APPM 2350 Project #2

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3 Defining the Mountain Range

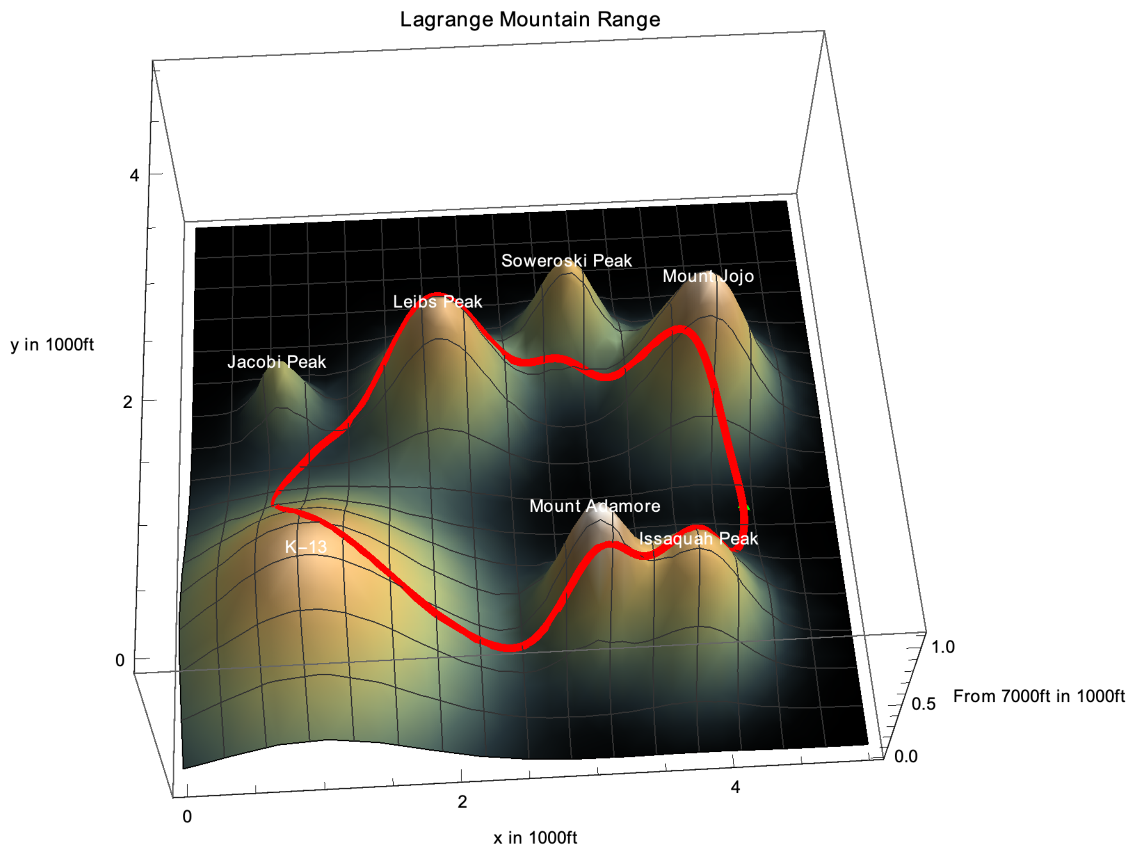
```
In[]:= mR = {{{1, 1}, 1, .9, "K-13"},
    {{3, 1}, 3, 1, "Mount Adamore"}, {{3.75, 1}, 2, .8, "Issaquah Peak"},
    {{4, 3}, 2, 1, "Mount Jojo"}, {{3, 3.5}, 3, .75, "Soweroski Peak"},
    {{2, 3}, 2, .9, "Leibs Peak"}, {{.75, 3}, 4, .5, "Jacobi Peak"}};

gaussian[ϵ_, r_] = E^(-(ϵ * r)^2);
m[x_, y_] := Sum[mR[[i, 3]] * gaussian[mR[[i, 2]],
     Sqrt[(Sqrt[(mR[[i, 1, 1]] - x)^2 + (mR[[i, 1, 2]] - y)^2])^2]], {i, 7}];
mountainLabels = Table[Graphics[{White, Text[mR[[i, 4]], mR[[i, 1]]]}], {i, 7}];
mountainLabels3D = Table[Graphics3D[{White, Text[mR[[i, 4]],
      {mR[[i, 1, 1]], mR[[i, 1, 2]], m[mR[[i, 1, 1]], mR[[i, 1, 2]]]}]}], {i, 7}];

mountainPlot3D = Plot3D[m[x, y], {x, 0, 5}, {y, 0, 5},
   AxesLabel -> {"x in 1000ft", "y in 1000ft", "From 7000ft in 1000ft"},
   PlotLabel -> "Lagrange Mountain Range", ColorFunction -> "GreenBrownTerrain"];

mountainContour =
  ContourPlot[m[x, y], {x, 0, 5}, {y, 0, 5}, PlotLegends -> Automatic,
   ColorFunction -> "Rainbow", Frame -> {True, True, False, False},
PlotLabel -> "Lagrange Mountain Range Contour", Contours -> 20,
   FrameLabel -> {"x in 1000ft", "y in 1000ft"}];
```

