Validation

In the following experiments, use the data provided in the files **in.dta** and **out.dta**. We are going to apply linear regression with a nonlinear transformation for classification (without regularization). The nonlinear transformation is given by φ_0 through φ_7 which transform (x_1, x_2) into

$$x_1 \qquad x_2 \qquad x_1^2 \qquad x_2^2 \qquad x_1 x_2 \qquad |x_1 - x_2| \qquad |x_1 + x_2|$$

To illustrate how taking out points for validation affects the performance, we will consider the hypotheses trained on $\mathcal{D}_{\text{train}}$ (without restoring the full $\mathcal{D}$ for training after validation is done).

```
(* Clear globals *)
Clear[NoValidationSelector, E1ValidationSelector, GenerateX,
 DoLinearRegressionExperiment, ClassificationE, ixD, ixy]
Clear[ϕ, ϕ3, ϕ4, ϕ5, ϕ6, ϕ7]
```

```
ixD = 1;
ixy = 2;
NoValidationSelector[D_, y_] := Module[{
   (* does no validation selection; returns parameters unchanged *)
   Dval = {}, yval = {}
  },
  {{D, y}, {Dval, yval}}
 ]
E1ValidationSelector[D_, y_] := Module[{
   (* this function isolates data
    and valadation points as required by experiment 1 *)
   Dval = {}, yval = {}
  },
  {{Part[D, 1 ;; 25], Part[y, 1 ;; 25]},
   {Part[D, 26 ;; 35], Part[y, 26 ;; 35]}}
 ]
E2ValidationSelector[D_, y_] := Module[{
   (* this function isolates data
    and valadation points as required by experiment 3 *)
   Dval = {}, yval = {}
  },
  {{Part[D, 26 ;; 35], Part[y, 26 ;; 35]},
   {Part[D, 1 ;; 25], Part[y, 1 ;; 25]}}
 ]
E1TestValidationSelector[D_, y_] := Module[{
   (* this function isolates data and
    valadation points as required by test experiment 1 *)
   Dval = {}, yval = {}
  },
  {{Part[D, 1 ;; 15], Part[y, 1 ;; 15]},
   {Part[D, 16 ;; 25], Part[y, 16 ;; 25]}}
 ]

GenerateX[OptionsPattern[]] :=
```

```mathematica
Module[{
   Dy, Dval, D, y, yval, f, d = 2,
   f1, f2,
   m, a, b, c,
   t1, t2,
   dotTest1, dotTest2, DotTest
   },

  f1 = RandomReal[{-1, 1}, {1, d}][[1]];
  f2 = RandomReal[{-1, 1}, {1, d}][[1]];

  m = (f1[[2]] - f2[[2]])/(f1[[1]] - f2[[1]]);
  a = -m;
  b = 1;
  c = m f1[[1]] - f1[[2]];
  f = {{c}, {a}, {b}};

  (* f should not dot to zero for our two original points! *)
  t1 = {1, f1[[1]], f1[[2]]};
  t2 = {1, f2[[1]], f2[[2]]};

  DotTest[v_, s_] := If[Abs[v] > 0.00000000001, Throw[s], 0];
  DotTest[t1.f, "t1 dot test failed"];
  DotTest[t2.f, "t2 dot test failed"];

  (*D = RandomReal[{-1,1},{OptionValue[DSize],d}];*)
  Dy = Import[OptionValue[R2DataFile], "Table"];
  D = Dy[[All(*1;;15*), {1, d}]];
  y = Dy[[All(*1;;15*), d + 1]];
  {{D, y}, {Dval, yval}} = OptionValue[ValidationSelector][D, y];
  {{D, y}, {Dval, yval}, f}
 ]
Options[GenerateX] =
  {R2DataFile → "in.dta", ValidationSelector → NoValidationSelector};

LinearTarget[f_, X_] := Sign[X.f];

NoFeature[X_] := X;
ϕ[X_, n_] :=
  Part[{1, #2, #3, #2^2, #3^2, #2 #3, Abs[#2 - #3], Abs[#2 + #3]}, 1 ;; n] & @@@ X;
(*Part[{1,#2+#3,#2-#3,#2^3,#3^3,#2^2+#3^2,0,0},1;;n]&@@@X;*)
ϕ[X_] := ϕ[X, 8];
ϕ1[X_] := ϕ[X, 2];
ϕ2[X_] := ϕ[X, 3];
ϕ3[X_] := ϕ[X, 4];
ϕ4[X_] := ϕ[X, 5];
ϕ5[X_] := ϕ[X, 6];
ϕ6[X_] := ϕ[X, 7];
ϕ7[X_] := ϕ[X, 8];
NoRegularizer[X_, λ_] := PseudoInverse[X] (*Inverse[X^T.X].X^T*);
```

```
Tikhonov[𝕏_, λ_] := Inverse[𝕏ᵀ.𝕏 + λ IdentityMatrix[Dimensions[𝕏][[2]]]].𝕏ᵀ;
DoLinearRegressionExperiment[𝒳_, OptionsPattern[]] :=
 Module[{
    𝒟, f, y, 𝕪,
    𝕏, 𝕏f, 𝕏fdag,
    w
   },
  {𝒟, f, y} = 𝒳;
  𝕏 = Function[x, Prepend[x, 1]] /@ 𝒟;
  𝕏f = OptionValue[DataFeature][𝕏];
  𝕪 = y;
  𝕏fdag = OptionValue[Regularizer][𝕏f, OptionValue[λ]];
  w = 𝕏fdag.𝕪;
  {w, 𝕏, 𝕪, 𝒟, f}
 ]
Options[DoLinearRegressionExperiment] = {TargetFunction → LinearTarget,
   DataFeature → ϕ, Regularizer → NoRegularizer, λ → 0};


ClassificationE[𝕏_, w_, 𝕪_, OptionsPattern[]] :=
 (*
 Determine classification error for hypothesis w when
   given data collection 𝕏 and labels 𝕪.  NOTE that this is a
   generic classification error function that is Eᵢₙ/Eₒᵤₜ-agnostic
 *)
 Module[{
    N, misses, sumOfMisses
   },
  N = Length[𝕪];
  misses =
   MapThread[If[#1 ≠ #2, 1, 0] &, {Sign[OptionValue[DataFeature][𝕏].w], 𝕪}];
  sumOfMisses = Total[misses];
  1
  ─ sumOfMisses
  N
 ]
Options[ClassificationE] = {DataFeature → ϕ};
```

Validation, E_{in}

Split **in.dta** into training (first 25 examples) and validation (last 10 examples). Train on the 25 examples only, using the validation set of 10 examples to select between five models that apply linear regression to φ_0 through φ_k, with k = 3,4,5,6,7. Note which validation set has the smallest classification error.

Validation, E_{out}

Evaluate the out-of-sample classification error using **out.dta** on the 5 models to see how well the validation set predicted the best of the 5 models. Note for which model the out-of-sample classification error is smallest.

```
(* Clear globals *)
Clear[Experiment1, e1Eval, e1Eout]
```

```
Experiment1[] :=
 (*
 Perform linear regression using the provided in-
  sample file with some data held back for validation,
 then use validation data to estimate Eout.
 *)
 Module[{
   Eout = {}, Eval = {},
   𝒟, 𝑦,
   𝒟val, 𝑦val,
   𝒟in, 𝒟out,
   𝕏val,
   𝕏in, 𝕏out,
   𝕪in, 𝕪out,
   w, 𝑓, 𝑑 = 2
   },

  {{𝒟, 𝑦}, {𝒟val, 𝑦val}, 𝑓} =
    Generate𝒳[ℝ2DataFile → "in.dta", ValidationSelector → E1ValidationSelector];
  {{𝒟out, 𝑦out}, empty, 𝑓} = Generate𝒳[ℝ2DataFile → "out.dta"];
  𝕏val = Function[x, Prepend[x, 1]] /@ 𝒟val;
  𝕏out = Function[x, Prepend[x, 1]] /@ 𝒟out;

  {w, 𝕏in, 𝕪in, 𝒟in, 𝑓} = DoLinearRegressionExperiment[{𝒟, 𝑓, 𝑦}, DataFeature → 𝜙3];
  AppendTo[Eval, ClassificationE[𝕏val, w, 𝑦val, DataFeature → 𝜙3]];
  AppendTo[Eout, ClassificationE[𝕏out, w, 𝑦out, DataFeature → 𝜙3]];

  {w, 𝕏in, 𝕪in, 𝒟in, 𝑓} = DoLinearRegressionExperiment[{𝒟, 𝑓, 𝑦}, DataFeature → 𝜙4];
  AppendTo[Eval, ClassificationE[𝕏val, w, 𝑦val, DataFeature → 𝜙4]];
  AppendTo[Eout, ClassificationE[𝕏out, w, 𝑦out, DataFeature → 𝜙4]];

  {w, 𝕏in, 𝕪in, 𝒟in, 𝑓} = DoLinearRegressionExperiment[{𝒟, 𝑓, 𝑦}, DataFeature → 𝜙5];
  AppendTo[Eval, ClassificationE[𝕏val, w, 𝑦val, DataFeature → 𝜙5]];
  AppendTo[Eout, ClassificationE[𝕏out, w, 𝑦out, DataFeature → 𝜙5]];

  {w, 𝕏in, 𝕪in, 𝒟in, 𝑓} = DoLinearRegressionExperiment[{𝒟, 𝑓, 𝑦}, DataFeature → 𝜙6];
  AppendTo[Eval, ClassificationE[𝕏val, w, 𝑦val, DataFeature → 𝜙6]];
  AppendTo[Eout, ClassificationE[𝕏out, w, 𝑦out, DataFeature → 𝜙6]];

  {w, 𝕏in, 𝕪in, 𝒟in, 𝑓} = DoLinearRegressionExperiment[{𝒟, 𝑓, 𝑦}, DataFeature → 𝜙7];
  AppendTo[Eval, ClassificationE[𝕏val, w, 𝑦val, DataFeature → 𝜙7]];
  AppendTo[Eout, ClassificationE[𝕏out, w, 𝑦out, DataFeature → 𝜙7]];

  {Eval, Eout}
 ]

{e1Eval, e1Eout} = Experiment1[];
StringForm["\n𝜙=3: E_val=``, E_out=``", e1Eval[[1]] × 1., e1Eout[[1]] × 1.]
StringForm["\n𝜙=4: E_val=``, E_out=``", e1Eval[[2]] × 1., e1Eout[[2]] × 1.]
StringForm["\n𝜙=5: E_val=``, E_out=``", e1Eval[[3]] × 1., e1Eout[[3]] × 1.]
StringForm["\n𝜙=6: E_val=``, E_out=``", e1Eval[[4]] × 1., e1Eout[[4]] × 1.]
StringForm["\n𝜙=7: E_val=``, E_out=``", e1Eval[[5]] × 1., e1Eout[[5]] × 1.]
```

ϕ=3: E_{val}=0.3`, $E_{out}$=0.42`

$\phi=4\text{:}\ E_{val}=0.5\text{`},\ E_{out}=0.416\text{`}$

$\phi=5\text{:}\ E_{val}=0.2\text{`},\ E_{out}=0.188\text{`}$

$\phi=6\text{:}\ E_{val}=0.\text{`},\ E_{out}=0.084\text{`}$

$\phi=7\text{:}\ E_{val}=0.1\text{`},\ E_{out}=0.072\text{`}$

```
Experiment1Test[] :=
 (*
 Perform linear regression using the provided in-
   sample file with some data held back for validation,
  then use validation data to estimate Eₒᵤₜ.
 *)
 Module[{
    Eout = {}, Eval = {},
    𝒟, 𝓎,
    𝒟val, 𝓎val,
    𝒟in, 𝒟out,
    𝕏val,
    𝕏in, 𝕏out,
    𝕪in, 𝕪out,
    𝓰s = {},
    w, f, d = 2
    },

   {{𝒟, 𝓎}, {𝒟val, 𝓎val}, f} = Generate𝒳[
      ℝ2DataFile → "in.dta", ValidationSelector → E1TestValidationSelector];
   {{𝒟out, 𝕪out}, empty, f} = Generate𝒳[ℝ2DataFile → "out.dta",
      ValidationSelector → E1TestValidationSelector];
   𝕏val = Function[x, Prepend[x, 1]] /@ 𝒟val;
   𝕏out = Function[x, Prepend[x, 1]] /@ 𝒟out;

   {w, 𝕏in, 𝕪in, 𝒟in, f} = DoLinearRegressionExperiment[{𝒟, f, 𝓎}, DataFeature → ϕ1];
   AppendTo[Eval, ClassificationE[𝕏val, w, 𝓎val, DataFeature → ϕ1]];
   AppendTo[Eout, ClassificationE[𝕏out, w, 𝕪out, DataFeature → ϕ1]];
   AppendTo[𝓰s, w];

   {w, 𝕏in, 𝕪in, 𝒟in, f} = DoLinearRegressionExperiment[{𝒟, f, 𝓎}, DataFeature → ϕ3];
   AppendTo[Eval, ClassificationE[𝕏val, w, 𝓎val, DataFeature → ϕ3]];
   AppendTo[Eout, ClassificationE[𝕏out, w, 𝕪out, DataFeature → ϕ3]];
   AppendTo[𝓰s, w];

   {w, 𝕏in, 𝕪in, 𝒟in, f} = DoLinearRegressionExperiment[{𝒟, f, 𝓎}, DataFeature → ϕ5];
   AppendTo[Eval, ClassificationE[𝕏val, w, 𝓎val, DataFeature → ϕ5]];
   AppendTo[Eout, ClassificationE[𝕏out, w, 𝕪out, DataFeature → ϕ5]];
   AppendTo[𝓰s, w];

   {Eval, Eout, 𝓰s}
  ]

{e1Eval, e1Eout, p1𝓰s} = Experiment1Test[];
StringForm["\nϕ=1: E_val=``, E_out=``, 𝓰⁻=``",
 e1Eval[[1]] × 1., e1Eout[[1]] × 1., p1𝓰s[[1]]]
StringForm["\nϕ=3: E_val=``, E_out=``, 𝓰⁻=``",
 e1Eval[[2]] × 1., e1Eout[[2]] × 1., p1𝓰s[[2]]]
StringForm["\nϕ=5: E_val=``, E_out=``, 𝓰⁻=``",
 e1Eval[[3]] × 1., e1Eout[[3]] × 1., p1𝓰s[[3]]]
```

ϕ=1: E_{val}=0.5`, $E_{out}$=0.5333333333333333`, 𝓰⁻={0.184054, 0.159572}

$\phi=3$: $E_{val}=0.5`$, $E_{out}=0.5333333333333333`$,
  $\mathbb{g}^-=\{0.173737, 0.173344, 0.119423, 0.0195201\}$

$\phi=5$: $E_{val}=0.1`$, $E_{out}=0.13333333333333333`$,
  $\mathbb{g}^-=\{-0.525701, 0.4197, 0.0159055, 0.0304904, 1.43639, -1.58619\}$

Test/validation role reversal, E_{in}

Reverse the role of training and validation sets; now training with the last 10 examples and validating with the first 25 examples. Note for which model the classification error on the validation set is smallest.

