Part b

Develop, exhibit, and explain code that applies your chosen method from part (a) to the minimisation of the Eggholder function, described at

`https://en.wikipedia.org/wiki/Test_functions_for_optimization`

You may call Matlab toolboxes (or Python packages) without explaining how they work internally.

Eggholder function:

$$f(x, y) = -(y + 47)\sin\sqrt{\left|\frac{x}{2} + (y + 47)\right|} - x\sin\sqrt{|x - (y + 47)|}$$

Subject to constraints:

$$-512 \le x, y \le 512$$

The genetic algorithm is implemented in matlab using the following function:

```
[x,fval,exitflag] = ga(fun,nvars,A,b,Aeq,beq,lb,ub,nonlcon,intcon,options)
```

```matlab
% Define the eggholder function such that x,y == x(1),x(2)
fun = @(x) -(x(2)+47)*sin(sqrt(abs(x(1)/2 + (x(2)+47)))) - ...
    x(1)*sin(sqrt(abs(x(1)-(x(2)+47))));

% Specify the number of variables
nvars = 2;

% There are no equality or inequality constraints for the eggholder function
A=[]; b=[]; Aeq=[]; beq=[];

% Define upper and lower bounds
lb = [-512 -512];
ub = [512 512];

% There no non linear or integer conditions
nonclon=[]; intcon=[];

% After experimenting with the funtion, the following hyperparameters have been found:
options = optimoptions('ga',...
   'ConstraintTolerance',1e-6, ...
   ...% Increases accuracy of model
   'PopulationSize',1000, ...
   ...% Increasing agents takes longer but increases likelihood of finding global minimum
   'EliteCount', 1, ...
   ...% Defaults to higher value and causes premature convergence
   'MutationFcn', {@mutationuniform, 1});
    % Using a mutation function prevents premature convergence
```

```matlab
% Run the algorithm a number of times to ensure global minimum is found
optimal = inf;
for i = 1:100
    [x,fval,exitflag,output] = ga(fun,2,A,b,Aeq,beq,lb,ub,nonclon,intcon,options);
    if fval < optimal
        % Save the optimal values
        optimal = fval;
        x_optimal = x;
        % Saves the seed state for plotting
        rngstate = output.rngstate;
    end
end

fprintf('The minimum value is %.3f, located at (%.3f, %.3f', optimal,...
    x_optimal(1), x_optimal(2))
```

The minimum value is -959.639, located at (512.000, 404.200