4 Analyzing the Mountain Range

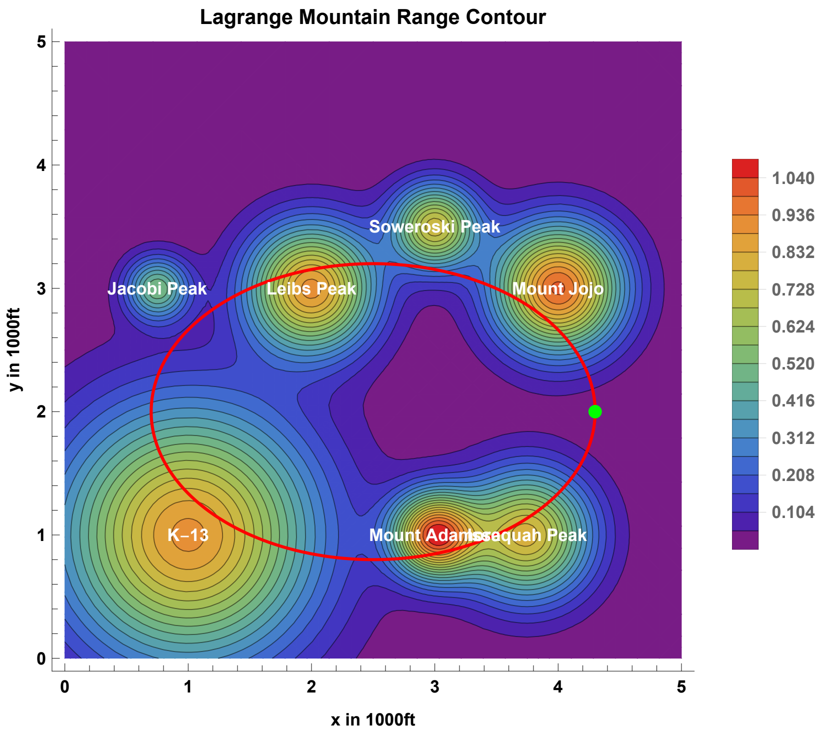
Plotting Paths

In[ ]:=
```
mt[t_] := Sum[mR[[i, 3]] *
    gaussian[mR[[i, 2]], Sqrt[(Sqrt[(mR[[i, 1, 1]] - (2.5 + 1.8 Cos[4 t]))^2 +
          (mR[[i, 1, 2]] - (2 + 1.2 Sin[4 t]))^2])^2]], {i, 7}];

r[t_] = {2.5 + 1.8 Cos[4 t], 2 + 1.2 Sin[4 t]};
r3D[t_] := {2.5 + 1.8 Cos[4 t], 2 + 1.2 Sin[4 t], mt[t]};

path3D = ParametricPlot3D[r3D[t], {t, 0, π/2}, PlotStyle -> {Red, Thickness[.01]}];
path = ParametricPlot[r[t], {t, 0, π/2}, PlotStyle -> Red];

point3D = Graphics3D[{PointSize[Large], Green, Point[r3D[0]]}];
point = Graphics[{PointSize[Large], Green, Point[r[0]]}];

Show[{mountainPlot3D , path3D, point3D, mountainLabels3D}]
Show[{mountainContour, path  , point, mountainLabels}]
```

Out[ ]=



Out[•]=



Honey Badger

In[•]:=
```
gradM[x_, y_] = Grad[m[x, y], {x, y}];
(* a = Table[Graphics3D[Arrow[Tube[{r3D[t],r3D[t]+gradr3D[t]}]]],{t,0,π/2,π/30}];
Show[{mountainPlot3D  ,path3D,point3D,a}]
*)

Dot[gradM[2.5 + 1.8 Cos[π], 2 + 1.2 Sin[π]], Normalize[r'[π / 4]]]
mt'[π / 4]
```