Test/validation role reversal, E_{out}

Once again, evaluate the out-of-sample classification error using **out.dta** on the 5 models to see how well the validation set predicted the best of the 5 models. Note for which model the out-of-sample classification error is smallest.

```
(* Clear globals *)
Clear[Experiment2, e2Eval, e2Eout]
```

```
Experiment2[] :=
  (*
  Perform linear regression using the provided in-
   sample file with some data held back for validation,
  then use validation data to estimate Eₒᵤₜ.
  *)
  Module[{
    Eout = {}, Eval = {},
    𝒟, 𝒴,
    𝒟val, 𝒴val,
    𝒟in, 𝒟out,
    𝕏val,
    𝕏in, 𝕏out,
    𝕪in, 𝕪out,
    w, f, d = 2
    },

    {{𝒟, 𝒴}, {𝒟val, 𝒴val}, f} =
     Generate𝒳[ℝ2DataFile → "in.dta", ValidationSelector → E2ValidationSelector];
    {{𝒟out, 𝒴out}, empty, f} = Generate𝒳[ℝ2DataFile → "out.dta"];
    𝕏val = Function[x, Prepend[x, 1]] /@ 𝒟val;
    𝕏out = Function[x, Prepend[x, 1]] /@ 𝒟out;

    {w, 𝕏in, 𝕪in, 𝒟in, f} = DoLinearRegressionExperiment[{𝒟, f, 𝒴}, DataFeature → ϕ3];
    AppendTo[Eval, ClassificationE[𝕏val, w, 𝒴val, DataFeature → ϕ3]];
    AppendTo[Eout, ClassificationE[𝕏out, w, 𝒴out, DataFeature → ϕ3]];

    {w, 𝕏in, 𝕪in, 𝒟in, f} = DoLinearRegressionExperiment[{𝒟, f, 𝒴}, DataFeature → ϕ4];
    AppendTo[Eval, ClassificationE[𝕏val, w, 𝒴val, DataFeature → ϕ4]];
    AppendTo[Eout, ClassificationE[𝕏out, w, 𝒴out, DataFeature → ϕ4]];

    {w, 𝕏in, 𝕪in, 𝒟in, f} = DoLinearRegressionExperiment[{𝒟, f, 𝒴}, DataFeature → ϕ5];
    AppendTo[Eval, ClassificationE[𝕏val, w, 𝒴val, DataFeature → ϕ5]];
    AppendTo[Eout, ClassificationE[𝕏out, w, 𝒴out, DataFeature → ϕ5]];

    {w, 𝕏in, 𝕪in, 𝒟in, f} = DoLinearRegressionExperiment[{𝒟, f, 𝒴}, DataFeature → ϕ6];
    AppendTo[Eval, ClassificationE[𝕏val, w, 𝒴val, DataFeature → ϕ6]];
    AppendTo[Eout, ClassificationE[𝕏out, w, 𝒴out, DataFeature → ϕ6]];

    {w, 𝕏in, 𝕪in, 𝒟in, f} = DoLinearRegressionExperiment[{𝒟, f, 𝒴}, DataFeature → ϕ7];
    AppendTo[Eval, ClassificationE[𝕏val, w, 𝒴val, DataFeature → ϕ7]];
    AppendTo[Eout, ClassificationE[𝕏out, w, 𝒴out, DataFeature → ϕ7]];

    {Eval, Eout}
  ]

{e1Eval, e1Eout} = Experiment2[];
StringForm["\nϕ=3: E_val=``, E_out=``", e1Eval[[1]] × 1., e1Eout[[1]] × 1.]
StringForm["\nϕ=4: E_val=``, E_out=``", e1Eval[[2]] × 1., e1Eout[[2]] × 1.]
StringForm["\nϕ=5: E_val=``, E_out=``", e1Eval[[3]] × 1., e1Eout[[3]] × 1.]
StringForm["\nϕ=6: E_val=``, E_out=``", e1Eval[[4]] × 1., e1Eout[[4]] × 1.]
StringForm["\nϕ=7: E_val=``, E_out=``", e1Eval[[5]] × 1., e1Eout[[5]] × 1.]
```

ϕ=3: E_{val}=0.28`, $E_{out}$=0.396`

$\phi=4$: $E_{val}=0.36\grave{}$, $E_{out}=0.388\grave{}$

$\phi=5$: $E_{val}=0.2\grave{}$, $E_{out}=0.284\grave{}$

$\phi=6$: $E_{val}=0.08\grave{}$, $E_{out}=0.192\grave{}$

$\phi=7$: $E_{val}=0.12\grave{}$, $E_{out}=0.196\grave{}$

Validation Bias

Problem 6

Let e_1 and e_2 be independent random variables, distributed uniformly over the interval [0, 1]. Let $e = \min(e_1, e_2)$. Observe the expected values of e_1, e_2, e.

```
Experiment3[n_] :=
 Module[{
    i,
    e1, e2,
    e1s = {}, e2s = {}, eMin = {}
   },
  For[i = 1, i ≤ n, i++, (
     e1 = RandomReal[];
     e2 = RandomReal[];
     AppendTo[e1s, e1];
     AppendTo[e2s, e2];
     AppendTo[eMin, Min[e1, e2]];
    )];
   { Total[e1s] ,  Total[e2s] ,  Total[eMin] }
         n            n            n
 ]
```

```
Experiment3[10 000]
.4 - .3333
.3333 - .25
```

{0.502401, 0.500103, 0.332812}

0.0667

0.0833

Cross Validation

Problem 7

We have the data points (x, y): (-1, 0), (ρ, 1), (1, 0), $\rho \geq 0$, and a choice between two models: constant { $h_0(x) = b$ } and linear { $h_1(x) = ax + b$ }. Let's find out for which value of ρ would the two models

be tied using leave-one-out cross- validation with the squared error measure.

```
E11[ρ_] := ( 2 / (ρ + 1) )^2 ;
```

```
E12[ρ_] := ( -2 / (ρ - 1) )^2 ;
```

```
E13[ρ_] := (1)^2 ;
```

```
E21[] := ( 1/2 )^2 ;
```

```
E22[] := ( 1/2 )^2 ;
```

```
E23[] := (1)^2 ;
```

```
E1[ρ_] := E11[ρ] + E12[ρ] + E13[ρ];
E2[] := E21[] + E22[] + E23[];
```

```
E1[ √(√3 + 4) ] × 1.
```

```
E1[ √(√3 - 1) ] × 1.
```

```
E1[ √(9 + 4√6) ] × 1.
```

```
E1[ √(9 - √6) ] × 1.
E2[] × 1.
```

```
3.40513
```

```
193.995
```

```
1.5
```

```
2.96065
```

```
1.5
```

PLA vs. SVM

(We're using MathSVM.m, available at **www.mathematica-journal.com/issue/v10i1/download**, for quadratic programming functionality. Just open the file and run it before executing the following code.)

In the following experiments, we compare PLA to SVM with hard margin (C→∞) on linearly separable data sets. For each run, we create our own target function f and data set $\mathcal{D}$. We take d = 2 and choose a random line in the plane as our target function f (we do this by taking two random, uniformly distributed points on [-1, 1] × [-1, 1] and taking the line passing through them), where one side of the line maps to +1 and the other maps to -1. We then choose the inputs x_n of the data set as random points in $\mathcal{X}$ = [-1, 1] × [-1, 1], and evaluate the target function on each x_n to get the corresponding output y_n. If all data points are on one side of the line, we discard the run and start a new

one.

We will start PLA with the all-zero vector and pick the misclassified point for each PLA iteration at random. We run PLA to find the final hypothesis g_{PLA} and measure the disagreement between f and g_{PLA} as $\mathbb{P}[f(\mathbb{x}) \neq g_{PLA}(\mathbb{x})]$ (we could either calculate this exactly, or approximate it by generating a sufficiently large, separate set of points to evaluate it--we'll choose the latter path). Now, we run SVM on the same data to find the final hypothesis g_{SVM} by solving

$$\min_{w,b} = \frac{1}{2} w^{\mathsf{T}} w$$
$$\text{s.t. } y_n(w^{\mathsf{T}} \mathbb{x}_n + b) \geq 1$$

using quadratic programming on the primal or the dual problem. We then measure the disagreement between f and g_{SVM} as $\mathbb{P}[f(\mathbb{x}) \neq g_{SVM}(\mathbb{x})]$, and count the number of support vectors you get in each run.

```
(* Clear globals *)
Clear[GenerateRandomX]
Clear[DoPLAExperiment, DoInteractivePLAExperiment, DoEoutTest]
```

```
(*<<MathSVM.m*)
GenerateRandomX[OptionsPattern[]] :=
 Module[{
    D, f, d = 2,
    f1, f2,
    m, a, b, c,
    t1, t2,
    dotTest1, dotTest2, DotTest
   },
   f1 = RandomReal[{-1, 1}, {1, d}][[1]];
   f2 = RandomReal[{-1, 1}, {1, d}][[1]];

   m = (f1[[2]] - f2[[2]])/(f1[[1]] - f2[[1]]);
   a = -m;
   b = 1;
   c = m f1[[1]] - f1[[2]];
   f = {{c}, {a}, {b}};

   (* f should not dot to zero for our two original points! *)
   t1 = {1, f1[[1]], f1[[2]]};
   t2 = {1, f2[[1]], f2[[2]]};

   DotTest[v_, s_] := If[Abs[v] > 0.00000000001, Throw[s], 0];
   DotTest[t1.f, "t1 dot test failed"];
   DotTest[t2.f, "t2 dot test failed"];

   D = RandomReal[{-1, 1}, {OptionValue[DSize], d}];

   {D, f}
```

```
    ]
Options[GenerateRandom𝒳] = {𝒟Size → 100};

DoPLAStep[w_, f_, 𝒟_, Converged_, Misses_] :=
 Module[{
    𝗑, h, chk,
    missedPoints,
    misses,
    numSamples,
    converged,
    w,
    i, ri
   },
   converged = Converged;
   misses = Misses;
   w = w;
   If[converged == 0, (
     converged = 1;
     missedPoints = {};
     numSamples = Length[𝒟];

     For[i = 1, i ≤ numSamples, i++, (
       (* cycle through the samples looking for misses *)
       𝗑 = Transpose[ArrayReshape[Prepend[𝒟[[i]], 1], {1, 3}]];
       h = Sign[(Transpose[w].𝗑)[[1, 1]]];
       chk = Sign[(Transpose[f].𝗑)[[1, 1]]];

       If[chk ≠ h, (
         (* if we have a miss...*)
         converged = 0;
         AppendTo[missedPoints, 𝗑];
         (*iterMisses++;*)
         0), 0]
      )];

     If[converged == 0, (
       (* if we've missed any points,
       then pick one of them at random for the hypothesis update *)
       misses++;
       ri = RandomInteger[{1, Length[missedPoints]}];
       𝗑 = missedPoints[[ri]];
       h = Sign[(Transpose[w].𝗑)[[1, 1]]];
       chk = Sign[(Transpose[f].𝗑)[[1, 1]]];
       w = w + chk * 𝗑; (* avoiding "cannot assign to raw object 0" *)
       (*w=q*)(* ...maybe because it was self-
        assigning and the last value in a "block" thing? *)
       (*ah no I think it's because it's declared as a parameter!*)
      )];
    )];
   {w, converged, misses}
 ]

DoPLAExperiment[𝒳_, OptionsPattern[]] :=
 Module[{
```

```
    𝒟, f, w, g,
     misses = 0,
     converged = 0
    },
   {𝒟, f} = 𝒳;
   w = OptionValue[w];

   While[converged == 0, (
      {w, converged, misses} = DoPLAStep[w, f, 𝒟, converged, misses];
     )];

   g = w;
   {g, Length[𝒟], misses}
  ]
Options[DoPLAExperiment] = {w → {{0}, {0}, {0}}};

DoInteractivePLAExperiment[𝒳_] :=
 DynamicModule[{
    𝒟, f, w, g,
    𝒟pos, 𝒟neg,
    fm, fb, sm, sb,
    misses = 0,
    converged = 0,
    i = 0
   },
  {𝒟, f} = 𝒳;
  w = {{0.000000001}, {0.000000001}, {0.000000001}};
  {w, converged, misses} = DoPLAStep[w, f, 𝒟, converged, misses];

  EventHandler[Dynamic[(
     {fm, fb} = GetYInterceptForm[f];
     {sm, sb} = GetYInterceptForm[w];
     𝒟pos = Select[𝒟, Sign[ArrayReshape[Prepend[#, 1], {1, 3}].f][[1, 1]] ≥ 0 &];
     𝒟neg = Select[𝒟, Sign[ArrayReshape[Prepend[#, 1], {1, 3}].f][[1, 1]] < 0 &];
     Show[
      ListPlot[{𝒟pos, 𝒟neg}, PlotMarkers → {"+", "-"}, PlotLabel → StringForm[
          "i=``, misses=``", i, misses]], Plot[{fm x + fb, sm x + sb}, {x, -2, 2}]
      ]
    )],
   {"KeyDown" :> ({w, converged, misses} = If[converged == 0,
        DoPLAStep[w, f, 𝒟, converged, misses], {w, converged, misses}]; i++)}
   ]
  ]

(*
DoLRtoPLASeries[runs_]:=
 Module[{
    g,𝕏,𝕪,𝒟,f,i,n,
    iterations,iterationses,avIterations
   },
   iterationses={};
   For[i=1,i≤runs,i++,(
     {g,𝕏,𝕪,𝒟,f}=DoLinearRegressionExperiment[Generate𝒳[𝒟Size→10]];
     {g,n,iterations}=DoPLAExperiment[{𝒟,f},w→g];
     AppendTo[iterationses,iterations];
```

```
    )];
  avIterations=Mean[iterationses];
  {runs,Length[𝒟],avIterations}
 ]
*)


(* interactive version *)
(*Problem7[]:=DoInteractivePLAExperiment[Generate𝒳[]]
  Problem7[]*)


(* single-run test version *)
(*Problem7[]:=DoPLAExperiment[Generate𝒳[]];
{p7g,p7n,p7iterations}=Problem7[];
StringForm["PLA results\n(N=``):\niterations to convergence=``",
 p7n, p7iterations]*)


DoSVMExperiment[𝒳_, 𝕪_, OptionsPattern[]] :=
 Module[{
    𝕏, 𝐐, A, p, a, b, c, α, N, 𝕨, 𝕓,
    svi, bias,
    numSupportVectors,
    dontcare𝑓
   },

   {𝕏, dontcare𝑓} = 𝒳;
   N = Length[𝕏];
   (*𝐐=𝕪.𝕪ᵀ𝕏.𝕏ᵀ;*)
   𝐐 = Outer[#1.#2 &, 𝕏, 𝕏, 1] * Outer[Times, 𝕪, 𝕪];
   (*A={𝕪,-1𝕪,IdentityMatrix[Length[𝕪]]};*)
   p = Table[-1, {N}]; (*Array[-1&,Length[𝕪]];*)
   a = Table[0, {N}];
   b = Table[∞, {N}];
   c = 0;

   α = QPSolve[𝐐, p, a, b, c, 𝕪, OptionValue[τ]];
   𝕨 = ∑_{n=1}^{N} 𝕪[[n]] α[[n]] 𝕏[[n]];
   (*𝕓=𝕪-𝕨.𝕏;*)
   numSupportVectors = Count[α, x_ /; x ≠ 0];

   svi = SparseArray[α]["NonzeroPositions"][[1]];
   bias = (1/𝕪[[svi]] - 𝕨.𝕏[[svi]][[1]])[[1]];
   (*checkbias = Bias[α,𝕏,𝕪];*)

   {𝕨, bias, numSupportVectors}
  ]
Options[DoSVMExperiment] = {τ → 0.01};


DoEoutTest[𝑓_, 𝑔_] :=
 Module[{
```

```
   n = 1000,
   𝕪f, 𝕪g,
   𝕏,
   𝒳, 𝒟, dontcaref,
   numMisses,
   i},

 𝒳 = GenerateRandom𝒳[𝒟Size → n];
 {𝒟, dontcaref} = 𝒳;
 𝕏 = Function[x, Prepend[x, 1]] /@ 𝒟;
 𝕪f = Sign[𝕏.f];
 𝕪g = Sign[𝕏.g];
 numMisses = Total[MapThread[If[(#1 ≠ #2), 1, 0] &, {𝕪f, 𝕪g}]];

 numMisses
 ─────────
     n

]


(* linear regression to PLA version *)
(*
Problem7[]:=DoLRtoPLASeries[1000];
{p7runs,p7n,p7AveIterations}=Problem7[];
StringForm[
 "LR to PLA results\n(runs=``, N=``):\naverage iterations to convergence=``",
 p7runs,p7n, p7AveIterations×1.]
*)
```

SVM v. PLA, N=10, 1000 runs

For N = 10, repeat the above experiment for 1000 runs. Observe how often is g_{SVM} better than g_{PLA} in approximating f.

```
(* clear globals *)
Clear[Experiment4, e4SVMbeatsPLApct, e4AveNumSupportVectors, e4runs, e4N]


(* linear regression to PLA version *)
Experiment4[OptionsPattern[]] := Module[{

   run, runs = 1000,
   i,
   𝕏, 𝕪, 𝕐,
   𝒳, 𝒟, f,
   gPLA, gPLAlength𝒟, gPLAmisses,
   ℙgPLAnotEqualsf, ℙgSVMnotEqualsf,
   SVMbeatsPLAtally = {},
   SVMweights, SVMbias,
   gSVM,
   numSupportVectors = {}, supportVectorCount,
   haveSplitData
   },

 For[run = 1, run ≤ runs, run++, (
```

```
    haveSplitData = False;
    While[¬ haveSplitData, (
        𝒳 = GenerateRandom𝒳[𝒟Size → OptionValue[n]];
        {𝒟, f} = 𝒳;
        𝕏 = Function[x, Prepend[x, 1]] /@ 𝒟;
        𝕪 = Sign[𝕏.f];
        haveSplitData = Abs[Total[Flatten[𝕪]]] < Length[𝕪]
         (* FAIL if all pos or all neg *)
        )]

     {gPLA, gPLAlength𝒟, gPLAmisses} = DoPLAExperiment[𝒳];
    ℙgPLAnotEqualsf = DoEoutTest[f, gPLA];


    y = 𝕪ᵀ[[1]];
    {SVMweights, SVMbias, supportVectorCount} = DoSVMExperiment[𝒳, y];
    gSVM = {Flatten[{SVMbias, SVMweights}]}ᵀ;
    ℙgSVMnotEqualsf = DoEoutTest[f, gSVM];
    AppendTo[numSupportVectors, supportVectorCount];

    AppendTo[SVMbeatsPLAtally, If[ℙgSVMnotEqualsf ≤ ℙgPLAnotEqualsf, 1, 0]];


    If[Mod[run, 1/100 OptionValue[IncrementNotificationPct] × runs] == 0,
     Print[StringForm["`` of `` complete (SVM wins=``%, ave. supports=``)...",
        run, runs, Total[SVMbeatsPLAtally]/Length[SVMbeatsPLAtally] × 100., Mean[numSupportVectors] × 1.]]];

    )]

  Print["...Done"];

  {Total[SVMbeatsPLAtally]/Length[SVMbeatsPLAtally] × 100, runs, Length[𝒟], Mean[numSupportVectors]}
 ]
Options[Experiment4] = {n → 10, IncrementNotificationPct → 10};

{e4SVMbeatsPLApct, e4runs, e4N, e4AveNumSupportVectors} = Experiment4[];
StringForm["PLA v. SVA ℙ[miss] results (runs=``,
  N=``):\nSVG awesomerness=``%\nave. no. support vectors=``",
 e4runs, e4N, e4SVMbeatsPLApct × 1., e4AveNumSupportVectors × 1.]
```

100 of 1000 complete (SVM wins=60.`%, ave. supports=2.83`)...

200 of 1000 complete (SVM wins=63.`%, ave. supports=2.845`)...

