

```
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```
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```

```
(* SVD Analysis of Cdc15 *)
```

```
(* Estimate Missing Data *)
```

```
(* Read Selected Data from Select_Data.txt *)
```

```
<< LinearAlgebra`MatrixManipulation`;  
<< NumericalMath`TrigFit`;  
<< Graphics`Graphics`;  
<< Graphics`Arrow`;  
Off[General::"spell"];
```

```
(* Define HardDrive *)
```

```
name = "Marzipan";
```

```
(* Cdc15 *)
```

```
stream = StringJoin[name, ":Desktop Folder:SPIE Data:Raw_Cdc15.txt"];  
matrix = ReadList[stream, Word, RecordLists -> True, NullWords -> True];  
{genes, arrays} = Dimensions[matrix] - {2, 1}  
Clear[stream];
```

```
{6113, 24}
```

```
genenames = TakeRows [  
  TakeColumns[matrix, {1, 1}],  
  {3, genes + 2}];  
arraynames = TakeColumns [  
  TakeRows[matrix, {1, 2}],  
  {2, arrays + 1}];  
matrix = TakeColumns [  
  TakeRows[matrix, {3, genes + 2}],  
  {2, arrays + 1}];  
matrix = ToExpression[matrix];
```

```
sizes = Flatten [  
  Table [  
    Dimensions [  
      Characters [  
        ToString[arraynames[[2, a]]]  
      ]  
    ], {a, 1, arrays}];  
size = Sort[sizes, OrderedQ[{{#2, #1}}]&][[1]];  
Do [  
  Do[arraynames[[2, a]] = StringJoin[ToString[arraynames[[2, a]]], " "],  
    {b, 1, size - sizes[[a]]},  
    {a, 1, arrays}];
```

```

(* Count Null Data *)

counter = Table[0, {genes}];
Do[
  counter[[a]] = counter[[a]] + Count[matrix[[a]], Null],
  {a, 1, genes}];

(* Locate Gene Position of Null Data *)

Clear[positions];
positions = Table[0, {a, 1, arrays + 1}];
Do[
  positions[[a]] = Flatten[
    Position[Flatten[counter], a - 1]],
  {a, 1, arrays + 1}];
numbers = Flatten[
  Table[
    Dimensions[positions[[a]],
    {a, 1, arrays + 1}]];

(* Create Display of Gene Position of Null Data *)

framex = Table[a - 1, {a, 2, arrays + 1}];
sizes = Flatten[
  Table[
    Dimensions[
      Characters[
        ToString[framex[[a]]]
      ]
    ], {a, 1, arrays}]];
Do[
  Do[framex[[a]] = StringJoin[" ", ToString[framex[[a]]],
    {b, 1, size - sizes[[a]]}],
  {a, 1, arrays}];
framex = Table[{a, framex[[a]]}, {a, 1, arrays}];
framey = {100, 200, 300, 400};
g = BarChart[Table[numbers[[a]], {a, 2, arrays + 1}],
  Frame -> True,
  Axes -> False,
  FrameTicks -> {framex, framey, None, None},
  PlotRange -> {{0.5, arrays + 0.5}, {0., 400}},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., 1.}] ->
  Text[a, {b, c - 100}, {0, 0}, {0, 1}];
g1 = Show[g,
  AspectRatio -> 13 / (arrays + 1),
  PlotRange -> All,
  DisplayFunction -> Identity];

```

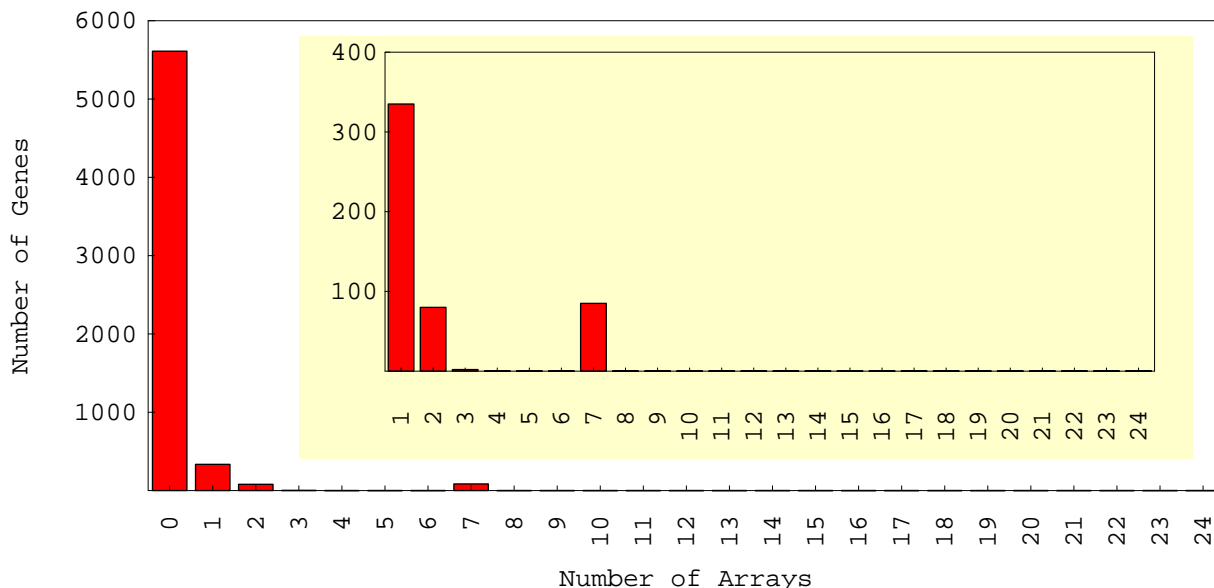
```