Out[•]= 0.605035

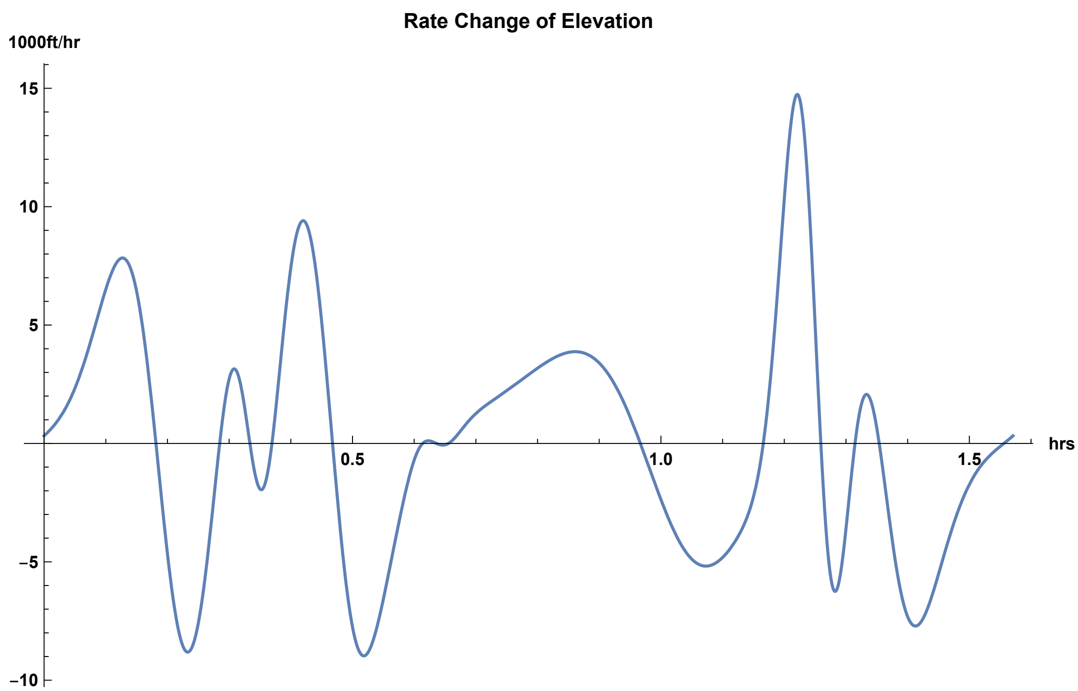
Out[•]= 2.90417

Change of Elevation

In[•]:=
```
Maximize[{mt'[t], t >= 0}, t]
Minimize[{mt'[t], 0 <= t <= π/2}, t]
Plot[mt'[t], {t, 0, π/2},
 PlotLabel -> "Rate Change of Elevation", AxesLabel -> {"hrs", "1000ft/hr"}]
```

Out[•]= {14.7402, {t → 1.22109}}

Out[•]= {-8.97206, {t → 0.51835}}

Out[•]=


In[•]:=
```
1.221086074164095 * 60
0.5183504795465874` * 60
```

Out[•]= 73.2652

Out[•]= 31.101

Highest Elevation

In[∘]:=
```
gradMount[x_, y_] := {16. E^(-16 ((0.75 - x)^2 + (3 - y)^2)) (0.75 - x) +
    1.8 E^(-(1 - x)^2 - (1 - y)^2) (1 - x) + 7.2 E^(-4 ((2 - x)^2 + (3 - y)^2)) (2 - x) +
    18 E^(-9 ((3 - x)^2 + (1 - y)^2)) (3 - x) + 13.5 E^(-9 ((3 - x)^2 + (3.5 - y)^2)) (3 - x) +
    6.4 E^(-4 ((3.75 - x)^2 + (1 - y)^2)) (3.75 - x) +
    8 E^(-4 ((4 - x)^2 + (3 - y)^2)) (4 - x), 1.8 E^(-(1 - x)^2 - (1 - y)^2) (1 - y) +
    18 E^(-9 ((3 - x)^2 + (1 - y)^2)) (1 - y) + 6.4 E^(-4 ((3.75 - x)^2 + (1 - y)^2)) (1 - y) +
    16. E^(-16 ((0.75 - x)^2 + (3 - y)^2)) (3 - y) +
    7.2 E^(-4 ((2 - x)^2 + (3 - y)^2)) (3 - y) + 8 E^(-4 ((4 - x)^2 + (3 - y)^2)) (3 - y) +
    13.5 E^(-9 ((3 - x)^2 + (3.5 - y)^2)) (3.5 - y)};
carR[x_, y_] := (x - 2.5)^2/3.24 + (y - 2)^2/1.44;
gradR[x_, y_] := {0.6172839506172839 (-2.5 + x), 1.3888888888888888 (-2 + y)};

FindRoot[{gradMount[x, y] == λ * gradR[x, y], carR[x, y] == 1},
 {{λ, -1}, {x, 3}, {y, 1}}]

(*Plot[mt[t],{t,0,π/2}]*)
m[3.074084653389694, 0.8626684621463107]
```

