In[163]:=
```
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  Attribution-NonCommercial-ShareAlike *)

SetOptions[EvaluationNotebook[], Background → White]
```

Support Vector Regression

Native code, not from Mathematica. Note the maximizer is Differential Evolution.

In[28]:=
```
SupportVectorRegression[{xm_, ym_}, K_, ϵ_, c_, method_] := Module[
{m, n, M, i, j, W, g, vars, sol, b},

m = Length[ym]; n = Length[xm[[1]]];
M = Table[K[xm[[i]], xm[[j]]], {i, 1, m}, {j, 1, m}] + 1 / c IdentityMatrix[m];
W = Sum[Subscript[α, i] ym[[i]], {i, 1, m}] - ϵ Sum[Abs[Subscript[α, i]], {i, 1, m}] -
    1 / 2 Sum[Sum[(Subscript[α, i] Subscript[α, j] M[[i, j]]), {j, 1, m}], {i, 1, m}];
g = Apply[And, Join[Table[-c < Subscript[α, i] <= c, {i, 1, m}],
      {(Sum[Subscript[α, i], {i, 1, m}] == 0)}]];

vars = Table[Subscript[α, i], {i, 1, m}];
sol = NMaximize[{W, g}, vars, Method -> method][[2]];
b = 1 / m Apply[Plus, Table[(ym[[j]] - Sum[Subscript[α, i] K[xm[[i]], xm[[j]]], {i, 1, m}] -
          ϵ - Subscript[α, j] / c) /. sol, {j, 1, m}]];
{(Sum[Subscript[α, i] K[xm[[i]], Table[Subscript[x, j], {j, 1, n}]], {i, 1, m}] + b) /. sol,
   vars /. sol, M,  W, g, vars, sol, b}];



waveletKernel[u_, v_] :=
  Product[(Cos[1.75 (u[[i]] - v[[i]]) / a] Exp[-((u[[i]] - v[[i]]) ^2) / (2 * a^2)]), {i, 1, Length[u]}];
rbfKernel[x_, z_] := Exp[-b (x - z).(x - z)];
polyKernel[x_, z_] := (e + x.z) ^d;
vovkKernel[x_, z_] := (1 - x.z) ^-d;
fourierKernel[x_, z_] := Product[(1 - q^2) / (2 (1 - 2 q Cos[x[[i]] - z[[i]]] + q^2)), {i, 1, Length[x]}];
```

Data

```
In[8]:= testdata = Import[
          FileNameJoin[{NotebookDirectory[], "aggregatefeaturesConorTest.csv"}], "CSV"];
        data = Import[FileNameJoin[{NotebookDirectory[],
             "aggregatefeaturesConorTrain.csv"}], "CSV"];
        Length@data
        Length@testdata

Out[10]= 68

Out[11]= 67
```

Regression

```
In[119]:=
        input = Map[Drop[#, 1] &, data];
        output = 0.3 * Map[First@# &, data];
        testinput = Map[Drop[#, 1] &, testdata];
        testoutput = 0.3 * Map[First@# &, testdata];



        (*some experimentation needed to find the optimum values,
        but we could use another search optimized on top to do just that*)
        epsilon = 0.0025; c = 200.0; a  = 14;


        method = "DifferentialEvolution";

        (*there are many more kernels, there is an entire theory for kernels in math.*)
        kernel = waveletKernel;

        (*Note {input,output} was used corresponding to training data*)
        F = SupportVectorRegression[{input, output}, kernel, epsilon, c, method];
```