300 of 1000 complete (SVM wins=60.66666666666667`%, ave. supports=2.8533333333333335`)...

400 of 1000 complete (SVM wins=59.75`%, ave. supports=2.8625`)...

500 of 1000 complete (SVM wins=60.8`%, ave. supports=2.87`)...

600 of 1000 complete (SVM wins=60.83333333333333`%, ave. supports=2.8716666666666666`)...

700 of 1000 complete (SVM wins=61.42857142857143`%, ave. supports=2.87`)...

800 of 1000 complete (SVM wins=61.5`%, ave. supports=2.87`)...

```
900 of 1000 complete (SVM wins=61.44444444444444`%, ave. supports=2.8633333333333333`)...

1000 of 1000 complete (SVM wins=61.199999999999996`%, ave. supports=2.863`)...

...Done

PLA v. SVA ℙ[miss] results (runs=1000, N=10):
SVG awesomerness=61.2`%
ave. no. support vectors=2.863`
```

SVM v. PLA, N=10, 1000 runs

We repeat the above experiment for N=100, 1000 runs. Note how often is g_{SVM} better than g_{PLA} in approximating f.

Number of support vectors

For the case N = 100, also note the average number of support vectors of g_{SVM} (averaged over the 1000 runs).

```
(* clear globals *)
Clear[e5SVMbeatsPLApct, e4runs, e4N, e4AveNumSupportVectors]
```

```
{e5SVMbeatsPLApct, e4runs, e4N, e4AveNumSupportVectors} =
  Experiment4[n → 100, IncrementNotificationPct → 0.1];
StringForm["PLA v. SVA ℙ[miss] results (runs=``, N=``):\nSVG
  awesomerness=``%\nave. no. support vectors=``",
 e4runs, e4N, e5SVMbeatsPLApct × 1., e4AveNumSupportVectors × 1.]
```

```
1 of 1000 complete (SVM wins=0.`%, ave. supports=3.`)...

2 of 1000 complete (SVM wins=50.`%, ave. supports=3.`)...

3 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

4 of 1000 complete (SVM wins=75.`%, ave. supports=3.`)...

5 of 1000 complete (SVM wins=80.`%, ave. supports=3.`)...

6 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

7 of 1000 complete (SVM wins=57.14285714285714`%, ave. supports=3.`)...

8 of 1000 complete (SVM wins=62.5`%, ave. supports=3.`)...

9 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

10 of 1000 complete (SVM wins=60.`%, ave. supports=3.`)...

11 of 1000 complete (SVM wins=63.63636363636363`%, ave. supports=3.`)...

12 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

13 of 1000 complete (SVM wins=69.23076923076923`%, ave. supports=3.`)...

14 of 1000 complete (SVM wins=71.42857142857143`%, ave. supports=3.`)...

15 of 1000 complete (SVM wins=73.33333333333333`%, ave. supports=3.`)...

16 of 1000 complete (SVM wins=75.`%, ave. supports=3.`)...

17 of 1000 complete (SVM wins=70.58823529411765`%, ave. supports=3.`)...
```

```
18 of 1000 complete (SVM wins=72.22222222222221`%, ave. supports=3.`)...

19 of 1000 complete (SVM wins=73.68421052631578`%, ave. supports=3.`)...

20 of 1000 complete (SVM wins=70.`%, ave. supports=3.`)...

21 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

22 of 1000 complete (SVM wins=68.18181818181817`%, ave. supports=3.`)...

23 of 1000 complete (SVM wins=65.21739130434783`%, ave. supports=3.`)...

24 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

25 of 1000 complete (SVM wins=68.`%, ave. supports=3.`)...

26 of 1000 complete (SVM wins=69.23076923076923`%, ave. supports=3.`)...

27 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

28 of 1000 complete (SVM wins=67.85714285714286`%, ave. supports=3.`)...

29 of 1000 complete (SVM wins=65.51724137931035`%, ave. supports=3.`)...

30 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

31 of 1000 complete (SVM wins=67.74193548387096`%, ave. supports=3.`)...

32 of 1000 complete (SVM wins=68.75`%, ave. supports=3.`)...

33 of 1000 complete (SVM wins=69.6969696969697`%, ave. supports=3.`)...

34 of 1000 complete (SVM wins=70.58823529411765`%, ave. supports=3.`)...

35 of 1000 complete (SVM wins=68.57142857142857`%, ave. supports=3.`)...

36 of 1000 complete (SVM wins=69.44444444444444`%, ave. supports=3.`)...

37 of 1000 complete (SVM wins=67.56756756756756`%, ave. supports=3.`)...

38 of 1000 complete (SVM wins=68.42105263157895`%, ave. supports=3.`)...

39 of 1000 complete (SVM wins=69.23076923076923`%, ave. supports=3.`)...

40 of 1000 complete (SVM wins=70.`%, ave. supports=3.`)...

41 of 1000 complete (SVM wins=68.29268292682927`%, ave. supports=3.`)...

42 of 1000 complete (SVM wins=69.04761904761905`%, ave. supports=3.`)...

43 of 1000 complete (SVM wins=67.44186046511628`%, ave. supports=3.`)...

44 of 1000 complete (SVM wins=65.9090909090909`%, ave. supports=3.`)...

45 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

46 of 1000 complete (SVM wins=67.3913043478261`%, ave. supports=3.`)...

47 of 1000 complete (SVM wins=65.95744680851064`%, ave. supports=3.`)...

48 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

49 of 1000 complete (SVM wins=65.3061224489796`%, ave. supports=3.`)...

50 of 1000 complete (SVM wins=66.`%, ave. supports=3.`)...

51 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

52 of 1000 complete (SVM wins=67.3076923076923`%, ave. supports=3.`)...

53 of 1000 complete (SVM wins=66.0377358490566`%, ave. supports=3.`)...
```

```
54 of 1000 complete (SVM wins=64.81481481481481`%, ave. supports=3.`)...

55 of 1000 complete (SVM wins=65.45454545454545`%, ave. supports=3.`)...

56 of 1000 complete (SVM wins=66.07142857142857`%, ave. supports=3.`)...

57 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

58 of 1000 complete (SVM wins=67.24137931034483`%, ave. supports=3.`)...

59 of 1000 complete (SVM wins=67.79661016949152`%, ave. supports=3.`)...

60 of 1000 complete (SVM wins=68.33333333333333`%, ave. supports=3.`)...

61 of 1000 complete (SVM wins=67.21311475409836`%, ave. supports=3.`)...

62 of 1000 complete (SVM wins=66.12903225806451`%, ave. supports=3.`)...

63 of 1000 complete (SVM wins=65.07936507936508`%, ave. supports=3.`)...

64 of 1000 complete (SVM wins=64.0625`%, ave. supports=3.`)...

65 of 1000 complete (SVM wins=64.61538461538461`%, ave. supports=3.`)...

66 of 1000 complete (SVM wins=65.15151515151516`%, ave. supports=3.`)...

67 of 1000 complete (SVM wins=64.17910447761194`%, ave. supports=3.`)...

68 of 1000 complete (SVM wins=64.70588235294117`%, ave. supports=3.`)...

69 of 1000 complete (SVM wins=65.21739130434783`%, ave. supports=3.`)...

70 of 1000 complete (SVM wins=64.28571428571429`%, ave. supports=3.`)...

71 of 1000 complete (SVM wins=63.38028169014085`%, ave. supports=3.`)...

72 of 1000 complete (SVM wins=63.888888888888886`%, ave. supports=3.`)...

73 of 1000 complete (SVM wins=63.013698630136986`%, ave. supports=3.`)...

74 of 1000 complete (SVM wins=63.51351351351351`%, ave. supports=3.`)...

75 of 1000 complete (SVM wins=64.`%, ave. supports=3.`)...

76 of 1000 complete (SVM wins=64.47368421052632`%, ave. supports=3.`)...

77 of 1000 complete (SVM wins=64.93506493506493`%, ave. supports=3.`)...

78 of 1000 complete (SVM wins=65.38461538461539`%, ave. supports=3.`)...

79 of 1000 complete (SVM wins=65.82278481012658`%, ave. supports=3.`)...

80 of 1000 complete (SVM wins=65.`%, ave. supports=3.`)...

81 of 1000 complete (SVM wins=65.4320987654321`%, ave. supports=3.`)...

82 of 1000 complete (SVM wins=65.85365853658537`%, ave. supports=3.`)...

83 of 1000 complete (SVM wins=66.26506024096386`%, ave. supports=3.`)...

84 of 1000 complete (SVM wins=66.66666666666666`%, ave. supports=3.`)...

85 of 1000 complete (SVM wins=67.05882352941175`%, ave. supports=3.`)...

86 of 1000 complete (SVM wins=67.44186046511628`%, ave. supports=3.`)...

87 of 1000 complete (SVM wins=67.81609195402298`%, ave. supports=3.`)...

88 of 1000 complete (SVM wins=67.04545454545455`%, ave. supports=3.`)...

89 of 1000 complete (SVM wins=66.29213483146067`%, ave. supports=3.`)...
```

```
90 of 1000 complete (SVM wins=65.55555555555556`%, ave. supports=3.`)...
91 of 1000 complete (SVM wins=64.83516483516483`%, ave. supports=3.`)...
92 of 1000 complete (SVM wins=65.21739130434783`%, ave. supports=3.`)...
93 of 1000 complete (SVM wins=65.59139784946237`%, ave. supports=3.`)...
94 of 1000 complete (SVM wins=65.95744680851064`%, ave. supports=3.`)...
95 of 1000 complete (SVM wins=65.26315789473685`%, ave. supports=3.`)...
96 of 1000 complete (SVM wins=65.625`%, ave. supports=3.`)...
97 of 1000 complete (SVM wins=65.97938144329896`%, ave. supports=3.`)...
98 of 1000 complete (SVM wins=65.3061224489796`%, ave. supports=3.`)...
99 of 1000 complete (SVM wins=64.64646464646465`%, ave. supports=3.`)...
100 of 1000 complete (SVM wins=65.`%, ave. supports=3.`)...
101 of 1000 complete (SVM wins=65.34653465346535`%, ave. supports=3.`)...
102 of 1000 complete (SVM wins=64.70588235294117`%, ave. supports=3.`)...
103 of 1000 complete (SVM wins=65.0485436893204`%, ave. supports=3.`)...
104 of 1000 complete (SVM wins=64.42307692307693`%, ave. supports=3.`)...
105 of 1000 complete (SVM wins=63.8095238095238`%, ave. supports=3.`)...
106 of 1000 complete (SVM wins=64.15094339622641`%, ave. supports=3.`)...
107 of 1000 complete (SVM wins=64.48598130841121`%, ave. supports=3.`)...
108 of 1000 complete (SVM wins=64.81481481481481`%, ave. supports=3.`)...
109 of 1000 complete (SVM wins=65.13761467889908`%, ave. supports=3.`)...
110 of 1000 complete (SVM wins=64.54545454545455`%, ave. supports=3.`)...
111 of 1000 complete (SVM wins=64.86486486486487`%, ave. supports=3.`)...
112 of 1000 complete (SVM wins=64.28571428571429`%, ave. supports=3.`)...
113 of 1000 complete (SVM wins=64.60176991150442`%, ave. supports=3.`)...
114 of 1000 complete (SVM wins=64.91228070175438`%, ave. supports=3.`)...
115 of 1000 complete (SVM wins=64.34782608695652`%, ave. supports=3.`)...
116 of 1000 complete (SVM wins=63.793103448275865`%, ave. supports=3.`)...
117 of 1000 complete (SVM wins=63.24786324786324`%, ave. supports=3.`)...
118 of 1000 complete (SVM wins=63.559322033898304`%, ave. supports=3.`)...
119 of 1000 complete (SVM wins=63.02521008403361`%, ave. supports=3.`)...
120 of 1000 complete (SVM wins=63.33333333333333`%, ave. supports=3.`)...
121 of 1000 complete (SVM wins=63.63636363636363`%, ave. supports=3.`)...
122 of 1000 complete (SVM wins=63.934426229508205`%, ave. supports=3.`)...
123 of 1000 complete (SVM wins=64.22764227642277`%, ave. supports=3.`)...
124 of 1000 complete (SVM wins=64.51612903225806`%, ave. supports=3.`)...
125 of 1000 complete (SVM wins=64.`%, ave. supports=3.`)...
```

```
126 of 1000 complete (SVM wins=64.28571428571429`%, ave. supports=3.`)...
127 of 1000 complete (SVM wins=64.56692913385827`%, ave. supports=3.`)...
128 of 1000 complete (SVM wins=64.84375`%, ave. supports=3.`)...
129 of 1000 complete (SVM wins=65.11627906976744`%, ave. supports=3.`)...
130 of 1000 complete (SVM wins=64.61538461538461`%, ave. supports=3.`)...
131 of 1000 complete (SVM wins=64.12213740458014`%, ave. supports=3.`)...
132 of 1000 complete (SVM wins=64.39393939393939`%, ave. supports=3.`)...
133 of 1000 complete (SVM wins=64.66165413533834`%, ave. supports=3.`)...
134 of 1000 complete (SVM wins=64.92537313432835`%, ave. supports=3.`)...
135 of 1000 complete (SVM wins=65.18518518518519`%, ave. supports=3.`)...
136 of 1000 complete (SVM wins=64.70588235294117`%, ave. supports=3.`)...
137 of 1000 complete (SVM wins=64.96350364963503`%, ave. supports=3.`)...
138 of 1000 complete (SVM wins=65.21739130434783`%, ave. supports=3.`)...
139 of 1000 complete (SVM wins=65.46762589928058`%, ave. supports=3.`)...
140 of 1000 complete (SVM wins=65.`%, ave. supports=3.`)...
141 of 1000 complete (SVM wins=65.24822695035462`%, ave. supports=3.`)...
142 of 1000 complete (SVM wins=65.49295774647888`%, ave. supports=3.`)...
143 of 1000 complete (SVM wins=65.03496503496503`%, ave. supports=3.`)...
144 of 1000 complete (SVM wins=65.27777777777779`%, ave. supports=3.`)...
145 of 1000 complete (SVM wins=64.82758620689654`%, ave. supports=3.`)...
146 of 1000 complete (SVM wins=64.38356164383562`%, ave. supports=3.`)...
147 of 1000 complete (SVM wins=64.62585034013605`%, ave. supports=3.`)...
148 of 1000 complete (SVM wins=64.1891891891892`%, ave. supports=3.`)...
149 of 1000 complete (SVM wins=63.758389261744966`%, ave. supports=3.`)...
150 of 1000 complete (SVM wins=63.33333333333333`%, ave. supports=3.`)...
151 of 1000 complete (SVM wins=62.913907284768214`%, ave. supports=3.`)...
152 of 1000 complete (SVM wins=63.1578947368421`%, ave. supports=3.`)...
153 of 1000 complete (SVM wins=63.39869281045751`%, ave. supports=3.`)...
154 of 1000 complete (SVM wins=62.98701298701299`%, ave. supports=3.`)...
155 of 1000 complete (SVM wins=63.2258064516129`%, ave. supports=3.`)...
156 of 1000 complete (SVM wins=63.46153846153846`%, ave. supports=3.`)...
157 of 1000 complete (SVM wins=63.69426751592356`%, ave. supports=3.`)...
158 of 1000 complete (SVM wins=63.92405063291139`%, ave. supports=3.`)...
159 of 1000 complete (SVM wins=64.15094339622641`%, ave. supports=3.`)...
160 of 1000 complete (SVM wins=64.375`%, ave. supports=3.`)...
161 of 1000 complete (SVM wins=64.59627329192547`%, ave. supports=3.`)...
```

162 of 1000 complete (SVM wins=64.81481481481481`%, ave. supports=3.`)...

163 of 1000 complete (SVM wins=64.41717791411043`%, ave. supports=3.`)...

164 of 1000 complete (SVM wins=64.63414634146342`%, ave. supports=3.`)...

165 of 1000 complete (SVM wins=64.84848484848484`%, ave. supports=3.`)...

166 of 1000 complete (SVM wins=64.45783132530121`%, ave. supports=3.`)...

167 of 1000 complete (SVM wins=64.07185628742515`%, ave. supports=3.`)...

168 of 1000 complete (SVM wins=63.69047619047619`%, ave. supports=3.`)...

169 of 1000 complete (SVM wins=63.905325443786985`%, ave. supports=3.`)...

170 of 1000 complete (SVM wins=63.52941176470588`%, ave. supports=3.`)...

171 of 1000 complete (SVM wins=63.74269005847953`%, ave. supports=3.`)...

172 of 1000 complete (SVM wins=63.372093023255815`%, ave. supports=3.`)...

173 of 1000 complete (SVM wins=63.005780346820806`%, ave. supports=3.`)...

174 of 1000 complete (SVM wins=62.643678160919535`%, ave. supports=3.`)...

175 of 1000 complete (SVM wins=62.857142857142854`%, ave. supports=3.`)...

176 of 1000 complete (SVM wins=63.06818181818182`%, ave. supports=3.`)...

177 of 1000 complete (SVM wins=63.2768361581921`%, ave. supports=3.`)...

178 of 1000 complete (SVM wins=63.48314606741573`%, ave. supports=3.`)...

179 of 1000 complete (SVM wins=63.687150837988824`%, ave. supports=3.`)...

180 of 1000 complete (SVM wins=63.888888888888886`%, ave. supports=3.`)...

181 of 1000 complete (SVM wins=64.08839779005525`%, ave. supports=3.`)...

182 of 1000 complete (SVM wins=63.73626373626373`%, ave. supports=3.`)...

183 of 1000 complete (SVM wins=63.387978142076506`%, ave. supports=3.`)...