framex = Table[a - 1, {a, 1, arrays + 1}];
sizes = Flatten[
  Table[
    Dimensions[
      Characters[
        ToString[framex[[a]]]
      ]
    ], {a, 1, arrays + 1}];
Do[
  Do[framex[[a]] = StringJoin[" ", ToString[framex[[a]]]],
    {b, 1, size - sizes[[a]]},
    {a, 1, arrays + 1}];
framex = Table[{a, framex[[a]]}, {a, 1, arrays + 1}];
framey = {1000, 2000, 3000, 4000, 5000, 6000};
labelx = ColumnForm[{"Number of Arrays"}, Center];
labely = ColumnForm[{"Number of Genes"}, Center];
g = BarChart[numbers,
  Frame -> True,
  Axes -> False,
  FrameLabel -> {labelx, labely, None, None},
  FrameTicks -> {framex, framey, None, None},
  GridLines -> {None, None},
  PlotRange -> {{0.5, arrays + 1.5}, {0, 6000}},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 2.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., 1.}] ->
  Text[labelx, {b, c - 800}, {0, 1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., 1.}] ->
  Text[a, {b, c - 800}, {0, 0}, {0, 1}];

(* Display Gene Position of Null Data *)

g2 = Show[{g,
  Graphics[{RGBColor[1, 1, 0.8], Rectangle[{4, 400}, {24.75, 5800}]},
  Graphics[{Rectangle[{0, -250}, {29, 5750}, g1]}]},
  AspectRatio -> 10 / (arrays + 1),
  PlotRange -> All];

```



```
(* Select Genes by Number of Missing Data Points *)
```

```
matrix = AppendRows[Table[{counter[[a]]}, {a, 1, genes}], genenames, matrix];  
matrix = Sort[matrix, OrderedQ[{{#1, #2}}&];  
fullgenenames = TakeColumns[  
  TakeRows[matrix, {1, numbers[[1]]}],  
  {2, 2}];  
fullmatrix = TakeColumns[  
  TakeRows[matrix, {1, numbers[[1]]}],  
  {3, arrays + 2}];  
missinggenenames1 = TakeColumns[  
  TakeRows[matrix, {numbers[[1]] + 1, numbers[[1]] + numbers[[2]]}],  
  {2, 2}];  
missingmatrix1 = TakeColumns[  
  TakeRows[matrix, {numbers[[1]] + 1, numbers[[1]] + numbers[[2]]}],  
  {3, arrays + 2}];  
missinggenenames2 = TakeColumns[  
  TakeRows[matrix, {  
    numbers[[1]] + numbers[[2]] + 1,  
    numbers[[1]] + numbers[[2]] + numbers[[3]]}],  
  {2, 2}];  
missingmatrix2 = TakeColumns[  
  TakeRows[matrix, {  
    numbers[[1]] + numbers[[2]] + 1,  
    numbers[[1]] + numbers[[2]] + numbers[[3]]}],  
  {3, arrays + 2}];
```

