Computing the average code length using probability weighted sum.
H=0;
for i=1:length(p_sorted)
H=H-p_sorted(i)*log2(p_sorted(i));
end
%Applying Shannon entropy formula H=-Σ(p*log2(p)) for binary coding.

disp("--------------------------------------");
fprintf("Entropy(H)=%.4f bits/pixel\n",H);
fprintf("AverageCodeLength(Lavg)=%.4f bits/pixel\n",Lavg);
fprintf("CodingEfficiency=%.2f %%\n",(H/Lavg)*100);
%Efficiency indicates how close coding is to the theoretical entropy limit.
function codes=shannon_fano(symbols,p,codes,startIdx,endIdx)
if startIdx>=endIdx
return;
end
%Stopping recursion when only one symbol remains.
totalProb=sum(p(startIdx:endIdx));
%Calculating total probability of the current symbol group.
runningSum=0;
```

```
splitIdx=startIdx;
for i=startIdx:endIdx
runningSum=runningSum+p(i);
%Finding cumulative probability until it reaches half of total.
if runningSum>=totalProb/2
splitIdx=i;
break;
end
end
for i=startIdx:splitIdx
codes(i)=codes(i)+"0";
end
%Assigning binary 0 to the first probability subset.
for i=splitIdx+1:endIdx
codes(i)=codes(i)+"1";
end
%Assigning binary 1 to the second probability subset.
codes=shannon_fano(symbols,p,codes,startIdx,splitIdx);
codes=shannon_fano(symbols,p,codes,splitIdx+1,endIdx);
%Recursively repeating the splitting until all symbols get a unique code.
end
```

```
Top 20 Shannon-Fano Codes for Image Symbols:
GrayLevel Probability Code
--------------------------------------
 52 0.022100 000000
 53 0.021374 000001
 51 0.021225 000010
 54 0.019489 000011
 50 0.019160 000100
 49 0.016711 000101
 55 0.016364 00011
 48 0.014474 0010000
 56 0.012952 0010001
 47 0.012923 001001
 46 0.011657 001010
 45 0.010558 001011
 57 0.010253 0011000
 44 0.009945 0011001
 43 0.009747 001101
 42 0.009683 0011100
 41 0.009426 0011101
 40 0.009404 001111
 39 0.009139 0100000
 38 0.009032 0100001
--------------------------------------
Entropy(H)=7.3823 bits/pixel
AverageCodeLength(Lavg)=7.4459 bits/pixel
CodingEfficiency=99.15 %
```

Published with MATLAB® R2025b