Out[∘]= {λ → -1.34201, x → 3.07408, y → 0.862668}

Out[∘]= 0.934484

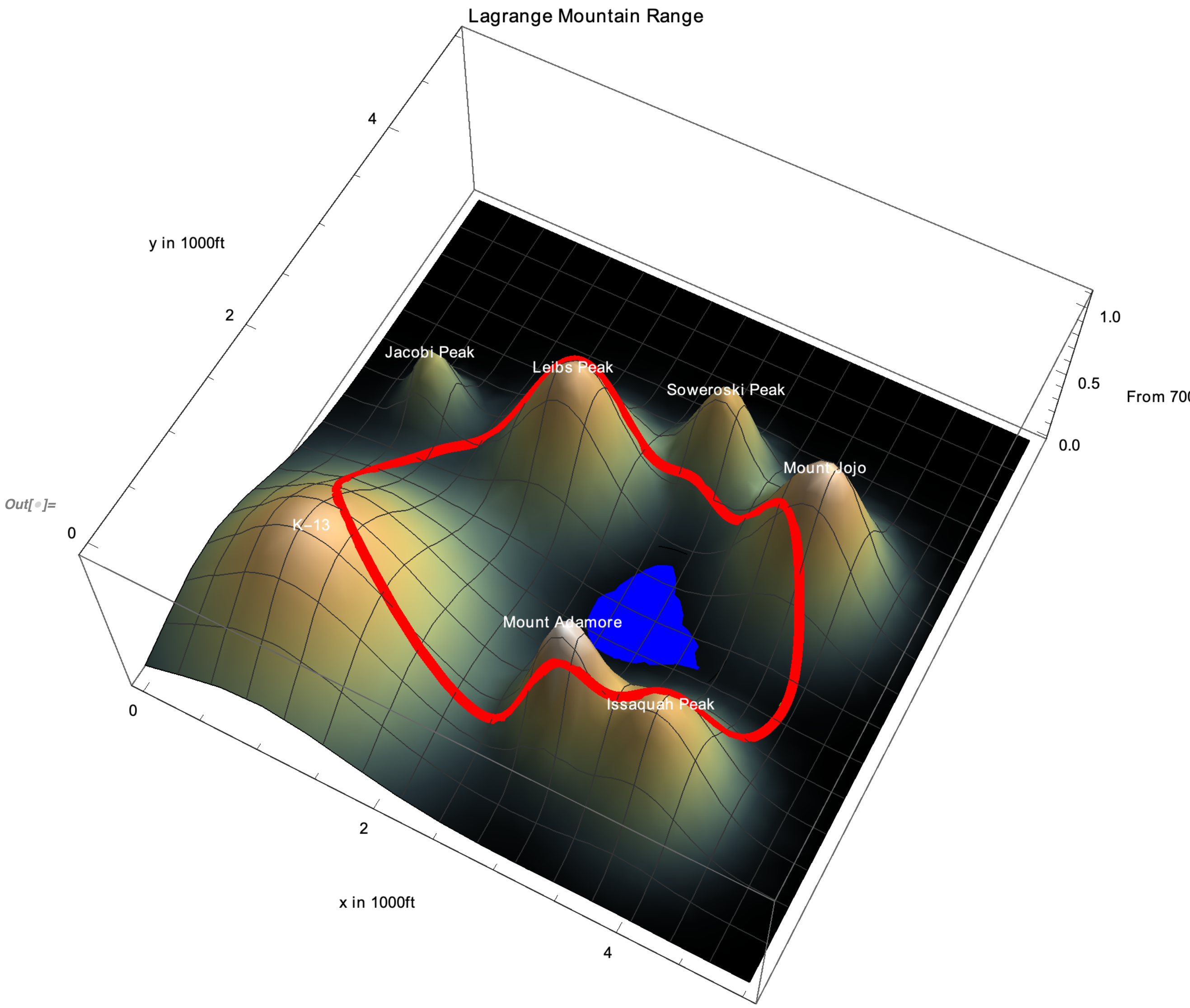
Thus the highest point is at 7934 ft above sea level.

Lake Mochi

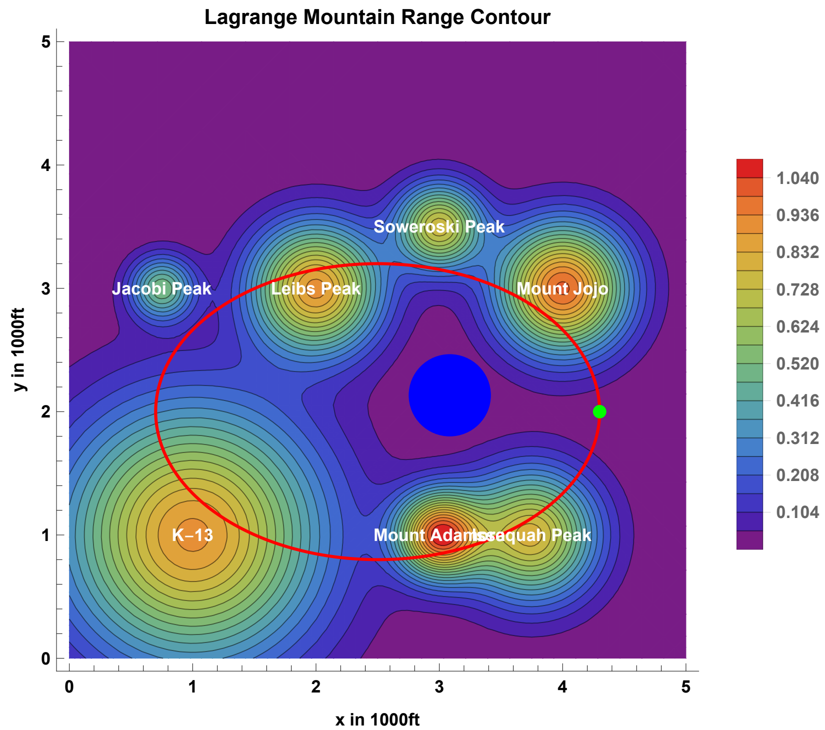
In[∘]:=
```
FindRoot[gradMount[x, y] == 0 , {{x, 3}, {y, 2}}]

mochi = Graphics[{Blue, Disk[{3.084891978358271, 2.1326960054211934}, 1/3]}];
mochi3D = Graphics3D[{Blue, Cylinder[{{3.084891978358271, 2.1326960054211934, 0},
      {3.084891978358271, 2.1326960054211934, 0.025}}, 2/3]}];

Show[{mountainPlot3D , path3D, point3D, mochi3D, mountainLabels3D}]
Show[{mountainContour, path  , point , mochi, mountainLabels}]
```

Out[∘]= {x → 3.08489, y → 2.1327}

Out[•]=


Lagrange Mountain Range
y in 1000ft
4
2
0
Jacobi Peak
Leibs Peak
Soweroski Peak
Mount Jojo
K–13
Mount Adamore
Issaquah Peak
1.0
0.5
0.0
From 70(
0
2
4
x in 1000ft