```
(* Locate Array Position of Null Data *)
```

```
locator1 = Table[0, {numbers[[2]]};  
Do[  
  locator1[[a]] = locator1[[a]] + Flatten[Position[missingmatrix1[[a]], Null]],  
  {a, 1, numbers[[2]]};  
locator2 = Table[0, {numbers[[3]]};  
Do[  
  locator2[[a]] = locator2[[a]] + Flatten[Position[missingmatrix2[[a]], Null]],  
  {a, 1, numbers[[3]]};
```

```
(* Sort Raw Data According to the Position of Missing Data Points for Each Gene *)
```

```
missingmatrix1 = AppendRows[locator1, missinggenenames1, missingmatrix1];  
missingmatrix1 = Sort[missingmatrix1, OrderedQ[{{#1, #2}}&];  
locator1 = TakeColumns[missingmatrix1, {1, 1}];  
missinggenenames1 = TakeColumns[missingmatrix1, {2, 2}];  
missingmatrix1 = TakeColumns[missingmatrix1, {3, arrays + 2}];  
missingmatrix2 = AppendRows[locator2, missinggenenames2, missingmatrix2];  
missingmatrix2 = Sort[missingmatrix2, OrderedQ[{{#1, #2}}&];  
locator2 = TakeColumns[missingmatrix2, {1, 2}];  
missinggenenames2 = TakeColumns[missingmatrix2, {3, 3}];  
missingmatrix2 = TakeColumns[missingmatrix2, {4, arrays + 3}];
```

```
(* Examine Subset of Genes with Full Data *)
```

```
(* Calculate Singular Value Decomposition *)
```

```
correlation = Dot[Transpose[fullmatrix], fullmatrix] / (arrays - 1);  
{eigenexpressions, eigengenes} = Eigensystem[correlation];  
eigenexpressions = Sqrt[(arrays - 1) * eigenexpressions];  
Clear[correlation];  
eigengenes[[2]] = -eigengenes[[2]];  
eigengenes[[3]] = -eigengenes[[3]];  
eigengenes[[6]] = -eigengenes[[6]];  
eigenarrays = Dot[eigengenes, Transpose[fullmatrix]];  
Do[  
  eigenarrays[[a]] = eigenarrays[[a]] / eigenexpressions[[a]],  
  {a, 1, arrays}];  
eigenarrays = Transpose[eigenarrays];  
arraycorrelations = Dot[DiagonalMatrix[eigenexpressions], eigengenes];  
genecorrelations = Dot[eigenarrays, DiagonalMatrix[eigenexpressions]];  
genecorrelations = Transpose[genecorrelations];  
probabilities = eigenexpressions^2 / Sum[eigenexpressions[[a]]^2, {a, 1, arrays}];  
entropy = -N[Sum[probabilities[[a]] * Log[probabilities[[a]]], {a, 1, arrays}] / Log[arrays];  
entropy = N[Round[100 * entropy] / 100]
```

0.21

```
(* Create Probabilities Bar Charts Displays *)
```

```
probabilities[[2]]
```

0.0291013

```
limit = 0.032;
```

```
Clear[gridx, framex, framey, sizes];  
gridx = Table[a, {a, 0, limit, N[limit/4]}];  
framex = gridx;  
sizes = Flatten[  
  Table[  
    Dimensions[  
      Characters[  
        ToString[framex[[a]]]  
      ]  
    ], {a, 1, 5}];  
Do[  
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],  
    {b, 1, 5 - sizes[[a]]},  
    {a, 1, 5}];  
  framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 5};  
  gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 5};  
  framey = Table[{a + 1, arrays - a - 9}, {a, 0, 15 - 2};  
  table = Table[probabilities[[arrays - a]], {a, 9, arrays - 2};
```