184 of 1000 complete (SVM wins=63.58695652173913`%, ave. supports=3.`)...

185 of 1000 complete (SVM wins=63.24324324324324`%, ave. supports=3.`)...

186 of 1000 complete (SVM wins=62.903225806451616`%, ave. supports=3.`)...

187 of 1000 complete (SVM wins=63.101604278074866`%, ave. supports=3.`)...

188 of 1000 complete (SVM wins=62.76595744680851`%, ave. supports=3.`)...

189 of 1000 complete (SVM wins=62.96296296296296`%, ave. supports=3.`)...

190 of 1000 complete (SVM wins=63.1578947368421`%, ave. supports=3.0052631578947366`)...

191 of 1000 complete (SVM wins=63.35078534031413`%, ave. supports=3.005235602094241`)...

192 of 1000 complete (SVM
 wins=63.541666666666664`%, ave. supports=3.0052083333333335`)...

193 of 1000 complete (SVM wins=63.730569948186535`%, ave. supports=3.005181347150259`)...

194 of 1000 complete (SVM wins=63.4020618556701`%, ave. supports=3.0051546391752577`)...

195 of 1000 complete (SVM wins=63.589743589743584`%, ave. supports=3.005128205128205`)...

196 of 1000 complete (SVM
 wins=63.775510204081634`%, ave. supports=3.0051020408163267`)...

```
197 of 1000 complete (SVM wins=63.95939086294417`%, ave. supports=3.00507614213198`)...

198 of 1000 complete (SVM wins=63.63636363636363`%, ave. supports=3.005050505050505`)...

199 of 1000 complete (SVM wins=63.81909547738693`%, ave. supports=3.0050251256281406`)...

200 of 1000 complete (SVM wins=64.`%, ave. supports=3.005`)...

201 of 1000 complete (SVM wins=64.17910447761194`%, ave. supports=3.0049751243781095`)...

202 of 1000 complete (SVM wins=64.35643564356435`%, ave. supports=3.004950495049505`)...

203 of 1000 complete (SVM wins=64.5320197044335`%, ave. supports=3.0049261083743843`)...

204 of 1000 complete (SVM wins=64.70588235294117`%, ave. supports=3.0049019607843137`)...

205 of 1000 complete (SVM wins=64.8780487804878`%, ave. supports=3.004878048780488`)...

206 of 1000 complete (SVM wins=64.56310679611651`%, ave. supports=3.004854368932039`)...

207 of 1000 complete (SVM wins=64.25120772946859`%, ave. supports=3.004830917874396`)...

208 of 1000 complete (SVM
  wins=63.942307692307686`%, ave. supports=3.0048076923076925`)...

209 of 1000 complete (SVM wins=64.11483253588517`%, ave. supports=3.0047846889952154`)...

210 of 1000 complete (SVM wins=63.8095238095238`%, ave. supports=3.0047619047619047`)...

211 of 1000 complete (SVM wins=63.98104265402843`%, ave. supports=3.004739336492891`)...

212 of 1000 complete (SVM wins=63.67924528301887`%, ave. supports=3.0047169811320753`)...

213 of 1000 complete (SVM wins=63.84976525821596`%, ave. supports=3.004694835680751`)...

214 of 1000 complete (SVM wins=63.55140186915887`%, ave. supports=3.0046728971962615`)...

215 of 1000 complete (SVM wins=63.72093023255814`%, ave. supports=3.0046511627906978`)...

216 of 1000 complete (SVM wins=63.42592592592593`%, ave. supports=3.0046296296296298`)...

217 of 1000 complete (SVM
  wins=63.594470046082954`%, ave. supports=3.0046082949308754`)...

218 of 1000 complete (SVM wins=63.30275229357798`%, ave. supports=3.0045871559633026`)...

219 of 1000 complete (SVM wins=63.4703196347032`%, ave. supports=3.0045662100456623`)...

220 of 1000 complete (SVM wins=63.63636363636363`%, ave. supports=3.0045454545454544`)...

221 of 1000 complete (SVM wins=63.80090497737556`%, ave. supports=3.004524886877828`)...

222 of 1000 complete (SVM wins=63.51351351351351`%, ave. supports=3.0045045045045047`)...

223 of 1000 complete (SVM wins=63.67713004484305`%, ave. supports=3.004484304932735`)...

224 of 1000 complete (SVM wins=63.83928571428571`%, ave. supports=3.0044642857142856`)...

225 of 1000 complete (SVM wins=63.55555555555556`%, ave. supports=3.0044444444444443`)...

226 of 1000 complete (SVM wins=63.716814159292035`%, ave. supports=3.004424778761062`)...

227 of 1000 complete (SVM wins=63.87665198237885`%, ave. supports=3.004405286343612`)...

228 of 1000 complete (SVM wins=64.03508771929825`%, ave. supports=3.004385964912281`)...

229 of 1000 complete (SVM wins=63.75545851528385`%, ave. supports=3.004366812227074`)...

230 of 1000 complete (SVM wins=63.91304347826087`%, ave. supports=3.0043478260869567`)...

231 of 1000 complete (SVM wins=63.63636363636363`%, ave. supports=3.0043290043290045`)...
```

```
232 of 1000 complete (SVM
   wins=63.793103448275865`%, ave. supports=3.0043103448275863`)...

233 of 1000 complete (SVM wins=63.94849785407726`%, ave. supports=3.004291845493562`)...

234 of 1000 complete (SVM wins=64.1025641025641`%, ave. supports=3.0042735042735043`)...

235 of 1000 complete (SVM wins=63.829787234042556`%, ave. supports=3.008510638297872`)...

236 of 1000 complete (SVM
   wins=63.559322033898304`%, ave. supports=3.0084745762711864`)...

237 of 1000 complete (SVM wins=63.29113924050633`%, ave. supports=3.0084388185654007`)...

238 of 1000 complete (SVM wins=63.4453781512605`%, ave. supports=3.008403361344538`)...

239 of 1000 complete (SVM wins=63.59832635983263`%, ave. supports=3.00836820083682`)...

240 of 1000 complete (SVM wins=63.74999999999999`%, ave. supports=3.0083333333333333`)...

241 of 1000 complete (SVM wins=63.48547717842323`%, ave. supports=3.008298755186722`)...

242 of 1000 complete (SVM wins=63.63636363636363`%, ave. supports=3.0082644628099175`)...

243 of 1000 complete (SVM wins=63.78600823045267`%, ave. supports=3.0082304526748973`)...

244 of 1000 complete (SVM
   wins=63.934426229508205`%, ave. supports=3.0081967213114753`)...

245 of 1000 complete (SVM wins=63.6734693877551`%, ave. supports=3.0081632653061225`)...

246 of 1000 complete (SVM wins=63.82113821138211`%, ave. supports=3.008130081300813`)...

247 of 1000 complete (SVM wins=63.96761133603239`%, ave. supports=3.0080971659919027`)...

248 of 1000 complete (SVM wins=63.70967741935484`%, ave. supports=3.0080645161290325`)...

249 of 1000 complete (SVM wins=63.45381526104418`%, ave. supports=3.0080321285140563`)...

250 of 1000 complete (SVM wins=63.6`%, ave. supports=3.008`)...

251 of 1000 complete (SVM wins=63.34661354581673`%, ave. supports=3.00796812749004`)...

252 of 1000 complete (SVM wins=63.49206349206349`%, ave. supports=3.007936507936508`)...

253 of 1000 complete (SVM wins=63.63636363636363`%, ave. supports=3.007905138339921`)...

254 of 1000 complete (SVM wins=63.38582677165354`%, ave. supports=3.0078740157480315`)...

255 of 1000 complete (SVM wins=63.52941176470588`%, ave. supports=3.007843137254902`)...

256 of 1000 complete (SVM wins=63.671875`%, ave. supports=3.0078125`)...

257 of 1000 complete (SVM wins=63.42412451361867`%, ave. supports=3.007782101167315`)...

258 of 1000 complete (SVM wins=63.17829457364341`%, ave. supports=3.007751937984496`)...

259 of 1000 complete (SVM wins=62.93436293436293`%, ave. supports=3.0077220077220077`)...

260 of 1000 complete (SVM wins=62.69230769230769`%, ave. supports=3.0076923076923077`)...

261 of 1000 complete (SVM wins=62.83524904214559`%, ave. supports=3.007662835249042`)...

262 of 1000 complete (SVM wins=62.97709923664122`%, ave. supports=3.0076335877862594`)...

263 of 1000 complete (SVM wins=63.11787072243346`%, ave. supports=3.0076045627376424`)...

264 of 1000 complete (SVM wins=63.25757575757576`%, ave. supports=3.007575757575758`)...

265 of 1000 complete (SVM wins=63.39622641509434`%, ave. supports=3.0075471698113208`)...

266 of 1000 complete (SVM wins=63.1578947368421`%, ave. supports=3.007518796992481`)...
```

```
267 of 1000 complete (SVM wins=62.92134831460674`%, ave. supports=3.00749063670412`)...

268 of 1000 complete (SVM wins=62.68656716417911`%, ave. supports=3.0074626865671643`)...

269 of 1000 complete (SVM wins=62.45353159851301`%, ave. supports=3.007434944237918`)...

270 of 1000 complete (SVM wins=62.59259259259259`%, ave. supports=3.0074074074074075`)...

271 of 1000 complete (SVM wins=62.36162361623616`%, ave. supports=3.007380073800738`)...

272 of 1000 complete (SVM wins=62.5`%, ave. supports=3.0073529411764706`)...

273 of 1000 complete (SVM
  wins=62.637362637362635`%, ave. supports=3.0073260073260073`)...

274 of 1000 complete (SVM wins=62.77372262773723`%, ave. supports=3.0072992700729926`)...

275 of 1000 complete (SVM
  wins=62.909090909090914`%, ave. supports=3.0072727272727273`)...

276 of 1000 complete (SVM wins=63.04347826086957`%, ave. supports=3.0072463768115942`)...

277 of 1000 complete (SVM wins=63.1768953068592`%, ave. supports=3.0072202166064983`)...

278 of 1000 complete (SVM wins=62.94964028776978`%, ave. supports=3.0071942446043165`)...

279 of 1000 complete (SVM wins=63.08243727598566`%, ave. supports=3.007168458781362`)...

280 of 1000 complete (SVM wins=63.21428571428571`%, ave. supports=3.007142857142857`)...

281 of 1000 complete (SVM wins=62.989323843416365`%, ave. supports=3.00711743772242`)...

282 of 1000 complete (SVM wins=63.12056737588653`%, ave. supports=3.00709219858156`)...

283 of 1000 complete (SVM wins=63.25088339222616`%, ave. supports=3.0070671378091873`)...

284 of 1000 complete (SVM wins=63.38028169014085`%, ave. supports=3.007042253521127`)...

285 of 1000 complete (SVM wins=63.1578947368421`%, ave. supports=3.0105263157894737`)...

286 of 1000 complete (SVM
  wins=63.286713286713294`%, ave. supports=3.0104895104895104`)...

287 of 1000 complete (SVM wins=63.41463414634146`%, ave. supports=3.010452961672474`)...

288 of 1000 complete (SVM
  wins=63.541666666666664`%, ave. supports=3.0104166666666665`)...

289 of 1000 complete (SVM wins=63.32179930795848`%, ave. supports=3.01038062283737`)...

290 of 1000 complete (SVM wins=63.44827586206897`%, ave. supports=3.010344827586207`)...

291 of 1000 complete (SVM
  wins=63.230240549828174`%, ave. supports=3.0103092783505154`)...

292 of 1000 complete (SVM wins=63.013698630136986`%, ave. supports=3.01027397260274`)...

293 of 1000 complete (SVM wins=63.13993174061433`%, ave. supports=3.0102389078498293`)...

294 of 1000 complete (SVM wins=63.26530612244898`%, ave. supports=3.010204081632653`)...

295 of 1000 complete (SVM wins=63.389830508474574`%, ave. supports=3.010169491525424`)...

296 of 1000 complete (SVM wins=63.17567567567568`%, ave. supports=3.010135135135135`)...

297 of 1000 complete (SVM wins=62.96296296296296`%, ave. supports=3.01010101010101`)...

298 of 1000 complete (SVM wins=63.08724832214765`%, ave. supports=3.01006711409396`)...

299 of 1000 complete (SVM wins=63.21070234113713`%, ave. supports=3.0100334448160537`)...

300 of 1000 complete (SVM wins=63.33333333333333`%, ave. supports=3.01`)...
```

301 of 1000 complete (SVM wins=63.12292358803987`%, ave. supports=3.009966777408638`)...

302 of 1000 complete (SVM
  wins=62.913907284768214`%, ave. supports=3.0099337748344372`)...

303 of 1000 complete (SVM wins=62.70627062706271`%, ave. supports=3.00990099009901`)...

304 of 1000 complete (SVM wins=62.82894736842105`%, ave. supports=3.0098684210526314`)...

305 of 1000 complete (SVM wins=62.62295081967213`%, ave. supports=3.0098360655737704`)...

306 of 1000 complete (SVM
  wins=62.745098039215684`%, ave. supports=3.0098039215686274`)...

307 of 1000 complete (SVM wins=62.866449511400646`%, ave. supports=3.009771986970684`)...

308 of 1000 complete (SVM wins=62.98701298701299`%, ave. supports=3.00974025974026`)...

309 of 1000 complete (SVM wins=62.7831715210356`%, ave. supports=3.0097087378640777`)...

310 of 1000 complete (SVM wins=62.58064516129033`%, ave. supports=3.009677419354839`)...

311 of 1000 complete (SVM wins=62.70096463022507`%, ave. supports=3.009646302250804`)...

312 of 1000 complete (SVM wins=62.5`%, ave. supports=3.0096153846153846`)...

313 of 1000 complete (SVM wins=62.30031948881789`%, ave. supports=3.009584664536741`)...

314 of 1000 complete (SVM
  wins=62.101910828025474`%, ave. supports=3.0095541401273884`)...

315 of 1000 complete (SVM wins=62.22222222222222`%, ave. supports=3.0095238095238095`)...

316 of 1000 complete (SVM wins=62.34177215189873`%, ave. supports=3.009493670886076`)...

317 of 1000 complete (SVM wins=62.46056782334385`%, ave. supports=3.0094637223974763`)...

318 of 1000 complete (SVM wins=62.57861635220125`%, ave. supports=3.009433962264151`)...

319 of 1000 complete (SVM wins=62.38244514106584`%, ave. supports=3.0094043887147337`)...

320 of 1000 complete (SVM wins=62.5`%, ave. supports=3.009375`)...

321 of 1000 complete (SVM
  wins=62.616822429906534`%, ave. supports=3.0093457943925235`)...

322 of 1000 complete (SVM
  wins=62.422360248447205`%, ave. supports=3.0093167701863353`)...

323 of 1000 complete (SVM wins=62.22910216718266`%, ave. supports=3.0092879256965945`)...

324 of 1000 complete (SVM wins=62.34567901234568`%, ave. supports=3.009259259259259`)...

325 of 1000 complete (SVM wins=62.46153846153846`%, ave. supports=3.0092307692307694`)...

326 of 1000 complete (SVM wins=62.26993865030674`%, ave. supports=3.0092024539877302`)...

327 of 1000 complete (SVM
  wins=62.079510703363916`%, ave. supports=3.0091743119266057`)...

328 of 1000 complete (SVM wins=62.19512195121951`%, ave. supports=3.0091463414634148`)...

329 of 1000 complete (SVM wins=62.31003039513677`%, ave. supports=3.0091185410334345`)...

330 of 1000 complete (SVM wins=62.42424242424243`%, ave. supports=3.0090909090909093`)...

331 of 1000 complete (SVM wins=62.2356495468278`%, ave. supports=3.009063444108761`)...

332 of 1000 complete (SVM
  wins=62.048192771084345`%, ave. supports=3.0090361445783134`)...

