Travelling salesman problem

Problem setup

Random cities on a square:

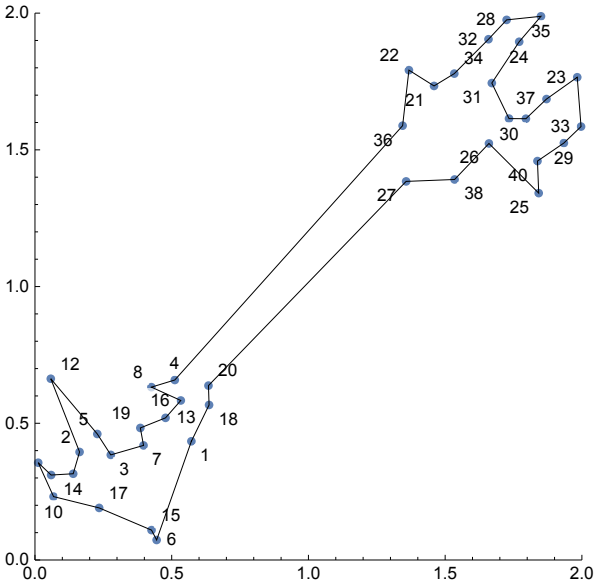
```
distribution = "TwoSquares";
n = 40;
xmin = 0.0; xmax = 2.0;
ymin = 0.0; ymax = 2.0;
If[distribution == "Random",
  cities = Table[{RandomReal[{xmin, xmax}], RandomReal[{ymin, ymax}]}, n]
 ];
If[distribution == "Circle",
  {x0, y0} = {(xmin + xmax) / 2, (ymin + ymax) / 2};
  r = (xmax - xmin) / 2;
  cities = Table[{x0 + r * Cos[i * 2 * π / n], y0 + r * Sin[i * 2 * π / n]}, {i, 1, n}]
 ];
If[distribution == "TwoSquares",
  cities = Table[{RandomReal[{xmin, xmax / 3}], RandomReal[{ymin, ymax / 3}]}, n / 2];
  cities = Join[cities,
    Table[{RandomReal[{2 xmax / 3, xmax}], RandomReal[{2 ymax / 3, ymax}]}, n / 2]]
 ];
distances = DistanceMatrix[cities];
(* NumberForm[MatrixForm[distances],3] *)
```

Efficient built-in algorithm to find the shortest tour in Mathematica

In[1064]:=
```
shortest = FindShortestTour[cities];
Print["The length of the shortest tour is ", shortest[[1]]];
Show[{ListPlot[Table[Labeled[cities[[i]], i], {i, 1, n}], PlotStyle → PointSize[Medium],
    PlotRange → {{xmin, xmax}, {ymin, ymax}}, AspectRatio → 1],
  Graphics[Line[cities[[shortest[[2]]]]]]}]
```

```
The length of the shortest tour is 7.568897008
```

Out[1066]=



Approximative solution using thermodynamic Monte Carlo method

Simple algorithm - just switch two random cities and use Metropolis to accept or reject a new tour

