```matlab
function proj07
% proj07
% uses the metropolis algorithm to decode a simple cypher
% Inputs: None
% Outputs: None
% Quan Le, CAAM 210, Fall 2019, Project 07
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% import strings
string1 = fileread('encodedtext1.txt');
string2 = fileread('encodedtext2.txt');
string3 = fileread('encodedtext3.txt');

% run the decoder on each encoded message
disp("decoded data" + newline)
disp("decoded encodedtext1.txt")
decoder(string1, 100000)
disp("decoded encodedtext2.txt")
decoder(string2, 100000)
disp("decoded encodedtext3.txt")
decoder(string3, 100000)
disp(newline)
end




function [message] = decoder(string,iter)
% [message] = decoder(string,iter)
% decodes an encoded message using a key mapping from the metropolis
% algorithm
% Inputs: string, an encoded message string
%         iter, the number of times to run the metropolis alg
% Outputs: message, the decoded message string


% generate the key using the metropolis algorithm
y = Metropolis(string,iter);

% construct the message
message = "";
len = length(string);
for char = string(1:(len-1)) % note that len-1 is used to exclude " '
 "
    yval = downlow(double(char));
    add = downlowinv(y(yval));
    message = message + add;
end

% replace ` with spaces
message = strrep(message,'`',' ');
end
```

```matlab
function [y] = Metropolis(string,trials)
% [y] = Metropolis(string,trials)
% generates a key for a simple cypher encoded message
% Inputs: string, an encoded message string
%         trials, the number of times to run the metropolis algorithm
% Outputs: y, the cypher key


% generate a completely random y
y = randperm(27);

% metropolis algotithm
for trial = 1:trials
    ymaybe = guess(y); % guess is a helper function, swaps two values
 in y
    proby = loglike(y, string);
    probymaybe = loglike(ymaybe, string);
    if probymaybe > proby
        y = ymaybe;
    else
        r = rand;
        threshold = exp(-loglike(y,string)+loglike(ymaybe,string));
        if r < threshold
            y = ymaybe;
        end
    end
end
end




function [ymaybe]=guess(y)
% [ymaybe]=guess(y)
% randomly swaps two elements in a cypher key, y
% Inputs: y, the initial cypher key
% Outputs: ymaybe, the edited cypher key


% swaps
ymaybe = y;
swap = randsample(27,2);
swap1 = y(swap(1));
swap2 = y(swap(2));
ymaybe(swap(1)) = swap2;
ymaybe(swap(2)) = swap1;
end

function [prob] = loglike(y, string)
% [prob] = loglike(y, string)
% finds the log-likelihood for a given y and string
% Inputs: y, the prospective cypher key
```

```matlab
%          string, the encoded message
% Outputs: prob, the log-likelihood of y and string


% load the letter transition probabilities
load("letterprob.mat");

% generate total probabilites
prob = 0;
for idx = 1:(length(string)-2) % iteration over character pairs
    char1 = string(idx);
    i = y(downlow(double(char1))); % conversion to code27
    char2 = string(idx+1);
    j = y(downlow(double(char2)));
    prob = prob+ log(letterprob(i,j));
end
end



function [code27] = downlow(ascii_num)
% [code27] = downlow(ascii_num)
% given an ascii code, it returns its equivalent in 1:27
% Inputs: ascii_num, the ascii representation of the character
% Outputs: code27, the representation of the character as an index in
%  1:27

code27 = ascii_num-95;
end



function [char_want] = downlowinv(code27)
% [char_want] = downlowinv(code27)
% given the code27 representation, it returns the character
% Inputs: code27, the representation of the character as an index in
%  1:27
% Outputs: char_want, the actual character

char_want = char(code27+95);
end
```

decoded data

decoded encodedtext1.txt

ans =

*   "ever since computers there have always been ghosts in the machine
 random segments of code that have grouped together to form unexpected
 protocols unanticipated these free radicals engender questions of
 free will creativity and even the nature of what we might call the
 soul why is it that when some robots are left in darkness they will
 seek out the light why is it that when robots are stored in an empty*

space they will group together rather than stand alone how do we explain this behavior random segments of code or is it something more when does a perceptual schematic become consciousness when does a difference engine become the search for truth when does a personality simulation become the bitter mote of a soul"

decoded encodedtext2.txt

ans =

"there is no strife no prequdice no national conflict in outer space as yet its hazards are hostile to us all its conjuest deserves the best of all mankind and its opportunity for peaceful cooperation many never come again but why some say the moon why choose this as our goal and they may well ask why climb the highest mountain why thirtyfive years ago fly the atlantic why does rice play texas we choose to go to the moon we choose to go to the moon in this decade and do the other things not because they are easy but because they are hard because that goal will serve to organize and measure the best of our energies and skills because that challenge is one that we are willing to accept one we are unwilling to postpone and one which we intend to win and the others too"