333 of 1000 complete (SVM wins=62.16216216216216`%, ave. supports=3.009009009009009`)...

```
334 of 1000 complete (SVM wins=62.27544910179641`%, ave. supports=3.0089820359281436`)...

335 of 1000 complete (SVM wins=62.38805970149254`%, ave. supports=3.008955223880597`)...

336 of 1000 complete (SVM wins=62.5`%, ave. supports=3.0089285714285716`)...

337 of 1000 complete (SVM wins=62.61127596439169`%, ave. supports=3.0089020771513355`)...

338 of 1000 complete (SVM
  wins=62.721893491124256`%, ave. supports=3.0088757396449703`)...

339 of 1000 complete (SVM wins=62.83185840707964`%, ave. supports=3.0088495575221237`)...

340 of 1000 complete (SVM wins=62.94117647058823`%, ave. supports=3.0088235294117647`)...

341 of 1000 complete (SVM
  wins=63.049853372434015`%, ave. supports=3.0087976539589443`)...

342 of 1000 complete (SVM wins=62.86549707602339`%, ave. supports=3.008771929824561`)...

343 of 1000 complete (SVM wins=62.973760932944614`%, ave. supports=3.008746355685131`)...

344 of 1000 complete (SVM wins=63.08139534883721`%, ave. supports=3.008720930232558`)...

345 of 1000 complete (SVM wins=63.18840579710145`%, ave. supports=3.008695652173913`)...

346 of 1000 complete (SVM wins=63.005780346820806`%, ave. supports=3.008670520231214`)...

347 of 1000 complete (SVM
  wins=62.824207492795395`%, ave. supports=3.0086455331412103`)...

348 of 1000 complete (SVM wins=62.93103448275862`%, ave. supports=3.0086206896551726`)...

349 of 1000 complete (SVM wins=62.75071633237822`%, ave. supports=3.008595988538682`)...

350 of 1000 complete (SVM wins=62.57142857142857`%, ave. supports=3.0085714285714285`)...

351 of 1000 complete (SVM wins=62.67806267806267`%, ave. supports=3.0085470085470085`)...

352 of 1000 complete (SVM wins=62.78409090909091`%, ave. supports=3.008522727272727`)...

353 of 1000 complete (SVM wins=62.606232294617556`%, ave. supports=3.008498583569405`)...

354 of 1000 complete (SVM wins=62.71186440677966`%, ave. supports=3.0084745762711864`)...

355 of 1000 complete (SVM wins=62.81690140845071`%, ave. supports=3.008450704225352`)...

356 of 1000 complete (SVM wins=62.92134831460674`%, ave. supports=3.008426966292135`)...

357 of 1000 complete (SVM wins=63.02521008403361`%, ave. supports=3.008403361344538`)...

358 of 1000 complete (SVM
  wins=63.128491620111724`%, ave. supports=3.0083798882681565`)...

359 of 1000 complete (SVM wins=62.95264623955432`%, ave. supports=3.0083565459610027`)...

360 of 1000 complete (SVM wins=62.77777777777778`%, ave. supports=3.0083333333333333`)...

361 of 1000 complete (SVM
  wins=62.603878116343495`%, ave. supports=3.0083102493074794`)...

362 of 1000 complete (SVM
  wins=62.430939226519335`%, ave. supports=3.0082872928176796`)...

363 of 1000 complete (SVM wins=62.53443526170799`%, ave. supports=3.0082644628099175`)...

364 of 1000 complete (SVM wins=62.637362637362635`%, ave. supports=3.008241758241758`)...

365 of 1000 complete (SVM wins=62.73972602739726`%, ave. supports=3.0082191780821916`)...

366 of 1000 complete (SVM
  wins=62.568306010928964`%, ave. supports=3.0081967213114753`)...
```

367 of 1000 complete (SVM wins=62.67029972752044`%, ave. supports=3.008174386920981`)...

368 of 1000 complete (SVM wins=62.77173913043478`%, ave. supports=3.0081521739130435`)...

369 of 1000 complete (SVM wins=62.87262872628726`%, ave. supports=3.008130081300813`)...

370 of 1000 complete (SVM
  wins=62.972972972972975`%, ave. supports=3.0081081081081082`)...

371 of 1000 complete (SVM wins=63.07277628032345`%, ave. supports=3.0080862533692723`)...

372 of 1000 complete (SVM wins=63.17204301075269`%, ave. supports=3.0080645161290325`)...

373 of 1000 complete (SVM wins=63.27077747989276`%, ave. supports=3.008042895442359`)...

374 of 1000 complete (SVM wins=63.36898395721925`%, ave. supports=3.0080213903743314`)...

375 of 1000 complete (SVM wins=63.46666666666667`%, ave. supports=3.008`)...

376 of 1000 complete (SVM wins=63.297872340425535`%, ave. supports=3.007978723404255`)...

377 of 1000 complete (SVM
  wins=63.395225464190986`%, ave. supports=3.0079575596816976`)...

378 of 1000 complete (SVM wins=63.49206349206349`%, ave. supports=3.007936507936508`)...

379 of 1000 complete (SVM wins=63.58839050131926`%, ave. supports=3.0079155672823217`)...

380 of 1000 complete (SVM wins=63.68421052631579`%, ave. supports=3.0078947368421054`)...

381 of 1000 complete (SVM wins=63.77952755905512`%, ave. supports=3.0078740157480315`)...

382 of 1000 complete (SVM wins=63.87434554973822`%, ave. supports=3.007853403141361`)...

383 of 1000 complete (SVM wins=63.9686684073107`%, ave. supports=3.0078328981723237`)...

384 of 1000 complete (SVM wins=64.0625`%, ave. supports=3.0078125`)...

385 of 1000 complete (SVM wins=64.15584415584415`%, ave. supports=3.0077922077922077`)...

386 of 1000 complete (SVM wins=64.24870466321244`%, ave. supports=3.0077720207253886`)...

387 of 1000 complete (SVM wins=64.08268733850129`%, ave. supports=3.007751937984496`)...

388 of 1000 complete (SVM wins=63.91752577319587`%, ave. supports=3.0077319587628866`)...

389 of 1000 complete (SVM wins=64.01028277634961`%, ave. supports=3.007712082262211`)...

390 of 1000 complete (SVM wins=64.1025641025641`%, ave. supports=3.0076923076923077`)...

391 of 1000 complete (SVM wins=64.19437340153452`%, ave. supports=3.0076726342710995`)...

392 of 1000 complete (SVM wins=64.03061224489795`%, ave. supports=3.00765306122449`)...

393 of 1000 complete (SVM wins=64.12213740458014`%, ave. supports=3.0076335877862594`)...

394 of 1000 complete (SVM wins=64.21319796954315`%, ave. supports=3.0076142131979697`)...

395 of 1000 complete (SVM wins=64.30379746835443`%, ave. supports=3.007594936708861`)...

396 of 1000 complete (SVM wins=64.39393939393939`%, ave. supports=3.007575757575758`)...

397 of 1000 complete (SVM wins=64.48362720403023`%, ave. supports=3.0075566750629723`)...

398 of 1000 complete (SVM wins=64.57286432160804`%, ave. supports=3.007537688442211`)...

399 of 1000 complete (SVM wins=64.41102756892231`%, ave. supports=3.007518796992481`)...

400 of 1000 complete (SVM wins=64.25`%, ave. supports=3.0075`)...

