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Problem 3

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```
clear all;
clc;
```

Given

How long does it take to climb a mountain? Let $z(x,y) = -0.1e^{y-(x-1)^2}sin(3\pi y/2)$

```
z_formula = @(x, y) -0.1.*exp(y-(x-1).^2).*sin(3*pi/2.*y);
```

The X and Y values of the different steps are given in the file hiking_trail.mat.

```
load hiking_trail.mat
```

Assume that your velocity is given by $v = e^{-m}$ where m is the slope.

```
vel = @(m) exp(-m);
```

Solve

Assume that the travel time is given by: $t = \Sigma \frac{\sqrt{\Delta x^2 + \Delta y^2 + \Delta z^2}}{e^{-m}}$ First thing to do is to solve for the z values at any (x,y) pair.

```
Z = z_formula(X, Y);
```

Now we can calculate the finite differences of X, Y, and Z.

```
stepX = X(2:end)- X(1:end-1);
stepY = Y(2:end)- Y(1:end-1);
stepZ = Z(2:end)- Z(1:end-1);
```

Once we have the finite differences in each of the vectors we can calculate a linear approximation of the slop at each step.

$$m = \frac{rise}{run} = \frac{\Delta z}{\sqrt{\Delta X^2 + \Delta y^2}}$$

```
stepS = sqrt(stepX.^2 + stepY.^2);  % chord length at each step
stepSlope = stepZ ./ stepS;
```

Now that we have the slope we can calculate the velocity at each step.

```
stepVelocity = exp(-stepSlope);
```

The total distance traveled on each step is the 3D pythagorean theorum.

```
stepDistance = sqrt(stepX.^2+stepY.^2+stepZ.^2);
```

The velocity of a point is defined as: $v = \frac{dist}{time}$ Rearranging: $t = \Sigma \frac{\Delta X}{\Delta v}$

```
stepTime = stepDistance ./ stepVelocity;
time = sum(stepTime);

display(time);
```

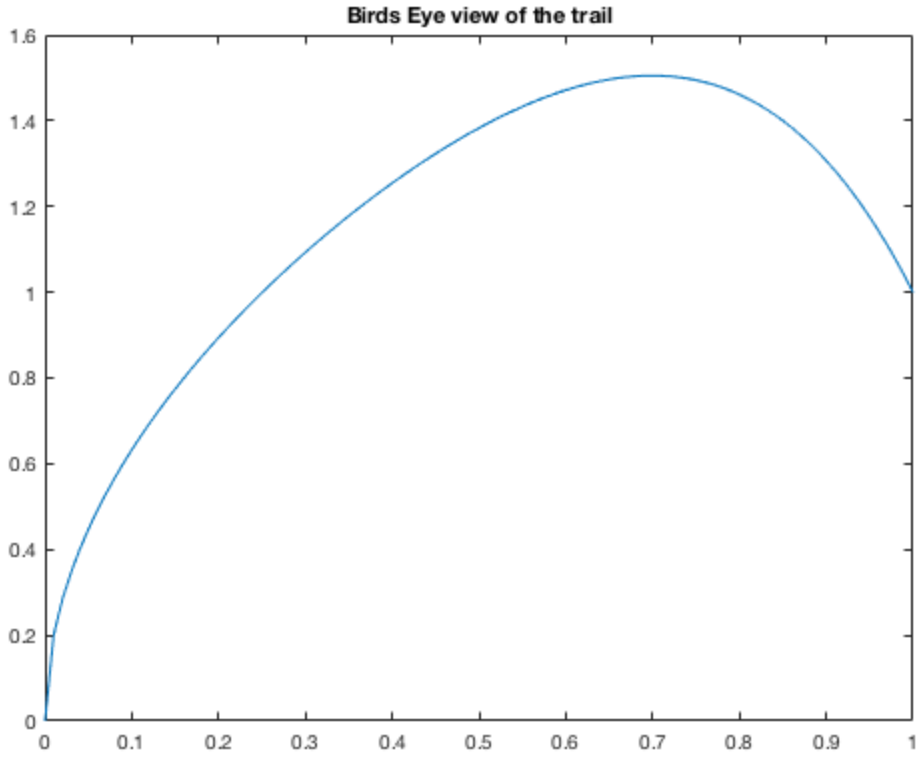
```
time =

    4.6848
```

Unfortunately, because we are not given any units for this problem we can't verify if this generally makes sense as an answer. Instead, let's make some pretty pictures.

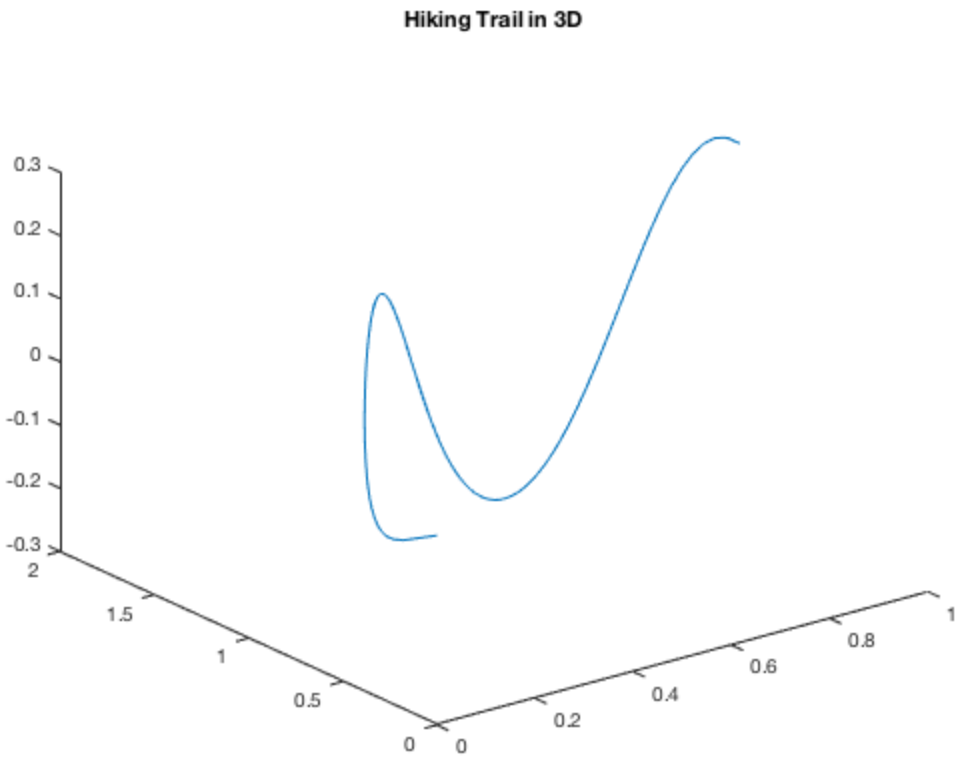
Bird's Eye View

```
plot(X, Y);
title('Birds Eye view of the trail');
```



3D Plot

```
plot3(X, Y, Z);
title('Hiking Trail in 3D');
```



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