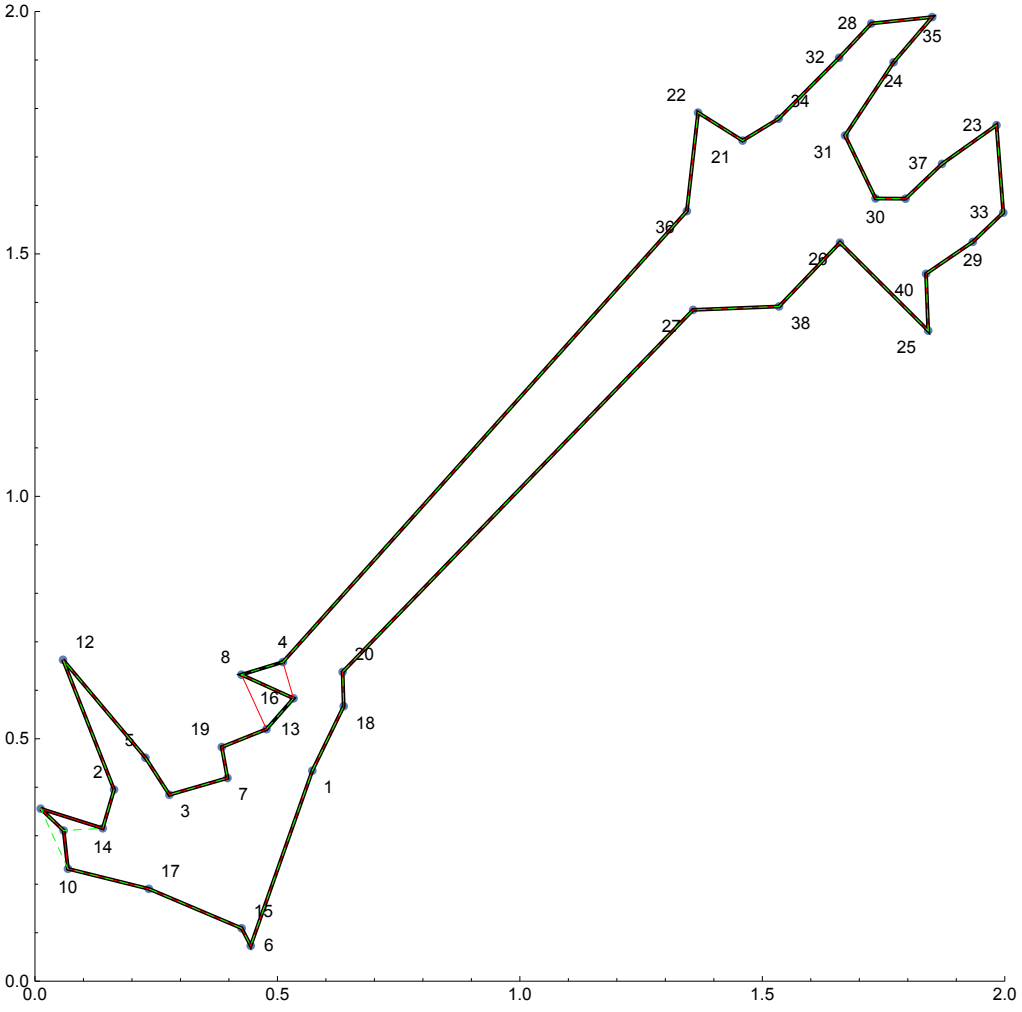
In[1434]:=
```
nIter = 40 000;
initialPerm = RandomSample[Range[n]]; (* shortest[[2,1;;n]]; *)
temp = 0.03;
{shortestDist, shortestPerm, totalDistances, savedPerm} =
  MCSolutionOfTSP[cities, distances, initialPerm, temp, nIter, "Cerny"];
temp = 0.01;
{shortestDist, shortestPerm, totalDistances, savedPerm} =
  MCSolutionOfTSP[cities, distances, shortestPerm, temp, nIter, "Cerny"];
nSave = Length[savedPerm];
Print["Shortest tour found (black) is ", shortestDist,
  ", but the actual shortest tour (green) is ", shortest[[1]]];
Show[{ListPlot[Table[Labeled[cities[[i]], i], {i, 1, n}], PlotStyle → PointSize[Medium],
    PlotRange → {{xmin, xmax}, {ymin, ymax}}, AspectRatio → 1],
  Graphics[{Thick, Black, Line[cities[[Append[shortestPerm, shortestPerm[[1]]]]]],
    Thin, Red, Line[cities[[Append[Last[savedPerm], Last[savedPerm][[1]]]]]],
    Thin, Dashed, Green, Line[cities[[shortest[[2]]]]]}]}]
ListPlot[totalDistances, PlotRange → All]
```

```
Total permutations rejected: 39 115
```

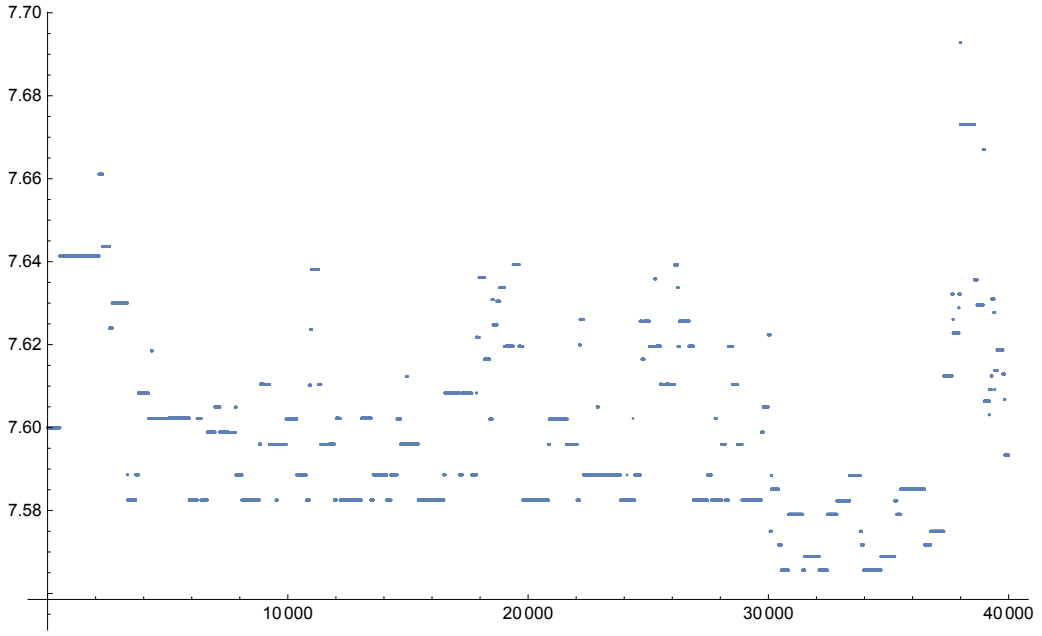
```
Total permutations rejected: 39 663
```

```
Shortest tour found (black) is 7.565622657
 , but the actual shortest tour (green) is 7.568897008
```

Out[1442]=



Out[1443]=



In[1444]:=
```
Manipulate[
 Show[{ListPlot[Table[Labeled[cities[[i]], i], {i, 1, n}], PlotStyle → PointSize[Medium],
    PlotRange → {{xmin, xmax}, {ymin, ymax}}, AspectRatio → 1],
   Graphics[Line[cities[[Append[savedPerm[[j]], savedPerm[[j, 1]]]]]]}], {j, 1, nSave, 1}]
```

Out[1444]=