Quadratic Kernel Regression

In[158]:=
```
Short[F[[1]], 20]
```

Out[158]//Short=

$$
\begin{aligned}
&99.4263 - 112.44\, e^{-\frac{x_1^2}{392}-\frac{x_2^2}{392}-\frac{1}{392}(0.17126-x_3)^2-\frac{1}{392}(0.79574-x_4)^2-\frac{1}{392}(0.1713-x_5)^2-\frac{1}{392}(1.937-x_6)^2-\frac{1}{392}(5.2538-x_7)^2-\frac{1}{392}(9.5958-x_8)^2-\frac{1}{392}(2} \\
&\quad \text{Cos}[0.125\, x_1]\, \text{Cos}[0.125\, x_2]\, \text{Cos}[0.125\, (0.17126-x_3)]\, \text{Cos}[0.125\, (0.79574-x_4)] \\
&\quad \text{Cos}[0.125\, (0.1713-x_5)]\, \text{Cos}[0.125\, (1.937-x_6)]\, \text{Cos}[0.125\, (5.2538-x_7)] \\
&\quad \text{Cos}[0.125\, (9.5958-x_8)]\, \text{Cos}[0.125\, (2.9-x_9)] + \ll 97 \gg + 47.6064 \\
&\quad e^{-\frac{x_1^2}{392}-\frac{1}{392}(3.8839-x_2)^2-\frac{1}{392}(11.141-x_3)^2-\frac{1}{392}(7.9125-x_4)^2-\frac{1}{392}(8.64-x_5)^2-\frac{1}{392}(12.952-x_6)^2-\frac{1}{392}(20.093-x_7)^2-\frac{1}{392}(44.913-} \\
&\quad \text{Cos}[0.125\, x_1]\, \text{Cos}[0.125\, (3.8839-x_2)]\, \text{Cos}[0.125\, (11.141-x_3)] \\
&\quad \text{Cos}[0.125\, (7.9125-x_4)]\, \text{Cos}[0.125\, (8.64-x_5)]\, \text{Cos}[0.125\, (12.952-x_6)] \\
&\quad \text{Cos}[0.125\, (20.093-x_7)]\, \text{Cos}[0.125\, (44.913-x_8)]\, \text{Cos}[0.125\, (22.2-x_9)]
\end{aligned}
$$

In[51]:=
```
(*https://en.wikipedia.org/wiki/Coefficient_of_determination*)
rSQUARED[y_, yhat_] := Module[{ybar, SStot, SSreg, SSres},

   ybar = Mean@y;
   SStot = Total@Map[(# - ybar) ^2 &, y];
   SSreg = Total@Map[(# - ybar) ^2 &, yhat];
   SSres = Total@Table[(y[[i]] - yhat[[i]]) ^2, {i, 1, Length@y}];

   1 - (SSres / SStot)

  ];
```

In[159]:=
```
rSQUARED[testoutput ,
 Table[F[[1]] /. (Flatten@Table[{Subscript[x, j] -> testinput[[i]][[j]]},
      {j, 1, Length@ (testinput[[i]])}]), {i, 1, Length@testinput}]]
```

Out[159]= 0.935999

SVR

In[164]:=
```
svr = Table[F[[1]] /. (Flatten@Table[{Subscript[x, j] -> testinput[[i]][[j]]},
      {j, 1, Length@ (testinput[[i]])}]), {i, 1, Length@testinput}]
```

Out[164]=
```
{95.2982, 98.8733, 92.6768, 97.4578, 90.7424, 107.898, 97.3888, 104.944, 35.5161,
 131.295, 149.335, 136.621, 148.474, 112.923, 147.173, 111.47, 143.887,
 30.4932, 117.881, 120.452, 114.871, 120.219, 104.723, 128.409, 103.096,
 129.83, 44.9977, 126.383, 124.31, 126.947, 124.701, 104.892, 98.4552, 104.254,
 101.502, 23.6242, 115.982, 110.205, 118.898, 106.302, 159.607, 126.483,
 149.391, 131.653, 39.7022, 155.437, 157.84, 155.116, 154.113, 131.377, 158.154,
 135.731, 160.141, 42.7113, 151.746, 155.392, 152.956, 155.941, 143.558,
 155.606, 141.267, 159.424, 34.7847, 157.023, 154.433, 157.665, 155.969}
```

Test Data

In[161]:=

```
testoutput
```

Out[161]=

```
{105.285, 98.487, 106.056, 97.68, 85.692, 100.008, 84.093, 101.265, 25.4403,
 144.399, 150.855, 144.438, 151.266, 134.718, 147.012, 132.93, 145.314,
 36.903, 118.689, 128.703, 115.053, 127.077, 114.741, 125.388, 115.767,
 129.663, 31.392, 119.136, 127.644, 117.321, 127.881, 95.328, 106.266,
 92.811, 106.377, 24.1647, 110.442, 107.679, 110.418, 107.643, 136.776,
 156.867, 134.88, 153.858, 42.519, 148.422, 160.779, 152.295, 160.548,
 144.609, 163.824, 143.43, 162.9, 42.933, 163.164, 163.953, 161.004, 164.436,
 143.016, 153.912, 143.871, 155.097, 35.85, 164.649, 156.477, 163.029, 158.91}
```

In[167]:=

```
ListLinePlot[{svr, testoutput}, PlotLegends → {"SVR", "Test Data"}]
```

Out[167]=