decoded encodedtext3.txt

ans =

"once upon a midnight dreary while i pondered weak and weary over many a quaint and curious volume of forgotten lore while i nodded nearly napping suddenly there came a tapping as of some one gently rapping rapping at my chamber door tis some visitor i muttered tapping at my chamber door only this and nothing more ah distinctly i remember it was in the bleak december and each separate dying ember wrought its ghost upon the floor eagerly i wished the morrow vainly i had sought to borrow from my books surcease of sorrow sorrow for the lost lenore for the rare and radiant maiden whom the angels name lenore nameless here for evermore and the silken sad uncertain rustling of each purple curtain thrilled me filled me with fantastic terrors never felt before so that now to still the beating of my heart i stood repeating tis some visitor entreating entrance at my chamber door some late visitor entreating entrance at my chamber door this it is and nothing more presently my soul grew stronger hesitating then no longer sir said i or madam truly your forgiveness i implore but the fact is i was napping and so gently you came rapping and so faintly you came tapping tapping at my chamber door that i scarce was sure i heard you here i opened wide the door darkness there and nothing more deep into that darkness peering long i stood there wondering fearing doubting dreaming dreams no mortal ever dared to dream before but the silence was unbroken and the darkness gave no token and the only word there spoken was the whispered word lenore this i whispered and an echo murmured back the word lenore merely this and nothing more back into the chamber turning all my soul within me burning soon again i heard a tapping somewhat louder than before surely said i surely that is something

at my window lattice let me see then what thereat is and this mystery
explore let my heart be still a moment and this mystery explore tis
the wind and nothing more   open here i flung the shutter when with
many a flirt and flutter in there stepped a stately raven of the
saintly days of yore not the least obeisance made he not a minute
stopped or stayed he but with mien of lord or lady perched above
my chamber door perched upon a bust of pallas just above my chamber
door perched and sat and nothing more then this ebony bird beguiling
my sad fancy into smiling by the grave and stern decorum of the
countenance it wore though thy crest be shorn and shaven thou i said
art sure no craven ghastly grim and ancient raven wandering from the
nightly shore tell me what thy lordly name is on the nights plutonian
shore   quoth the raven nevermore much i marvelled this ungainly fowl
to hear discourse so plainly though its answer little meaning little
relevancy bore for we cannot help agreeing that no living human being
ever yet was blessed with seeing bird above his chamber door bird or
beast above the sculptured bust above his chamber door with such name
as nevermore but the raven sitting lonely on the placid bust spoke
only that one word as if his soul in that one word he did outpour
nothing further then he uttered not a feather then he fluttered till
i scarcely more than muttered other friends have flown before on the
morrow he will leave me as my hopes have flown before then the bird
said nevermore startled at the stillness broken by reply so aptly
spoken doubtless said i what it utters is its only stock and store
caught from some unhappy master whom unmerciful disaster followed
fast and followed faster till his songs one burden bore till the
dirges of his hope that melancholy burden bore of   nevernevermore
but the raven still beguiling all my sad soul into smiling straight
i wheeled a cushioned seat in front of bird and bust and door then
upon the velvet sinking i betook myself to linking fancy unto fancy
thinking what this ominous bird of yore what this grim ungainly
ghastly gaunt and ominous bird of yore meant in croaking nevermore
this i sat engaged in guessing but no syllable expressing to the
fowl whose fiery eyes now burned into my bosoms core this and more
i sat divining with my head at ease reclining on the cushions velvet
lining that the lamplight gloated oer but whose velvet violet lining
with the lamplight gloating oer she shall press ah nevermore   then
methought the air grew denser perfumed from an unseen censer swung
by seraphim whose footfalls tinkled on the tufted floor wretch i
cried thy god hath lent thee by these angels he has sent thee respite
respite and nepenthe from thy memories of lenore   quaff oh quaff this
kind nepenthe and forget this lost lenore   quoth the raven nevermore
prophet   said i thing of evil prophet still if bird or devil   whether
tempter sent or whether tempest tossed thee here ashore desolate yet
all undaunted on this desert land enchanted on this home by horror
haunted tell me truly i implore is there is there balm in gilead
tell me tell me i implore   quoth the raven nevermore prophet   said
i thing of evil   prophet still if bird or devil by that heaven that
bends above us by that god we both adore tell this soul with sorrow
laden if within the distant aidenn it shall clasp a sainted maiden
whom the angels name lenore clasp a rare and radiant maiden whom the
angels name lenore quoth the raven nevermore be that word our sign
of parting bird or fiend   i shrieked upstarting get thee back into
the tempest and the nights plutonian shore   leave no black plume

as a token of that lie thy soul hath spoken leave my loneliness
unbroken quit the bust above my door take thy beak from out my
heart and take thy form from off my door quoth the raven nevermore
and the raven never flitting still is sitting still is sitting on the
pallid bust of pallas just above my chamber door and his eyes have
all the seeming of a demons that is dreaming and the lamplight oer
him streaming throws his shadow on the floor and my soul from out
that shadow that lies floating on the floor shall be lifted nevermore
"