Out[•]=



Rock inside of trail

In[•]:=
```
NIntegrate[1, {x, 0.7, 4.3},
   {y, 0.06666666666666667 (30. - 1. Sqrt[-301. + 500. x - 100. x^2]),
    0.06666666666666667 (30. + Sqrt[-301. + 500. x - 100. x^2])},
   {z, -7, m[x, y]}] * 1000^3
```

Out[•]= 4.9366×10^{10}

In[•]:=

Clairautnium

In[•]:=
```
delta[x_, y_, z_] := E^(-.25 ((x - 2.5)^2 + (y - 2.5)^2 + (z - .2)^2));
NIntegrate[delta[x, y, z], {x, 0, 5}, {y, 0, 5}, {z, 0, m[x, y]}] * 1000^-3
```

Out[•]= 2.51448×10^{-9}

For Intro

In[•]:=
```
delta[x_, y_, z_] := E^(-.25 ((x - 2.5)^2 + (y - 2.5)^2 + (z - .2)^2));
NIntegrate[delta[x, y, z], {x, 0, 5}, {y, 0, 5}, {z, 0, m[x, y]}]
ArcLength[r3D[t], {t, 0, π/2}]
```

Out[•]= 2.51448

Out[•]= 11.8138

In[•]:=
```
NIntegrate[Abs[mt'[t]], {t, 0, π/2}] * 1000
```

Out[•]= 6032.68

EC

In[1]:=
```
(* All of the Radial Functions *)
aussian[a_, r_] := e^(-(a*r)^2);
multiquadric[a_, r_] := Sqrt[1 + (a*r)^2];
inverseQuadratic[a_, r_] := 1/(1 + (a*r)^2);
inverseMultiquadric[a_, r_] := 1/Sqrt[1 + (a*r)^2];

gau[l_, a_, x_, y_, xBar_, yBar_]  :=
  l * aussian[a, Sqrt[(Sqrt[(xBar - x)^2 + (yBar - y)^2])^2]];
invM[l_, a_, x_, y_, xBar_, yBar_]  :=
  l * inverseMultiquadric[a, Sqrt[(Sqrt[(xBar - x)^2 + (yBar - y)^2])^2]];
mult[l_, a_, x_, y_, xBar_, yBar_]  :=
 l * multiquadric[a, Sqrt[(Sqrt[(xBar - x)^2 + (yBar - y)^2])^2]];
invQ [l_, a_, x_, y_, xBar_, yBar_] :=
 l * inverseQuadratic[a, Sqrt[(Sqrt[(xBar - x)^2 + (yBar - y)^2])^2]];

funcTable[i_, l_, a_, x_, y_, xBar_, yBar_] :=
  Switch[i, 1, gau[l, a, x, y, xBar, yBar], 2, invQ[l, a, x, y, xBar, yBar],
   3, invM[l, a, x, y, xBar, yBar], 4, mult[l, a, x, y, xBar, yBar]];

(*
  List of point {{xMiddle,yMiddle},{epsilon},{lambda},{plot function}}
 plot function:
  1:gaussian
   2:inverseQuadratic
   3:inverseMultiquadric
   4:multiquadric
*)

ecMount = Table[Table[{{Random[Real, {0, 5}, 3], Random[Real, {0, 5}, 3]},
     Random[Real, {1, 5}, 3], Random[Real, {-.5, 3}, 3], Random[Integer, {1, 3}]},
    {k, Random[Integer, {10, 40}]}], {m, 50}];

ecM[x_, y_, j_] :=
  Sum[funcTable[ecMount[[j, i, 4]], ecMount[[j, i, 3]], ecMount[[j, i, 2]], x, y,
    ecMount[[j, i, 1, 1]], ecMount[[j, i, 1, 2]]], {i, Length[ecMount[[j]]]}];

allPlots = Table[Plot3D[ecM[x, y, n], {x, 0, 5}, {y, 0, 5},
   PlotRange → All, ColorFunction -> "GreenBrownTerrain"], {n, 50}]
```