401 of 1000 complete (SVM wins=64.33915211970074`%, ave. supports=3.0074812967581046`)...

```
402 of 1000 complete (SVM wins=64.42786069651741`%, ave. supports=3.0074626865671643`)...
403 of 1000 complete (SVM wins=64.26799007444168`%, ave. supports=3.0074441687344913`)...
404 of 1000 complete (SVM wins=64.35643564356435`%, ave. supports=3.007425742574257`)...
405 of 1000 complete (SVM wins=64.44444444444444`%, ave. supports=3.0074074074074075`)...
406 of 1000 complete (SVM wins=64.5320197044335`%, ave. supports=3.0073891625615765`)...
407 of 1000 complete (SVM wins=64.61916461916462`%, ave. supports=3.0073710073710074`)...
408 of 1000 complete (SVM wins=64.70588235294117`%, ave. supports=3.0073529411764706`)...
409 of 1000 complete (SVM wins=64.54767726161369`%, ave. supports=3.0073349633251834`)...
410 of 1000 complete (SVM wins=64.63414634146342`%, ave. supports=3.0073170731707317`)...
411 of 1000 complete (SVM wins=64.47688564476886`%, ave. supports=3.0072992700729926`)...
412 of 1000 complete (SVM wins=64.32038834951457`%, ave. supports=3.0072815533980584`)...
413 of 1000 complete (SVM wins=64.40677966101694`%, ave. supports=3.0072639225181597`)...
414 of 1000 complete (SVM wins=64.4927536231884`%, ave. supports=3.0072463768115942`)...
415 of 1000 complete (SVM wins=64.33734939759036`%, ave. supports=3.0072289156626506`)...
416 of 1000 complete (SVM wins=64.1826923076923`%, ave. supports=3.0072115384615383`)...
417 of 1000 complete (SVM wins=64.26858513189448`%, ave. supports=3.0071942446043165`)...
418 of 1000 complete (SVM wins=64.11483253588517`%, ave. supports=3.007177033492823`)...
419 of 1000 complete (SVM wins=63.961813842482094`%, ave. supports=3.007159904534606`)...
420 of 1000 complete (SVM wins=64.04761904761904`%, ave. supports=3.007142857142857`)...
421 of 1000 complete (SVM wins=64.13301662707839`%, ave. supports=3.007125890736342`)...
422 of 1000 complete (SVM wins=63.98104265402843`%, ave. supports=3.0071090047393363`)...
423 of 1000 complete (SVM wins=64.0661938534279`%, ave. supports=3.00709219858156`)...
424 of 1000 complete (SVM wins=64.15094339622641`%, ave. supports=3.0070754716981134`)...
425 of 1000 complete (SVM wins=64.23529411764706`%, ave. supports=3.0070588235294116`)...
426 of 1000 complete (SVM wins=64.08450704225352`%, ave. supports=3.007042253521127`)...
427 of 1000 complete (SVM wins=64.16861826697892`%, ave. supports=3.0070257611241216`)...
428 of 1000 complete (SVM wins=64.25233644859813`%, ave. supports=3.0070093457943927`)...
429 of 1000 complete (SVM wins=64.1025641025641`%, ave. supports=3.006993006993007`)...
430 of 1000 complete (SVM wins=64.18604651162791`%, ave. supports=3.0093023255813955`)...
431 of 1000 complete (SVM wins=64.2691415313225`%, ave. supports=3.0092807424593966`)...
432 of 1000 complete (SVM wins=64.35185185185185`%, ave. supports=3.009259259259259`)...
433 of 1000 complete (SVM wins=64.20323325635104`%, ave. supports=3.0092378752886835`)...
434 of 1000 complete (SVM wins=64.0552995391705`%, ave. supports=3.0092165898617513`)...
435 of 1000 complete (SVM wins=63.9080459770115`%, ave. supports=3.0091954022988507`)...
436 of 1000 complete (SVM wins=63.76146788990825`%, ave. supports=3.0091743119266057`)...
437 of 1000 complete (SVM wins=63.84439359267735`%, ave. supports=3.009153318077803`)...
```

```
438 of 1000 complete (SVM wins=63.926940639269404`%, ave. supports=3.009132420091324`)...
439 of 1000 complete (SVM wins=63.781321184510254`%, ave. supports=3.009111617312073`)...
440 of 1000 complete (SVM wins=63.86363636363637`%, ave. supports=3.0090909090909093`)...
441 of 1000 complete (SVM wins=63.94557823129252`%, ave. supports=3.0090702947845807`)...
442 of 1000 complete (SVM wins=63.80090497737556`%, ave. supports=3.009049773755656`)...
443 of 1000 complete (SVM wins=63.88261851015802`%, ave. supports=3.0090293453724604`)...
444 of 1000 complete (SVM wins=63.96396396396396`%, ave. supports=3.009009009009009`)...
445 of 1000 complete (SVM wins=64.04494382022472`%, ave. supports=3.0089887640449438`)...
446 of 1000 complete (SVM wins=64.12556053811659`%, ave. supports=3.008968609865471`)...
447 of 1000 complete (SVM wins=64.20581655480984`%, ave. supports=3.0089485458612977`)...
448 of 1000 complete (SVM wins=64.28571428571429`%, ave. supports=3.0089285714285716`)...
449 of 1000 complete (SVM wins=64.3652561247216`%, ave. supports=3.0089086859688194`)...
450 of 1000 complete (SVM wins=64.22222222222223`%, ave. supports=3.008888888888889`)...
451 of 1000 complete (SVM wins=64.30155210643017`%, ave. supports=3.008869179600887`)...
452 of 1000 complete (SVM wins=64.38053097345133`%, ave. supports=3.0088495575221237`)...
453 of 1000 complete (SVM wins=64.45916114790286`%, ave. supports=3.0088300220750552`)...
454 of 1000 complete (SVM wins=64.53744493392071`%, ave. supports=3.0088105726872247`)...
455 of 1000 complete (SVM wins=64.3956043956044`%, ave. supports=3.0087912087912088`)...
456 of 1000 complete (SVM wins=64.47368421052632`%, ave. supports=3.008771929824561`)...
457 of 1000 complete (SVM wins=64.33260393873084`%, ave. supports=3.008752735229759`)...
458 of 1000 complete (SVM wins=64.41048034934498`%, ave. supports=3.0087336244541483`)...
459 of 1000 complete (SVM wins=64.4880174291939`%, ave. supports=3.008714596949891`)...
460 of 1000 complete (SVM wins=64.34782608695652`%, ave. supports=3.008695652173913`)...
461 of 1000 complete (SVM wins=64.20824295010846`%, ave. supports=3.0086767895878523`)...
462 of 1000 complete (SVM wins=64.06926406926407`%, ave. supports=3.0086580086580086`)...
463 of 1000 complete (SVM wins=64.14686825053995`%, ave. supports=3.0107991360691146`)...
464 of 1000 complete (SVM wins=64.22413793103449`%, ave. supports=3.0107758620689653`)...
465 of 1000 complete (SVM wins=64.08602150537635`%, ave. supports=3.010752688172043`)...
466 of 1000 complete (SVM wins=64.16309012875536`%, ave. supports=3.0107296137339055`)...
467 of 1000 complete (SVM wins=64.02569593147751`%, ave. supports=3.0107066381156318`)...
468 of 1000 complete (SVM wins=64.1025641025641`%, ave. supports=3.0106837606837606`)...
469 of 1000 complete (SVM wins=64.17910447761194`%, ave. supports=3.0106609808102345`)...
470 of 1000 complete (SVM wins=64.25531914893618`%, ave. supports=3.0106382978723403`)...
471 of 1000 complete (SVM wins=64.3312101910828`%, ave. supports=3.010615711252654`)...
472 of 1000 complete (SVM wins=64.19491525423729`%, ave. supports=3.010593220338983`)...
473 of 1000 complete (SVM wins=64.05919661733616`%, ave. supports=3.010570824524313`)...
```

```
474 of 1000 complete (SVM wins=63.92405063291139`%, ave. supports=3.0105485232067513`)...

475 of 1000 complete (SVM wins=63.78947368421053`%, ave. supports=3.0105263157894737`)...

476 of 1000 complete (SVM wins=63.86554621848739`%, ave. supports=3.0105042016806722`)...

477 of 1000 complete (SVM wins=63.941299790356396`%, ave. supports=3.010482180293501`)...

478 of 1000 complete (SVM wins=63.80753138075313`%, ave. supports=3.010460251046025`)...

479 of 1000 complete (SVM wins=63.67432150313152`%, ave. supports=3.010438413361169`)...

480 of 1000 complete (SVM
  wins=63.541666666666664`%, ave. supports=3.0104166666666665`)...

481 of 1000 complete (SVM wins=63.61746361746362`%, ave. supports=3.0103950103950106`)...

482 of 1000 complete (SVM wins=63.69294605809128`%, ave. supports=3.0103734439834025`)...

483 of 1000 complete (SVM wins=63.76811594202898`%, ave. supports=3.010351966873706`)...

484 of 1000 complete (SVM wins=63.84297520661158`%, ave. supports=3.010330578512397`)...

485 of 1000 complete (SVM wins=63.71134020618556`%, ave. supports=3.0103092783505154`)...

486 of 1000 complete (SVM wins=63.78600823045267`%, ave. supports=3.0102880658436213`)...

487 of 1000 complete (SVM
  wins=63.860369609856264`%, ave. supports=3.0102669404517455`)...

488 of 1000 complete (SVM
  wins=63.934426229508205`%, ave. supports=3.0102459016393444`)...

489 of 1000 complete (SVM wins=64.0081799591002`%, ave. supports=3.0102249488752557`)...

490 of 1000 complete (SVM wins=63.87755102040816`%, ave. supports=3.010204081632653`)...

491 of 1000 complete (SVM wins=63.951120162932796`%, ave. supports=3.010183299389002`)...

492 of 1000 complete (SVM wins=64.02439024390245`%, ave. supports=3.0101626016260163`)...

493 of 1000 complete (SVM wins=64.09736308316431`%, ave. supports=3.0101419878296145`)...

494 of 1000 complete (SVM wins=64.17004048582996`%, ave. supports=3.0101214574898787`)...

495 of 1000 complete (SVM wins=64.24242424242425`%, ave. supports=3.01010101010101`)...

496 of 1000 complete (SVM wins=64.31451612903226`%, ave. supports=3.0100806451612905`)...

497 of 1000 complete (SVM wins=64.1851106639839`%, ave. supports=3.0100603621730384`)...

498 of 1000 complete (SVM wins=64.2570281124498`%, ave. supports=3.0100401606425704`)...

499 of 1000 complete (SVM wins=64.32865731462925`%, ave. supports=3.0100200400801604`)...

500 of 1000 complete (SVM wins=64.4`%, ave. supports=3.01`)...

501 of 1000 complete (SVM wins=64.47105788423154`%, ave. supports=3.0099800399201597`)...

502 of 1000 complete (SVM wins=64.5418326693227`%, ave. supports=3.00996015936255`)...

503 of 1000 complete (SVM wins=64.41351888667992`%, ave. supports=3.0099403578528827`)...

504 of 1000 complete (SVM wins=64.48412698412699`%, ave. supports=3.009920634920635`)...

505 of 1000 complete (SVM wins=64.55445544554456`%, ave. supports=3.00990099009901`)...

506 of 1000 complete (SVM wins=64.42687747035573`%, ave. supports=3.0098814229249014`)...

507 of 1000 complete (SVM wins=64.29980276134121`%, ave. supports=3.009861932938856`)...

508 of 1000 complete (SVM wins=64.37007874015748`%, ave. supports=3.0098425196850394`)...
```

```
509 of 1000 complete (SVM wins=64.44007858546169`%, ave. supports=3.0098231827111985`)...
510 of 1000 complete (SVM wins=64.50980392156863`%, ave. supports=3.0098039215686274`)...
511 of 1000 complete (SVM wins=64.38356164383562`%, ave. supports=3.01174168297456`)...
512 of 1000 complete (SVM wins=64.453125`%, ave. supports=3.01171875`)...
513 of 1000 complete (SVM wins=64.5224171539961`%, ave. supports=3.0116959064327484`)...
514 of 1000 complete (SVM wins=64.39688715953308`%, ave. supports=3.0116731517509727`)...
515 of 1000 complete (SVM wins=64.27184466019418`%, ave. supports=3.0116504854368933`)...
516 of 1000 complete (SVM wins=64.34108527131784`%, ave. supports=3.011627906976744`)...
517 of 1000 complete (SVM wins=64.21663442940039`%, ave. supports=3.011605415860735`)...
518 of 1000 complete (SVM wins=64.28571428571429`%, ave. supports=3.011583011583012`)...
519 of 1000 complete (SVM wins=64.35452793834297`%, ave. supports=3.0115606936416186`)...
520 of 1000 complete (SVM wins=64.23076923076924`%, ave. supports=3.0115384615384615`)...
521 of 1000 complete (SVM wins=64.10748560460652`%, ave. supports=3.0115163147792705`)...
522 of 1000 complete (SVM wins=64.17624521072797`%, ave. supports=3.0114942528735633`)...
523 of 1000 complete (SVM wins=64.24474187380497`%, ave. supports=3.011472275334608`)...
524 of 1000 complete (SVM wins=64.31297709923665`%, ave. supports=3.0114503816793894`)...
525 of 1000 complete (SVM wins=64.38095238095238`%, ave. supports=3.0114285714285716`)...
526 of 1000 complete (SVM wins=64.25855513307985`%, ave. supports=3.011406844106464`)...
527 of 1000 complete (SVM wins=64.32637571157495`%, ave. supports=3.0113851992409866`)...
528 of 1000 complete (SVM wins=64.39393939393939`%, ave. supports=3.0113636363636362`)...
529 of 1000 complete (SVM wins=64.27221172022685`%, ave. supports=3.011342155009452`)...
530 of 1000 complete (SVM wins=64.33962264150944`%, ave. supports=3.0113207547169814`)...
531 of 1000 complete (SVM wins=64.40677966101694`%, ave. supports=3.0112994350282487`)...
532 of 1000 complete (SVM wins=64.47368421052632`%, ave. supports=3.011278195488722`)...
533 of 1000 complete (SVM wins=64.54033771106941`%, ave. supports=3.0112570356472794`)...
534 of 1000 complete (SVM wins=64.60674157303372`%, ave. supports=3.0112359550561796`)...
535 of 1000 complete (SVM wins=64.48598130841121`%, ave. supports=3.011214953271028`)...
536 of 1000 complete (SVM wins=64.55223880597015`%, ave. supports=3.0111940298507465`)...
537 of 1000 complete (SVM wins=64.61824953445065`%, ave. supports=3.011173184357542`)...
538 of 1000 complete (SVM wins=64.68401486988847`%, ave. supports=3.0111524163568775`)...
539 of 1000 complete (SVM wins=64.7495361781076`%, ave. supports=3.0111317254174397`)...
540 of 1000 complete (SVM wins=64.81481481481481`%, ave. supports=3.011111111111111`)...
541 of 1000 complete (SVM wins=64.69500924214418`%, ave. supports=3.011090573012939`)...
542 of 1000 complete (SVM wins=64.76014760147602`%, ave. supports=3.011070110701107`)...
543 of 1000 complete (SVM wins=64.82504604051566`%, ave. supports=3.0110497237569063`)...
544 of 1000 complete (SVM wins=64.88970588235294`%, ave. supports=3.011029411764706`)...
```

```
545 of 1000 complete (SVM wins=64.95412844036697`%, ave. supports=3.0110091743119267`)...
546 of 1000 complete (SVM wins=65.01831501831502`%, ave. supports=3.010989010989011`)...
547 of 1000 complete (SVM wins=65.08226691042047`%, ave. supports=3.010968921389397`)...
548 of 1000 complete (SVM wins=65.14598540145985`%, ave. supports=3.010948905109489`)...
549 of 1000 complete (SVM wins=65.20947176684882`%, ave. supports=3.010928961748634`)...
550 of 1000 complete (SVM wins=65.27272727272727`%, ave. supports=3.0109090909090908`)...
551 of 1000 complete (SVM wins=65.33575317604355`%, ave. supports=3.010889292196007`)...
552 of 1000 complete (SVM wins=65.21739130434783`%, ave. supports=3.010869565217391`)...
553 of 1000 complete (SVM wins=65.28028933092224`%, ave. supports=3.0108499095840866`)...
554 of 1000 complete (SVM wins=65.34296028880865`%, ave. supports=3.0108303249097474`)...
555 of 1000 complete (SVM wins=65.22522522522523`%, ave. supports=3.0108108108108107`)...
556 of 1000 complete (SVM wins=65.28776978417267`%, ave. supports=3.0107913669064748`)...
557 of 1000 complete (SVM wins=65.1705565529623`%, ave. supports=3.0107719928186714`)...
558 of 1000 complete (SVM wins=65.23297491039428`%, ave. supports=3.010752688172043`)...
559 of 1000 complete (SVM wins=65.29516994633273`%, ave. supports=3.0107334525939176`)...
560 of 1000 complete (SVM wins=65.35714285714286`%, ave. supports=3.0107142857142857`)...
561 of 1000 complete (SVM wins=65.41889483065954`%, ave. supports=3.0106951871657754`)...
562 of 1000 complete (SVM wins=65.48042704626334`%, ave. supports=3.0106761565836297`)...
563 of 1000 complete (SVM wins=65.54174067495559`%, ave. supports=3.0106571936056836`)...
564 of 1000 complete (SVM wins=65.42553191489363`%, ave. supports=3.0106382978723403`)...
565 of 1000 complete (SVM wins=65.48672566371681`%, ave. supports=3.010619469026549`)...
566 of 1000 complete (SVM wins=65.54770318021201`%, ave. supports=3.010600706713781`)...
567 of 1000 complete (SVM wins=65.4320987654321`%, ave. supports=3.0105820105820107`)...
568 of 1000 complete (SVM wins=65.3169014084507`%, ave. supports=3.01056338028169`)...
569 of 1000 complete (SVM wins=65.37785588752196`%, ave. supports=3.0105448154657295`)...
570 of 1000 complete (SVM wins=65.43859649122807`%, ave. supports=3.008771929824561`)...
571 of 1000 complete (SVM wins=65.49912434325745`%, ave. supports=3.008756567425569`)...
572 of 1000 complete (SVM wins=65.55944055944056`%, ave. supports=3.0087412587412588`)...
573 of 1000 complete (SVM wins=65.44502617801047`%, ave. supports=3.0087260034904015`)...
574 of 1000 complete (SVM wins=65.50522648083623`%, ave. supports=3.008710801393728`)...
575 of 1000 complete (SVM wins=65.39130434782608`%, ave. supports=3.008695652173913`)...
576 of 1000 complete (SVM wins=65.27777777777779`%, ave. supports=3.0086805555555554`)...
577 of 1000 complete (SVM wins=65.33795493934143`%, ave. supports=3.0086655112651646`)...
578 of 1000 complete (SVM wins=65.39792387543253`%, ave. supports=3.0086650519031142`)...
579 of 1000 complete (SVM wins=65.45768566493955`%, ave. supports=3.0086355785837653`)...
580 of 1000 complete (SVM wins=65.51724137931035`%, ave. supports=3.0086206896551726`)...
```

```
581 of 1000 complete (SVM wins=65.57659208261619`%, ave. supports=3.008605851979346`)...
582 of 1000 complete (SVM wins=65.63573883161511`%, ave. supports=3.008591065292096`)...
583 of 1000 complete (SVM wins=65.52315608919382`%, ave. supports=3.008576329331046`)...
584 of 1000 complete (SVM wins=65.58219178082192`%, ave. supports=3.0085616438356166`)...
585 of 1000 complete (SVM wins=65.47008547008546`%, ave. supports=3.0085470085470085`)...
586 of 1000 complete (SVM wins=65.52901023890784`%, ave. supports=3.008532423208191`)...
587 of 1000 complete (SVM wins=65.58773424190801`%, ave. supports=3.008517887563884`)...
588 of 1000 complete (SVM wins=65.64625850340136`%, ave. supports=3.008503401360544`)...
589 of 1000 complete (SVM wins=65.53480475382003`%, ave. supports=3.0084889643463497`)...
590 of 1000 complete (SVM wins=65.42372881355932`%, ave. supports=3.0084745762711864`)...
591 of 1000 complete (SVM wins=65.48223350253807`%, ave. supports=3.008460236886633`)...
592 of 1000 complete (SVM wins=65.54054054054053`%, ave. supports=3.008445945945946`)...
593 of 1000 complete (SVM wins=65.43001686340641`%, ave. supports=3.0084317032040473`)...
594 of 1000 complete (SVM wins=65.31986531986533`%, ave. supports=3.008417508417508`)...
595 of 1000 complete (SVM wins=65.21008403361344`%, ave. supports=3.008403361344538`)...
596 of 1000 complete (SVM wins=65.26845637583892`%, ave. supports=3.0083892617449663`)...
597 of 1000 complete (SVM wins=65.15912897822446`%, ave. supports=3.0083752093802345`)...
598 of 1000 complete (SVM wins=65.21739130434783`%, ave. supports=3.008361204013378`)...
599 of 1000 complete (SVM wins=65.27545909849749`%, ave. supports=3.008347245409015`)...
600 of 1000 complete (SVM wins=65.16666666666666`%, ave. supports=3.0083333333333333`)...
601 of 1000 complete (SVM wins=65.22462562396007`%, ave. supports=3.0083194675540765`)...
602 of 1000 complete (SVM wins=65.28239202657808`%, ave. supports=3.0083056478405314`)...
603 of 1000 complete (SVM wins=65.17412935323384`%, ave. supports=3.0082918739635156`)...
604 of 1000 complete (SVM wins=65.23178807947019`%, ave. supports=3.0082781456953644`)...
605 of 1000 complete (SVM wins=65.12396694214875`%, ave. supports=3.0082644628099175`)...
606 of 1000 complete (SVM wins=65.18151815181518`%, ave. supports=3.0082508250825084`)...
607 of 1000 complete (SVM wins=65.23887973640856`%, ave. supports=3.0082372322899507`)...
608 of 1000 complete (SVM wins=65.29605263157895`%, ave. supports=3.008223684210526`)...
609 of 1000 complete (SVM wins=65.1888341543514`%, ave. supports=3.0082101806239736`)...
610 of 1000 complete (SVM wins=65.24590163934427`%, ave. supports=3.0081967213114753`)...
611 of 1000 complete (SVM wins=65.30278232405891`%, ave. supports=3.0081833060556464`)...
612 of 1000 complete (SVM wins=65.359477124183`%, ave. supports=3.008169934640523`)...
613 of 1000 complete (SVM wins=65.41598694942904`%, ave. supports=3.00815660685155`)...
614 of 1000 complete (SVM wins=65.30944625407166`%, ave. supports=3.00814332247557`)...
615 of 1000 complete (SVM wins=65.3658536585366`%, ave. supports=3.008130081300813`)...
616 of 1000 complete (SVM wins=65.42207792207793`%, ave. supports=3.008116883116883`)...
```

```
617 of 1000 complete (SVM wins=65.47811993517017`%, ave. supports=3.0081037277147487`)...
618 of 1000 complete (SVM wins=65.53398058252428`%, ave. supports=3.0080906148867315`)...
619 of 1000 complete (SVM wins=65.4281098546042`%, ave. supports=3.008077544426494`)...
620 of 1000 complete (SVM wins=65.32258064516128`%, ave. supports=3.0080645161290325`)...
621 of 1000 complete (SVM wins=65.37842190016103`%, ave. supports=3.0080515297906603`)...
622 of 1000 complete (SVM wins=65.27331189710611`%, ave. supports=3.008038585209003`)...
623 of 1000 complete (SVM wins=65.32905296950241`%, ave. supports=3.0080256821829856`)...
624 of 1000 complete (SVM wins=65.38461538461539`%, ave. supports=3.0080128205128207`)...
625 of 1000 complete (SVM wins=65.28`%, ave. supports=3.008`)...
626 of 1000 complete (SVM wins=65.33546325878594`%, ave. supports=3.0079872204472844`)...
627 of 1000 complete (SVM wins=65.23125996810208`%, ave. supports=3.007974481658692`)...
628 of 1000 complete (SVM wins=65.12738853503186`%, ave. supports=3.0079617834394905`)...
629 of 1000 complete (SVM wins=65.18282988871225`%, ave. supports=3.0079491255961845`)...
630 of 1000 complete (SVM wins=65.07936507936508`%, ave. supports=3.007936507936508`)...
631 of 1000 complete (SVM wins=64.97622820919176`%, ave. supports=3.007923930269414`)...
632 of 1000 complete (SVM wins=64.87341772151899`%, ave. supports=3.007911392405063`)...
633 of 1000 complete (SVM wins=64.92890995260665`%, ave. supports=3.007898894154818`)...
634 of 1000 complete (SVM wins=64.98422712933754`%, ave. supports=3.0078864353312302`)...
635 of 1000 complete (SVM wins=65.03937007874015`%, ave. supports=3.0078740157480315`)...
636 of 1000 complete (SVM wins=65.09433962264151`%, ave. supports=3.007861635220126`)...
637 of 1000 complete (SVM wins=65.149136577708`%, ave. supports=3.0078492935635794`)...
638 of 1000 complete (SVM wins=65.04702194357367`%, ave. supports=3.0078369905956115`)...
639 of 1000 complete (SVM wins=65.10172143974961`%, ave. supports=3.007824726134585`)...
640 of 1000 complete (SVM wins=65.15625`%, ave. supports=3.009375`)...
641 of 1000 complete (SVM wins=65.05460218408736`%, ave. supports=3.0093603744149764`)...
642 of 1000 complete (SVM wins=65.10903426791276`%, ave. supports=3.0093457943925235`)...
643 of 1000 complete (SVM wins=65.16329704510109`%, ave. supports=3.0093312597200623`)...
644 of 1000 complete (SVM wins=65.21739130434783`%, ave. supports=3.0093167701863353`)...
645 of 1000 complete (SVM wins=65.11627906976744`%, ave. supports=3.0093023255813955`)...
646 of 1000 complete (SVM wins=65.17027863777089`%, ave. supports=3.0092879256965945`)...
647 of 1000 complete (SVM wins=65.2241112828439`%, ave. supports=3.009273570324575`)...
648 of 1000 complete (SVM wins=65.12345679012346`%, ave. supports=3.009259259259259`)...
649 of 1000 complete (SVM wins=65.0231124807396`%, ave. supports=3.00924499229584`)...
650 of 1000 complete (SVM wins=65.07692307692308`%, ave. supports=3.0092307692307694`)...
651 of 1000 complete (SVM wins=65.13056835637481`%, ave. supports=3.0092165898617513`)...
652 of 1000 complete (SVM wins=65.1840490797546`%, ave. supports=3.0092024539877302`)...
```

```
653 of 1000 complete (SVM wins=65.08422664624808`%, ave. supports=3.009188361408882`)...
654 of 1000 complete (SVM wins=65.13761467889908`%, ave. supports=3.0091743119266057`)...
655 of 1000 complete (SVM wins=65.0381679389313`%, ave. supports=3.0106870229007634`)...
656 of 1000 complete (SVM wins=65.09146341463415`%, ave. supports=3.010670731707317`)...
657 of 1000 complete (SVM wins=65.14459665144597`%, ave. supports=3.010654490106545`)...
658 of 1000 complete (SVM wins=65.19756838905775`%, ave. supports=3.0106382978723403`)...
659 of 1000 complete (SVM wins=65.25037936267071`%, ave. supports=3.01062215477997`)...
660 of 1000 complete (SVM wins=65.30303030303031`%, ave. supports=3.0106060606060607`)...
661 of 1000 complete (SVM wins=65.35552193645991`%, ave. supports=3.010590015128593`)...
662 of 1000 complete (SVM wins=65.40785498489427`%, ave. supports=3.010574018126888`)...
663 of 1000 complete (SVM wins=65.46003016591251`%, ave. supports=3.0105580693815988`)...
664 of 1000 complete (SVM wins=65.51204819277109`%, ave. supports=3.0105421686746987`)...
665 of 1000 complete (SVM wins=65.41353383458647`%, ave. supports=3.0105263157894737`)...
666 of 1000 complete (SVM wins=65.31531531531532`%, ave. supports=3.0105105105105103`)...
667 of 1000 complete (SVM wins=65.36731634182908`%, ave. supports=3.0104947526236883`)...
668 of 1000 complete (SVM wins=65.41916167664671`%, ave. supports=3.0104790419161676`)...
669 of 1000 complete (SVM wins=65.47085201793722`%, ave. supports=3.008968609865471`)...
670 of 1000 complete (SVM wins=65.5223880597015`%, ave. supports=3.008955223880597`)...
671 of 1000 complete (SVM wins=65.424739195231`%, ave. supports=3.008941877794337`)...
672 of 1000 complete (SVM wins=65.47619047619048`%, ave. supports=3.0089285714285716`)...
673 of 1000 complete (SVM wins=65.37890044576523`%, ave. supports=3.0089153046062407`)...
674 of 1000 complete (SVM wins=65.43026706231454`%, ave. supports=3.0089020771513355`)...
675 of 1000 complete (SVM wins=65.33333333333333`%, ave. supports=3.008888888888889`)...
676 of 1000 complete (SVM wins=65.38461538461539`%, ave. supports=3.0088757396449703`)...
677 of 1000 complete (SVM wins=65.4357459379616`%, ave. supports=3.0088626292466767`)...
678 of 1000 complete (SVM wins=65.33923303834808`%, ave. supports=3.0088495575221237`)...
679 of 1000 complete (SVM wins=65.39027982326951`%, ave. supports=3.008836524300442`)...
680 of 1000 complete (SVM wins=65.29411764705883`%, ave. supports=3.0088235294117647`)...
681 of 1000 complete (SVM wins=65.34508076358296`%, ave. supports=3.0088105726872247`)...
682 of 1000 complete (SVM wins=65.24926686217009`%, ave. supports=3.0087976539589443`)...
683 of 1000 complete (SVM wins=65.30014641288433`%, ave. supports=3.0087847730600292`)...
684 of 1000 complete (SVM wins=65.2046783625731`%, ave. supports=3.008771929824561`)...
685 of 1000 complete (SVM wins=65.1094890510949`%, ave. supports=3.0087591240875913`)...
686 of 1000 complete (SVM wins=65.01457725947522`%, ave. supports=3.008746355685131`)...
687 of 1000 complete (SVM wins=65.06550218340611`%, ave. supports=3.0087336244541483`)...
688 of 1000 complete (SVM wins=64.97093023255815`%, ave. supports=3.008720930232558`)...
```

```
689 of 1000 complete (SVM wins=64.87663280116111`%, ave. supports=3.008708272859216`)...
690 of 1000 complete (SVM wins=64.92753623188405`%, ave. supports=3.008695652173913`)...
691 of 1000 complete (SVM wins=64.97829232995659`%, ave. supports=3.008683068017366`)...
692 of 1000 complete (SVM wins=65.02890173410405`%, ave. supports=3.008670520231214`)...
693 of 1000 complete (SVM wins=65.07936507936508`%, ave. supports=3.0086580086580086`)...
694 of 1000 complete (SVM wins=65.12968299711815`%, ave. supports=3.0086455331412103`)...
695 of 1000 complete (SVM wins=65.03597122302158`%, ave. supports=3.0086330935251797`)...
696 of 1000 complete (SVM wins=65.08620689655173`%, ave. supports=3.0086206896551726`)...
697 of 1000 complete (SVM wins=65.13629842180775`%, ave. supports=3.0086083213773316`)...
698 of 1000 complete (SVM wins=65.18624641833811`%, ave. supports=3.008595988538682`)...
699 of 1000 complete (SVM wins=65.23605150214593`%, ave. supports=3.0085836909871246`)...
700 of 1000 complete (SVM wins=65.28571428571428`%, ave. supports=3.0085714285714285`)...
701 of 1000 complete (SVM wins=65.33523537803138`%, ave. supports=3.0085592011412268`)...
702 of 1000 complete (SVM wins=65.24216524216524`%, ave. supports=3.0085470085470085`)...
703 of 1000 complete (SVM wins=65.29160739687056`%, ave. supports=3.008534850640114`)...
704 of 1000 complete (SVM wins=65.19886363636364`%, ave. supports=3.008522727272727`)...
705 of 1000 complete (SVM wins=65.1063829787234`%, ave. supports=3.008510638297872`)...
706 of 1000 complete (SVM wins=65.15580736543909`%, ave. supports=3.008498583569405`)...
707 of 1000 complete (SVM wins=65.06364922206507`%, ave. supports=3.0084865629420086`)...
708 of 1000 complete (SVM wins=65.11299435028248`%, ave. supports=3.0084745762711864`)...
709 of 1000 complete (SVM wins=65.16220028208744`%, ave. supports=3.008462623413258`)...
710 of 1000 complete (SVM wins=65.07042253521126`%, ave. supports=3.008450704225352`)...
711 of 1000 complete (SVM wins=64.9789029535865`%, ave. supports=3.0084388185654007`)...
712 of 1000 complete (SVM wins=65.02808988764045`%, ave. supports=3.008426966292135`)...
713 of 1000 complete (SVM wins=65.07713884992987`%, ave. supports=3.0084151472650773`)...
714 of 1000 complete (SVM wins=65.12605042016807`%, ave. supports=3.008403361344538`)...
715 of 1000 complete (SVM wins=65.17482517482517`%, ave. supports=3.0083916083916082`)...
716 of 1000 complete (SVM wins=65.22346368715084`%, ave. supports=3.0083798882681565`)...
717 of 1000 complete (SVM wins=65.27196652719665`%, ave. supports=3.00836820083682`)...
718 of 1000 complete (SVM wins=65.32033426183844`%, ave. supports=3.0083565459610027`)...
719 of 1000 complete (SVM wins=65.22948539638386`%, ave. supports=3.008344923504868`)...
720 of 1000 complete (SVM wins=65.27777777777779`%, ave. supports=3.0083333333333333`)...
721 of 1000 complete (SVM wins=65.3259361997226`%, ave. supports=3.0083217753120666`)...
722 of 1000 complete (SVM wins=65.37396121883657`%, ave. supports=3.0083102493074794`)...
723 of 1000 complete (SVM wins=65.283540802213`%, ave. supports=3.008298755186722`)...
724 of 1000 complete (SVM wins=65.19337016574586`%, ave. supports=3.0082872928176796`)...
```

```
725 of 1000 complete (SVM wins=65.24137931034483`%, ave. supports=3.0082758620689654`)...
726 of 1000 complete (SVM wins=65.28925619834712`%, ave. supports=3.0082644628099175`)...
727 of 1000 complete (SVM wins=65.33700137551581`%, ave. supports=3.0082530949105917`)...
728 of 1000 complete (SVM wins=65.38461538461539`%, ave. supports=3.008241758241758`)...
729 of 1000 complete (SVM wins=65.4320987654321`%, ave. supports=3.0082304526748973`)...
730 of 1000 complete (SVM wins=65.47945205479452`%, ave. supports=3.0082191780821916`)...
731 of 1000 complete (SVM wins=65.38987688098496`%, ave. supports=3.008207934336525`)...
732 of 1000 complete (SVM wins=65.43715846994536`%, ave. supports=3.0081967213114753`)...
733 of 1000 complete (SVM wins=65.34788540245566`%, ave. supports=3.00818553888131`)...
734 of 1000 complete (SVM wins=65.39509536784742`%, ave. supports=3.008174386920981`)...
735 of 1000 complete (SVM wins=65.3061224489796`%, ave. supports=3.0081632653061225`)...
736 of 1000 complete (SVM wins=65.35326086956522`%, ave. supports=3.0081521739130435`)...
737 of 1000 complete (SVM wins=65.26458616010855`%, ave. supports=3.0081411126187247`)...
738 of 1000 complete (SVM wins=65.31165311653116`%, ave. supports=3.008130081300813`)...
739 of 1000 complete (SVM wins=65.2232746955345`%, ave. supports=3.0081190798376185`)...
740 of 1000 complete (SVM wins=65.27027027027027`%, ave. supports=3.0081081081081082`)...
741 of 1000 complete (SVM wins=65.31713900134952`%, ave. supports=3.0080971659919027`)...
742 of 1000 complete (SVM wins=65.36388140161725`%, ave. supports=3.0080862533692723`)...
743 of 1000 complete (SVM wins=65.41049798115746`%, ave. supports=3.0080753701211305`)...
744 of 1000 complete (SVM wins=65.45698924731182`%, ave. supports=3.0080645161290325`)...
745 of 1000 complete (SVM wins=65.36912751677852`%, ave. supports=3.0080536912751676`)...
746 of 1000 complete (SVM wins=65.28150134048258`%, ave. supports=3.008042895442359`)...
747 of 1000 complete (SVM wins=65.19410977242302`%, ave. supports=3.0080321285140563`)...
748 of 1000 complete (SVM wins=65.24064171122996`%, ave. supports=3.0080213903743314`)...
749 of 1000 complete (SVM wins=65.28704939919892`%, ave. supports=3.0080106809078773`)...
750 of 1000 complete (SVM wins=65.2`%, ave. supports=3.008`)...
751 of 1000 complete (SVM wins=65.24633821571238`%, ave. supports=3.007989347536618`)...
752 of 1000 complete (SVM wins=65.29255319148936`%, ave. supports=3.007978723404255`)...
753 of 1000 complete (SVM wins=65.33864541832669`%, ave. supports=3.00796812749004`)...
754 of 1000 complete (SVM wins=65.38461538461539`%, ave. supports=3.0079575596816976`)...
755 of 1000 complete (SVM wins=65.43046357615894`%, ave. supports=3.0079470198675495`)...
756 of 1000 complete (SVM wins=65.47619047619048`%, ave. supports=3.007936507936508`)...
757 of 1000 complete (SVM wins=65.5217965653897`%, ave. supports=3.0079260237780714`)...
758 of 1000 complete (SVM wins=65.4353562005277`%, ave. supports=3.0079155672823217`)...
759 of 1000 complete (SVM wins=65.34914361001317`%, ave. supports=3.007905138339921`)...
760 of 1000 complete (SVM wins=65.26315789473685`%, ave. supports=3.0078947368421054`)...
```

```
761 of 1000 complete (SVM wins=65.17739816031536`%, ave. supports=3.0078843626806835`)...

762 of 1000 complete (SVM wins=65.2230971128609`%, ave. supports=3.0078740157480315`)...

763 of 1000 complete (SVM wins=65.26867627785059`%, ave. supports=3.0078636959370906`)...

764 of 1000 complete (SVM wins=65.18324607329843`%, ave. supports=3.007853403141361`)...

765 of 1000 complete (SVM wins=65.22875816993464`%, ave. supports=3.007843137254902`)...

766 of 1000 complete (SVM wins=65.27415143603133`%, ave. supports=3.0078328981723237`)...

767 of 1000 complete (SVM wins=65.31942633637549`%, ave. supports=3.0078226857887875`)...

768 of 1000 complete (SVM wins=65.36458333333334`%, ave. supports=3.0078125`)...

769 of 1000 complete (SVM wins=65.40962288686606`%, ave. supports=3.0078023407022108`)...

770 of 1000 complete (SVM wins=65.32467532467533`%, ave. supports=3.0077922077922077`)...

771 of 1000 complete (SVM wins=65.23994811932555`%, ave. supports=3.007782101167315`)...

772 of 1000 complete (SVM wins=65.15544041450777`%, ave. supports=3.0077720207253886`)...

773 of 1000 complete (SVM wins=65.07115135834411`%, ave. supports=3.0077619663648125`)...

774 of 1000 complete (SVM wins=65.11627906976744`%, ave. supports=3.007751937984496`)...

775 of 1000 complete (SVM wins=65.03225806451613`%, ave. supports=3.007741935483871`)...

776 of 1000 complete (SVM wins=65.07731958762886`%, ave. supports=3.0077319587628866`)...

777 of 1000 complete (SVM wins=65.12226512226512`%, ave. supports=3.0077220077220077`)...

778 of 1000 complete (SVM wins=65.16709511568124`%, ave. supports=3.007712082262211`)...

779 of 1000 complete (SVM wins=65.08344030808729`%, ave. supports=3.0077021822849805`)...

780 of 1000 complete (SVM wins=65.`%, ave. supports=3.0076923076923077`)...

781 of 1000 complete (SVM wins=65.04481434058899`%, ave. supports=3.0076824583866837`)...

782 of 1000 complete (SVM wins=64.9616368286445`%, ave. supports=3.0076726342710995`)...

783 of 1000 complete (SVM wins=65.00638569604087`%, ave. supports=3.007662835249042`)...

784 of 1000 complete (SVM wins=64.9234693877551`%, ave. supports=3.00765306122449`)...

785 of 1000 complete (SVM wins=64.96815286624204`%, ave. supports=3.007643312101911`)...

786 of 1000 complete (SVM wins=65.01272264631042`%, ave. supports=3.0076335877862594`)...

787 of 1000 complete (SVM wins=65.0571791613723`%, ave. supports=3.007623888182973`)...

788 of 1000 complete (SVM wins=65.1015228426396`%, ave. supports=3.0076142131979697`)...

789 of 1000 complete (SVM wins=65.14575411913816`%, ave. supports=3.0076045627376424`)...

790 of 1000 complete (SVM wins=65.18987341772153`%, ave. supports=3.007594936708861`)...

791 of 1000 complete (SVM wins=65.2338811630847`%, ave. supports=3.0075853350189634`)...

792 of 1000 complete (SVM wins=65.15151515151516`%, ave. supports=3.007575757575758`)...

793 of 1000 complete (SVM wins=65.19546027742749`%, ave. supports=3.007566204287516`)...

794 of 1000 complete (SVM wins=65.23929471032746`%, ave. supports=3.0075566750629723`)...

795 of 1000 complete (SVM wins=65.15723270440252`%, ave. supports=3.0075471698113208`)...

796 of 1000 complete (SVM wins=65.07537688442211`%, ave. supports=3.007537688442211`)...
```