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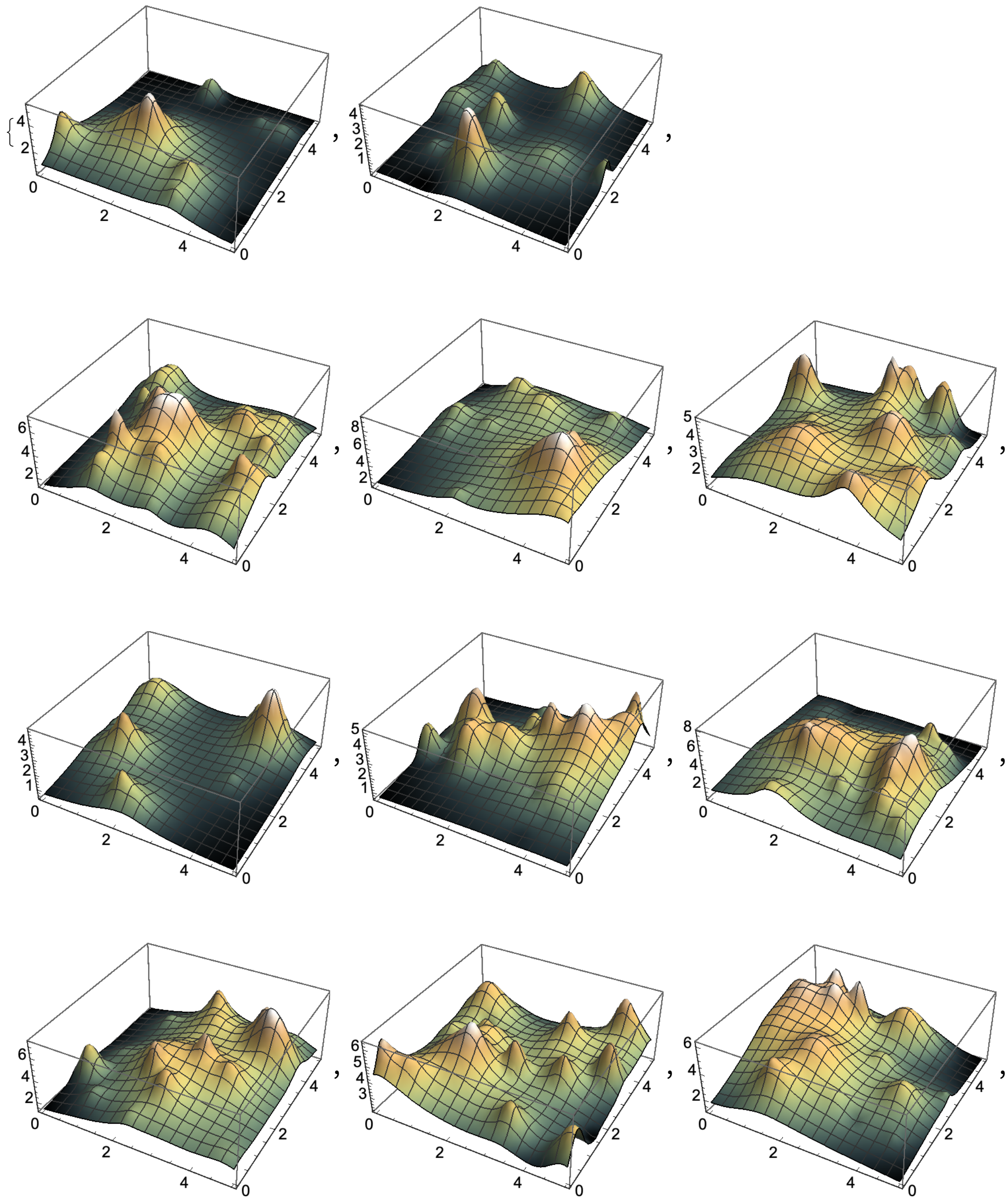
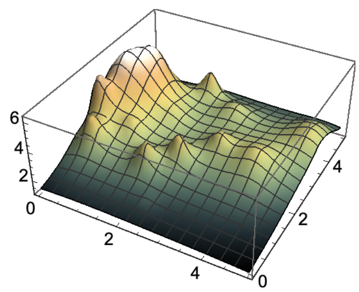
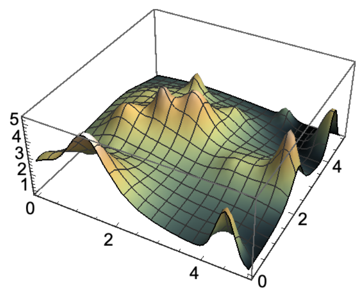
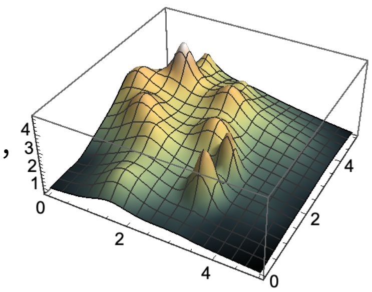
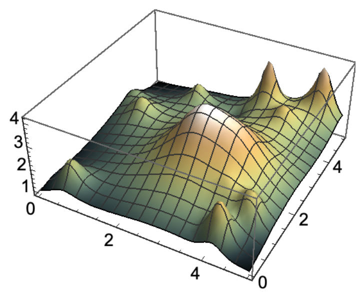
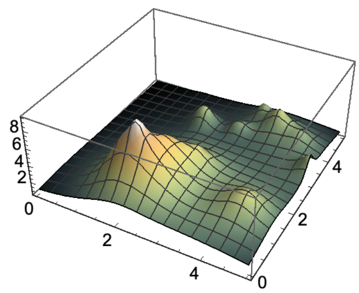
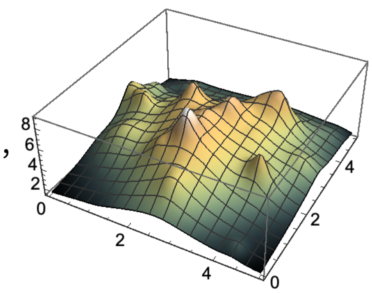
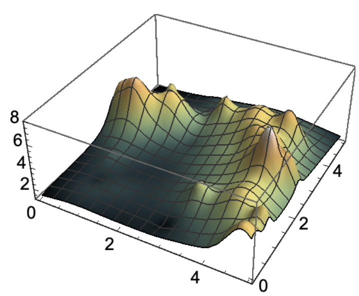
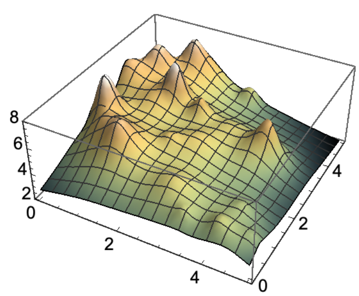
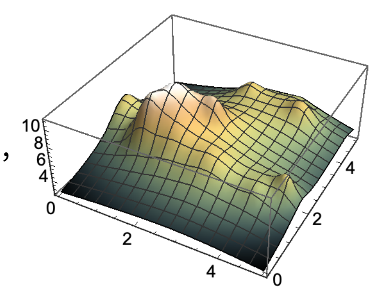
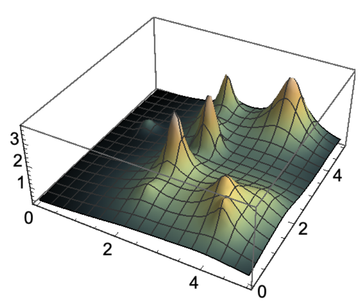
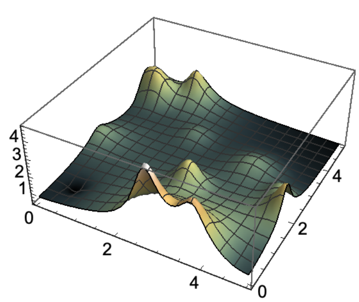
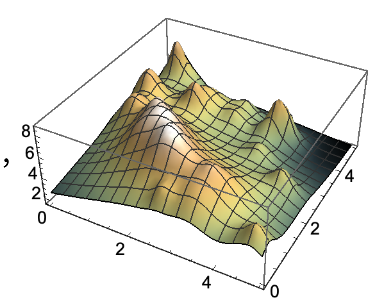
Out[11]=