797 of 1000 complete (SVM wins=65.11919698870766`%, ave. supports=3.0075282308657467`)...

798 of 1000 complete (SVM wins=65.16290726817043`%, ave. supports=3.007518796992481`)...

799 of 1000 complete (SVM wins=65.081351689612`%, ave. supports=3.0075093867334166`)...

800 of 1000 complete (SVM wins=65.`%, ave. supports=3.0075`)...

801 of 1000 complete (SVM wins=64.91885143570538`%, ave. supports=3.00749063670412`)...

802 of 1000 complete (SVM wins=64.96259351620948`%, ave. supports=3.0074812967581046`)...

803 of 1000 complete (SVM wins=65.00622665006227`%, ave. supports=3.00747198007472`)...

804 of 1000 complete (SVM wins=65.04975124378109`%, ave. supports=3.0074626865671643`)...

805 of 1000 complete (SVM wins=65.09316770186335`%, ave. supports=3.0074534161490685`)...

806 of 1000 complete (SVM wins=65.136476426799`%, ave. supports=3.0074441687344913`)...

807 of 1000 complete (SVM wins=65.05576208178438`%, ave. supports=3.007434944237918`)...

808 of 1000 complete (SVM wins=64.97524752475248`%, ave. supports=3.007425742574257`)...

809 of 1000 complete (SVM wins=65.01854140914709`%, ave. supports=3.007416563658838`)...

810 of 1000 complete (SVM wins=65.06172839506172`%, ave. supports=3.0074074074074075`)...

811 of 1000 complete (SVM wins=64.98150431565968`%, ave. supports=3.0073982737361282`)...

812 of 1000 complete (SVM wins=65.02463054187191`%, ave. supports=3.0073891625615765`)...

813 of 1000 complete (SVM wins=65.06765067650676`%, ave. supports=3.007380073800738`)...

814 of 1000 complete (SVM wins=64.98771498771498`%, ave. supports=3.0073710073710074`)...

815 of 1000 complete (SVM wins=64.9079754601227`%, ave. supports=3.007361963190184`)...

816 of 1000 complete (SVM wins=64.95098039215686`%, ave. supports=3.0073529411764706`)...

817 of 1000 complete (SVM wins=64.99388004895961`%, ave. supports=3.00734394124847`)...

818 of 1000 complete (SVM wins=64.91442542787286`%, ave. supports=3.0073349633251834`)...

819 of 1000 complete (SVM wins=64.95726495726495`%, ave. supports=3.0073260073260073`)...

820 of 1000 complete (SVM wins=65.`%, ave. supports=3.0073170731707317`)...

821 of 1000 complete (SVM wins=65.04263093788063`%, ave. supports=3.0073081607795373`)...

822 of 1000 complete (SVM wins=65.08515815085158`%, ave. supports=3.0072992700729926`)...

823 of 1000 complete (SVM wins=65.00607533414338`%, ave. supports=3.0072904009720536`)...

824 of 1000 complete (SVM wins=64.92718446601941`%, ave. supports=3.0072815533980584`)...

825 of 1000 complete (SVM wins=64.84848484848484`%, ave. supports=3.0072727272727273`)...

826 of 1000 complete (SVM wins=64.89104116222761`%, ave. supports=3.0072639225181597`)...

827 of 1000 complete (SVM wins=64.81257557436517`%, ave. supports=3.007255139056832`)...

828 of 1000 complete (SVM wins=64.73429951690821`%, ave. supports=3.0072463768115942`)...

829 of 1000 complete (SVM wins=64.77683956574187`%, ave. supports=3.0072376357056694`)...

830 of 1000 complete (SVM wins=64.81927710843374`%, ave. supports=3.0072289156626506`)...

831 of 1000 complete (SVM wins=64.86161251504213`%, ave. supports=3.0072202166064983`)...

832 of 1000 complete (SVM wins=64.90384615384616`%, ave. supports=3.0072115384615383`)...

```
833 of 1000 complete (SVM wins=64.82593037214886`%, ave. supports=3.007202881152461`)...
834 of 1000 complete (SVM wins=64.86810551558753`%, ave. supports=3.0071942446043165`)...
835 of 1000 complete (SVM wins=64.79041916167665`%, ave. supports=3.007185628742515`)...
836 of 1000 complete (SVM wins=64.83253588516746`%, ave. supports=3.007177033492823`)...
837 of 1000 complete (SVM wins=64.75507765830346`%, ave. supports=3.007168458781362`)...
838 of 1000 complete (SVM wins=64.67780429594272`%, ave. supports=3.007159904534606`)...
839 of 1000 complete (SVM wins=64.71990464839095`%, ave. supports=3.0071513706793804`)...
840 of 1000 complete (SVM wins=64.64285714285715`%, ave. supports=3.007142857142857`)...
841 of 1000 complete (SVM wins=64.68489892984543`%, ave. supports=3.0071343638525563`)...
842 of 1000 complete (SVM wins=64.60807600950119`%, ave. supports=3.007125890736342`)...
843 of 1000 complete (SVM wins=64.5314353499407`%, ave. supports=3.00711743772242`)...
844 of 1000 complete (SVM wins=64.57345971563981`%, ave. supports=3.0071090047393363`)...
845 of 1000 complete (SVM wins=64.61538461538461`%, ave. supports=3.0071005917159765`)...
846 of 1000 complete (SVM wins=64.53900709219859`%, ave. supports=3.00709219858156`)...
847 of 1000 complete (SVM wins=64.46280991735537`%, ave. supports=3.0070838252656436`)...
848 of 1000 complete (SVM wins=64.50471698113208`%, ave. supports=3.0070754716981134`)...
849 of 1000 complete (SVM wins=64.54652532391049`%, ave. supports=3.0070671378091873`)...
850 of 1000 complete (SVM wins=64.47058823529412`%, ave. supports=3.0070588235294116`)...
851 of 1000 complete (SVM wins=64.5123384253819`%, ave. supports=3.007050528789659`)...
852 of 1000 complete (SVM wins=64.43661971830986`%, ave. supports=3.007042253521127`)...
853 of 1000 complete (SVM wins=64.36107854630716`%, ave. supports=3.007033997655334`)...
854 of 1000 complete (SVM wins=64.40281030444966`%, ave. supports=3.0070257611241216`)...
855 of 1000 complete (SVM wins=64.44444444444444`%, ave. supports=3.007017543859649`)...
856 of 1000 complete (SVM wins=64.48598130841121`%, ave. supports=3.0070093457943927`)...
857 of 1000 complete (SVM wins=64.52742123687281`%, ave. supports=3.0070011668611434`)...
858 of 1000 complete (SVM wins=64.45221445221445`%, ave. supports=3.006993006993007`)...
859 of 1000 complete (SVM wins=64.49359720605355`%, ave. supports=3.0069848661233993`)...
860 of 1000 complete (SVM wins=64.4186046511628`%, ave. supports=3.0069767441860464`)...
861 of 1000 complete (SVM wins=64.45993031358886`%, ave. supports=3.008130081300813`)...
862 of 1000 complete (SVM wins=64.50116009280742`%, ave. supports=3.008120649651972`)...
863 of 1000 complete (SVM wins=64.42641946697567`%, ave. supports=3.00811123986095`)...
864 of 1000 complete (SVM wins=64.4675925925926`%, ave. supports=3.0081018518518516`)...
865 of 1000 complete (SVM wins=64.39306358381502`%, ave. supports=3.008092485549133`)...
866 of 1000 complete (SVM wins=64.43418013856814`%, ave. supports=3.008083140877598`)...
867 of 1000 complete (SVM wins=64.3598615916955`%, ave. supports=3.008073817762399`)...
868 of 1000 complete (SVM wins=64.28571428571429`%, ave. supports=3.0080645161290325`)...
```

```
869 of 1000 complete (SVM wins=64.32681242807826`%, ave. supports=3.008055235903337`)...
870 of 1000 complete (SVM wins=64.25287356321839`%, ave. supports=3.0080459770114945`)...
871 of 1000 complete (SVM wins=64.2939150401837`%, ave. supports=3.008036739380023`)...
872 of 1000 complete (SVM wins=64.22018348623854`%, ave. supports=3.00802752293578`)...
873 of 1000 complete (SVM wins=64.26116838487972`%, ave. supports=3.0080183276059564`)...
874 of 1000 complete (SVM wins=64.30205949656751`%, ave. supports=3.0080091533180777`)...
875 of 1000 complete (SVM wins=64.34285714285714`%, ave. supports=3.008`)...
876 of 1000 complete (SVM wins=64.38356164383562`%, ave. supports=3.0079908675799087`)...
877 of 1000 complete (SVM wins=64.31014823261117`%, ave. supports=3.007981755986317`)...
878 of 1000 complete (SVM wins=64.3507972665148`%, ave. supports=3.007972665148064`)...
879 of 1000 complete (SVM wins=64.39135381114903`%, ave. supports=3.0079635949943118`)...
880 of 1000 complete (SVM wins=64.43181818181817`%, ave. supports=3.0079545454545453`)...
881 of 1000 complete (SVM wins=64.35868331441543`%, ave. supports=3.00794551645857`)...
882 of 1000 complete (SVM wins=64.39909297052154`%, ave. supports=3.007936507936508`)...
883 of 1000 complete (SVM wins=64.43941109852774`%, ave. supports=3.0079275198187996`)...
884 of 1000 complete (SVM wins=64.47963800904978`%, ave. supports=3.007918552036199`)...
885 of 1000 complete (SVM wins=64.51977401129943`%, ave. supports=3.007909604519774`)...
886 of 1000 complete (SVM wins=64.55981941309255`%, ave. supports=3.007900677200903`)...
887 of 1000 complete (SVM wins=64.4870349492672`%, ave. supports=3.007891770011274`)...
888 of 1000 complete (SVM wins=64.52702702702703`%, ave. supports=3.0078828828828827`)...
889 of 1000 complete (SVM wins=64.45444319460067`%, ave. supports=3.0078740157480315`)...
890 of 1000 complete (SVM wins=64.38202247191012`%, ave. supports=3.007865168539326`)...
891 of 1000 complete (SVM wins=64.42199775533109`%, ave. supports=3.0078563411896746`)...
892 of 1000 complete (SVM wins=64.34977578475336`%, ave. supports=3.007847533632287`)...
893 of 1000 complete (SVM wins=64.38969764837627`%, ave. supports=3.007838745800672`)...
894 of 1000 complete (SVM wins=64.31767337807607`%, ave. supports=3.0078299776286355`)...
895 of 1000 complete (SVM wins=64.35754189944134`%, ave. supports=3.0078212290502795`)...
896 of 1000 complete (SVM wins=64.28571428571429`%, ave. supports=3.0078125`)...
897 of 1000 complete (SVM wins=64.21404682274247`%, ave. supports=3.007803790412486`)...
898 of 1000 complete (SVM wins=64.25389755011136`%, ave. supports=3.007795100222717`)...
899 of 1000 complete (SVM wins=64.18242491657396`%, ave. supports=3.007786429365962`)...
900 of 1000 complete (SVM wins=64.22222222222223`%, ave. supports=3.0077777777777777`)...
901 of 1000 complete (SVM wins=64.26193118756936`%, ave. supports=3.0077691453940067`)...
902 of 1000 complete (SVM wins=64.30155210643017`%, ave. supports=3.007760532150776`)...
903 of 1000 complete (SVM wins=64.34108527131784`%, ave. supports=3.007751937984496`)...
904 of 1000 complete (SVM wins=64.38053097345133`%, ave. supports=3.0077433628318584`)...
```

```
905 of 1000 complete (SVM wins=64.41988950276243`%, ave. supports=3.007734806629834`)...
906 of 1000 complete (SVM wins=64.45916114790286`%, ave. supports=3.007726269315673`)...
907 of 1000 complete (SVM wins=64.49834619625138`%, ave. supports=3.007717750826902`)...
908 of 1000 complete (SVM wins=64.42731277533039`%, ave. supports=3.0077092511013217`)...
909 of 1000 complete (SVM wins=64.46644664466447`%, ave. supports=3.0077007700770078`)...
910 of 1000 complete (SVM wins=64.50549450549451`%, ave. supports=3.0076923076923077`)...
911 of 1000 complete (SVM wins=64.43468715697036`%, ave. supports=3.00768386388584`)...
912 of 1000 complete (SVM wins=64.3640350877193`%, ave. supports=3.0076754385964914`)...
913 of 1000 complete (SVM wins=64.40306681270536`%, ave. supports=3.0076670317634173`)...
914 of 1000 complete (SVM wins=64.33260393873084`%, ave. supports=3.0076586433260393`)...
915 of 1000 complete (SVM wins=64.37158469945355`%, ave. supports=3.0076502732240438`)...
916 of 1000 complete (SVM wins=64.41048034934498`%, ave. supports=3.0076419213973797`)...
917 of 1000 complete (SVM wins=64.44929116684843`%, ave. supports=3.0076335877862594`)...
918 of 1000 complete (SVM wins=64.37908496732027`%, ave. supports=3.0076252723311545`)...
919 of 1000 complete (SVM wins=64.41784548422198`%, ave. supports=3.0076169749727963`)...
920 of 1000 complete (SVM wins=64.34782608695652`%, ave. supports=3.007608695652174`)...
921 of 1000 complete (SVM wins=64.38653637350706`%, ave. supports=3.007600434310532`)...
922 of 1000 complete (SVM wins=64.42516268980476`%, ave. supports=3.007592190889371`)...
923 of 1000 complete (SVM wins=64.46370530877573`%, ave. supports=3.0075839653304444`)...
924 of 1000 complete (SVM wins=64.5021645021645`%, ave. supports=3.007575757575758`)...
925 of 1000 complete (SVM wins=64.43243243243244`%, ave. supports=3.0075675675675675`)...
926 of 1000 complete (SVM wins=64.47084233261339`%, ave. supports=3.0075593952483803`)...
927 of 1000 complete (SVM wins=64.5091693635383`%, ave. supports=3.0075512405609492`)...
928 of 1000 complete (SVM wins=64.4396551724138`%, ave. supports=3.007543103448276`)...
929 of 1000 complete (SVM wins=64.47793326157158`%, ave. supports=3.007534983853606`)...
930 of 1000 complete (SVM wins=64.51612903225806`%, ave. supports=3.00752688172043`)...
931 of 1000 complete (SVM wins=64.4468313641246`%, ave. supports=3.007518796992481`)...
932 of 1000 complete (SVM wins=64.48497854077253`%, ave. supports=3.007510729613734`)...
933 of 1000 complete (SVM wins=64.41586280814576`%, ave. supports=3.007502679528403`)...
934 of 1000 complete (SVM wins=64.45396145610277`%, ave. supports=3.007494646680942`)...
935 of 1000 complete (SVM wins=64.3850267379679`%, ave. supports=3.0074866310160426`)...
936 of 1000 complete (SVM wins=64.42307692307693`%, ave. supports=3.0074786324786325`)...
937 of 1000 complete (SVM wins=64.35432230522946`%, ave. supports=3.007470651013874`)...
938 of 1000 complete (SVM wins=64.28571428571429`%, ave. supports=3.0074626865671643`)...
939 of 1000 complete (SVM wins=64.32374866879658`%, ave. supports=3.007454739084132`)...
940 of 1000 complete (SVM wins=64.25531914893618`%, ave. supports=3.0074468085106383`)...
```

941 of 1000 complete (SVM wins=64.29330499468651`%, ave. supports=3.0074388947927737`)...

942 of 1000 complete (SVM wins=64.22505307855626`%, ave. supports=3.007430997876858`)...

943 of 1000 complete (SVM wins=64.26299045599151`%, ave. supports=3.007423117709438`)...

944 of 1000 complete (SVM wins=64.30084745762711`%, ave. supports=3.007415254237288`)...

945 of 1000 complete (SVM wins=64.33862433862434`%, ave. supports=3.0074074074074075`)...

946 of 1000 complete (SVM wins=64.37632135306553`%, ave. supports=3.007399577167019`)...

947 of 1000 complete (SVM wins=64.30834213305174`%, ave. supports=3.007391763463569`)...

948 of 1000 complete (SVM wins=64.34599156118144`%, ave. supports=3.007383966244726`)...

949 of 1000 complete (SVM wins=64.2781875658588`%, ave. supports=3.0073761854583774`)...

950 of 1000 complete (SVM wins=64.31578947368422`%, ave. supports=3.0073684210526315`)...

951 of 1000 complete (SVM wins=64.24815983175604`%, ave. supports=3.007360672975815`)...

952 of 1000 complete (SVM wins=64.18067226890757`%, ave. supports=3.0073529411764706`)...

953 of 1000 complete (SVM wins=64.21825813221406`%, ave. supports=3.0073452256033577`)...

954 of 1000 complete (SVM wins=64.15094339622641`%, ave. supports=3.007337526205451`)...

955 of 1000 complete (SVM wins=64.18848167539267`%, ave. supports=3.007329842931937`)...

956 of 1000 complete (SVM wins=64.22594142259415`%, ave. supports=3.0073221757322175`)...

957 of 1000 complete (SVM wins=64.26332288401254`%, ave. supports=3.0073145245559036`)...

958 of 1000 complete (SVM wins=64.30062630480167`%, ave. supports=3.0073068893528183`)...

959 of 1000 complete (SVM wins=64.23357664233576`%, ave. supports=3.0072992700729926`)...

960 of 1000 complete (SVM wins=64.27083333333333`%, ave. supports=3.0072916666666667`)...

961 of 1000 complete (SVM wins=64.30801248699271`%, ave. supports=3.0072840790842874`)...

962 of 1000 complete (SVM wins=64.24116424116424`%, ave. supports=3.007276507276507`)...

963 of 1000 complete (SVM wins=64.17445482866043`%, ave. supports=3.007268951194185`)...

964 of 1000 complete (SVM wins=64.10788381742739`%, ave. supports=3.0072614107883817`)...

965 of 1000 complete (SVM wins=64.14507772020725`%, ave. supports=3.007253886010363`)...

966 of 1000 complete (SVM wins=64.18219461697723`%, ave. supports=3.0072463768115942`)...

967 of 1000 complete (SVM wins=64.21923474663909`%, ave. supports=3.0072388831437435`)...

968 of 1000 complete (SVM wins=64.15289256198346`%, ave. supports=3.0072314049586777`)...

969 of 1000 complete (SVM wins=64.18988648090816`%, ave. supports=3.007223942208462`)...

970 of 1000 complete (SVM wins=64.22680412371135`%, ave. supports=3.0072164948453610`)...

971 of 1000 complete (SVM wins=64.16065911431514`%, ave. supports=3.007209062821833`)...

972 of 1000 complete (SVM wins=64.19753086419753`%, ave. supports=3.007201646090535`)...

973 of 1000 complete (SVM wins=64.23432682425488`%, ave. supports=3.0071942446043165`)...

974 of 1000 complete (SVM wins=64.27104722792608`%, ave. supports=3.0071868583162216`)...

975 of 1000 complete (SVM wins=64.3076923076923`%, ave. supports=3.0071794871794872`)...

976 of 1000 complete (SVM wins=64.34426229508196`%, ave. supports=3.007172131147541`)...

977 of 1000 complete (SVM wins=64.38075742067554`%, ave. supports=3.007164790174002`)...

978 of 1000 complete (SVM wins=64.31492842535788`%, ave. supports=3.007157464212679`)...

979 of 1000 complete (SVM wins=64.24923391215526`%, ave. supports=3.007150153217569`)...

980 of 1000 complete (SVM wins=64.18367346938776`%, ave. supports=3.007142857142857`)...

981 of 1000 complete (SVM wins=64.22018348623854`%, ave. supports=3.0071355759429155`)...

982 of 1000 complete (SVM wins=64.15478615071282`%, ave. supports=3.0071283095723014`)...

983 of 1000 complete (SVM wins=64.1912512716175`%, ave. supports=3.0071210579857577`)...

984 of 1000 complete (SVM wins=64.1260162601626`%, ave. supports=3.0071138211382116`)...

985 of 1000 complete (SVM wins=64.06091370558376`%, ave. supports=3.0071065989847714`)...

986 of 1000 complete (SVM wins=64.09736308316431`%, ave. supports=3.0070993914807302`)...

987 of 1000 complete (SVM wins=64.13373860182371`%, ave. supports=3.00709219858156`)...

988 of 1000 complete (SVM wins=64.17004048582996`%, ave. supports=3.007085020242915`)...

989 of 1000 complete (SVM wins=64.20626895854399`%, ave. supports=3.007077856420627`)...

990 of 1000 complete (SVM wins=64.14141414141415`%, ave. supports=3.007070707070707`)...

991 of 1000 complete (SVM wins=64.07669021190716`%, ave. supports=3.007063572149344`)...

992 of 1000 complete (SVM wins=64.11290322580645`%, ave. supports=3.007056451612903`)...

993 of 1000 complete (SVM wins=64.14904330312186`%, ave. supports=3.0070493454179257`)...

994 of 1000 complete (SVM wins=64.1851106639839`%, ave. supports=3.007042253521127`)...

995 of 1000 complete (SVM wins=64.22110552763819`%, ave. supports=3.007035175879397`)...

996 of 1000 complete (SVM wins=64.2570281124498`%, ave. supports=3.0070281124497993`)...

997 of 1000 complete (SVM wins=64.29287863590773`%, ave. supports=3.0070210631895686`)...

998 of 1000 complete (SVM wins=64.22845691382766`%, ave. supports=3.0070140280561124`)...

999 of 1000 complete (SVM wins=64.26426426426426`%, ave. supports=3.007007007007007`)...

1000 of 1000 complete (SVM wins=64.3`%, ave. supports=3.007`)...

...Done

PLA v. SVA $\mathbb{P}$[miss] results (runs=1000, N=100):
SVG awesomerness=64.3`%
ave. no. support vectors=3.007`

**(* managed to get this to work by manually opening
 the package .m file and hitting the run button *)? QPSolve**

QPSolve[Q,p,a,b,c,y,τ] solves the quadratic programming problem min $\alpha.Q.\alpha+p.\alpha$, subject to a$\leq\alpha\leq$b and y.α=c.
   QPSolve uses the GSMO algorithm described by Keerthi et al. τ is a solution tolerance parameter (0.01 or
   so is usually good enough for SVMs). Q must be a positive semidefinite matrix to guarantee convergence.