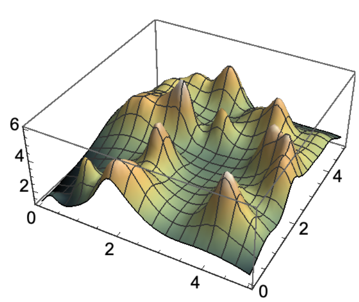
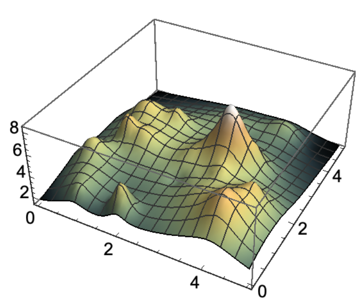
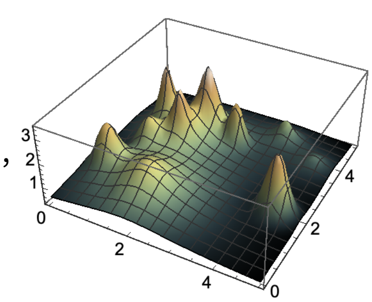


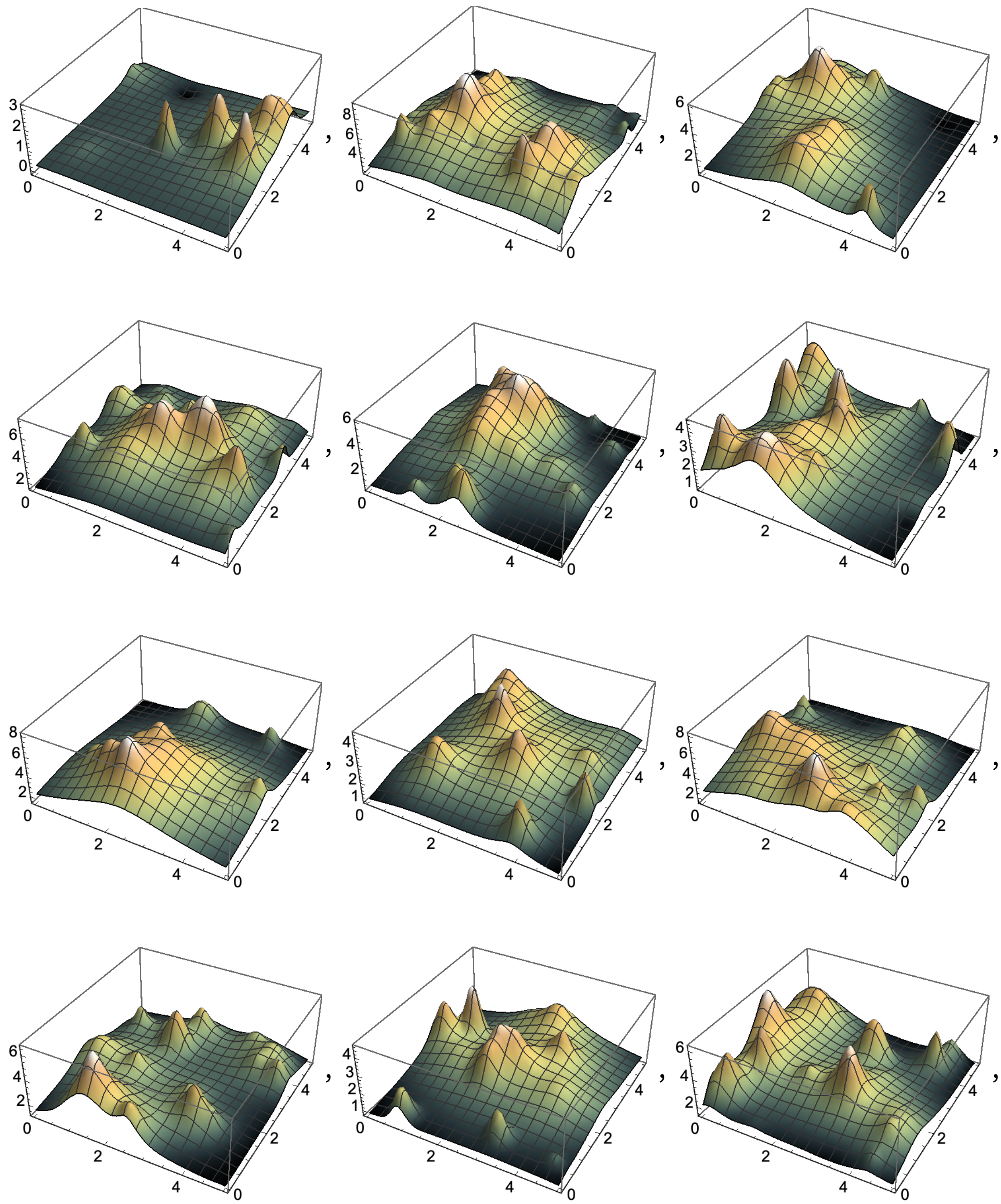
, , ,

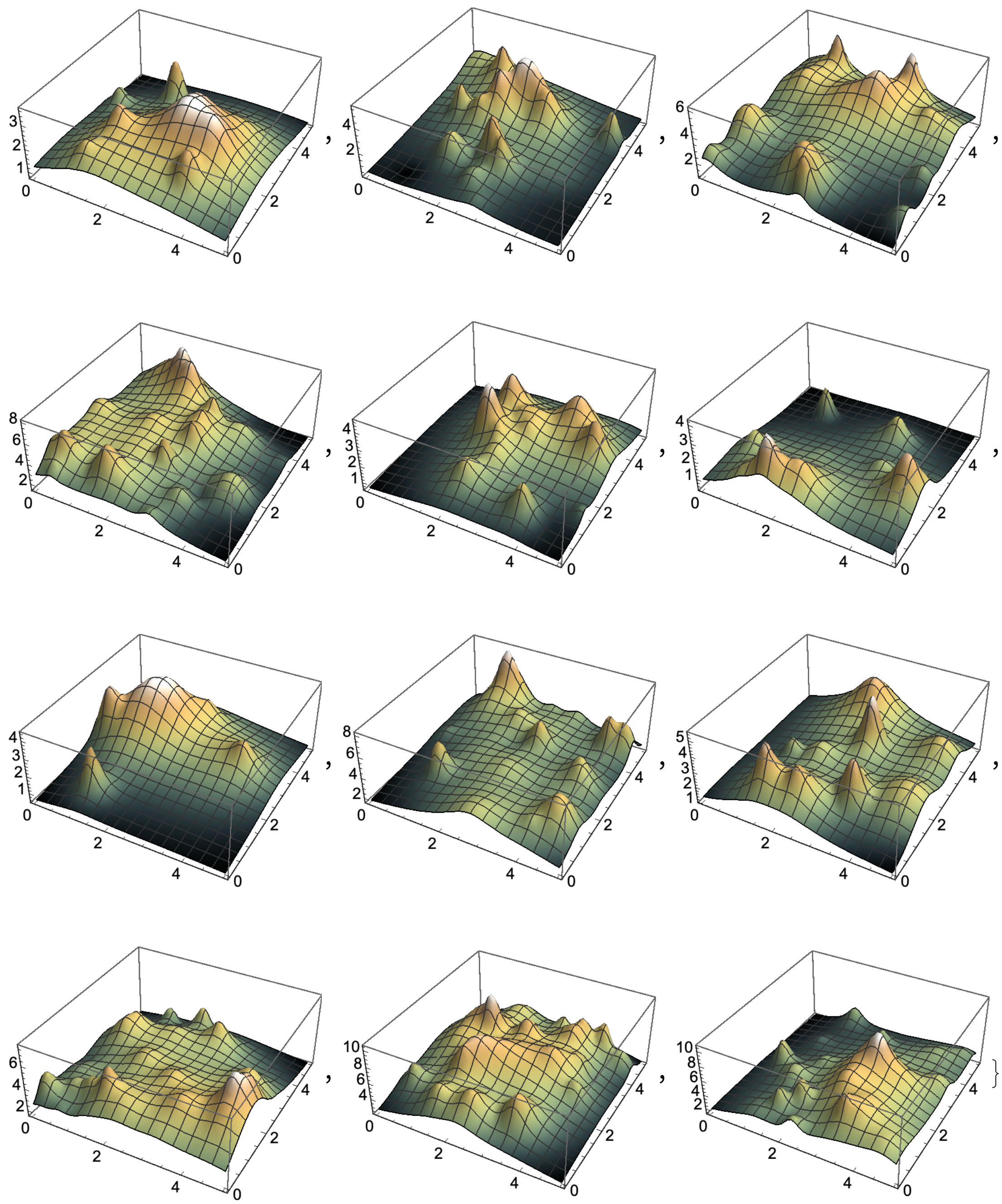
, , ,

, , ,

, , ,

, , ,





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