```

g = BarChart[
  table,
  BarOrientation -> Horizontal,
  PlotRange -> {{0, limit*1.0001}, {0.5, 15 - 1 + 0.5}},
  AspectRatio -> 1,
  Axes -> False,
  Frame -> True,
  FrameTicks -> {None, framey, framex, None},
  FrameLabel -> {None, None, None, None},
  GridLines -> {gridx, None},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 1.75}, {0, 0}, {0, 1}];
g1 = Show[g,
  AspectRatio -> 1.25,
  PlotRange -> All,
  DisplayFunction -> Identity];

gridx = Table[a, {a, 0, 1, 0.2}];
framex = gridx;
sizes = Flatten[
  Table[
    Dimensions[
      Characters[
        ToString[framex[[a]]]
      ]
    ], {a, 1, 6}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " ",
    {b, 1, size - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]],
  framex[[a]]}, {a, 1, 6}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 6}];
framey = Table[{a + 1, arrays - a}, {a, 0, arrays - 1}];
labelx = ColumnForm[
  {"(b) Eigenexpression Probability", StringJoin["d = ", ToString[entropy]], " "}, Center];
g = BarChart[
  Table[probabilities[[arrays - a]], {a, 0, arrays - 1}],
  BarOrientation -> Horizontal,
  PlotRange -> {{0, 1.0001}, {0.5, arrays + 0.5}},
  AspectRatio -> 1,
  Axes -> False,
  Frame -> True,
  FrameTicks -> {None, framey, framex, None},
  FrameLabel -> {None, None, labelx, None},
  GridLines -> {gridx, None},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g2 = Show[{g,
  Graphics[{RGBColor[1, 1, 0.8], Rectangle[{0.1, 0.6}, {0.98, 22.6}]}],
  Graphics[{Rectangle[{0.1, 0.6}, {0.98, 22.6}, g1]}]},
  AspectRatio -> 1.35,
  PlotRange -> All,
  DisplayFunction -> Identity];

```

(\* Create Eigengenes 2D Red & Green Raster Display \*)

```

contrast = 3.5;
displaying = Table[
  If[contrast * eigengenes[[i, j]] > 0,
    If[contrast * eigengenes[[i, j]] < 1, {contrast * eigengenes[[i, j]], 0}, {1, 0}],
    If[contrast * eigengenes[[i, j]] > -1, {0, -contrast * eigengenes[[i, j]]}, {0, 1}]],
  {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = "Eigengenes";
labelx = ColumnForm[{"(a) Arrays", " ", " "}, Center];
g = Show[
  Graphics[
    RasterArray[
      Table[
        RGBColor[
          displaying[[i, j, 1]], displaying[[i, j, 2]], 0
        ],
        {i, arrays, 1, -1}, {j, 1, arrays}
      ]],
    AspectRatio -> 1, Frame -> True,
    FrameTicks -> {None, framey, framex, None},
    FrameLabel -> {None, labely, labelx, None},
    DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 3, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g1 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All,
  DisplayFunction -> Identity];

```

(\* Create Selected Eigengenes Graph Display \*)

```

eigengenes1 = Chop[TrigFit[eigengenes[[1]], 2, {x, arrays - 1}], 0.05]
eigengenes3 = Chop[TrigFit[Drop[Drop[eigengenes[[3]], {23, 24}], {1, 3}], 2, {x - 3, arrays - 4}], 0.1]
eigengenes4 = Chop[TrigFit[Drop[Drop[eigengenes[[4]], {23, 24}], {1, 3}], 3, {x - 3, arrays - 4}], 0.1]
eigengenes5 = Chop[TrigFit[Drop[Drop[eigengenes[[5]], {23, 24}], {1, 3}], 3, {x - 3, arrays - 4}], 0.1]
eigengenes6 = Chop[TrigFit[Drop[Drop[eigengenes[[6]], {23, 24}], {1, 3}], 3, {x - 3, arrays - 4}], 0.1]
0.20336

```

$$-0.111808 \sin\left[\frac{1}{10} \pi (-3 + x)\right] - 0.137003 \sin\left[\frac{1}{5} \pi (-3 + x)\right]$$

$$-0.11518 \cos\left[\frac{1}{10} \pi (-3 + x)\right] + 0.179586 \cos\left[\frac{1}{5} \pi (-3 + x)\right]$$

$$0.128552 \cos\left[\frac{1}{5} \pi (-3 + x)\right] + 0.187231 \sin\left[\frac{1}{5} \pi (-3 + x)\right]$$

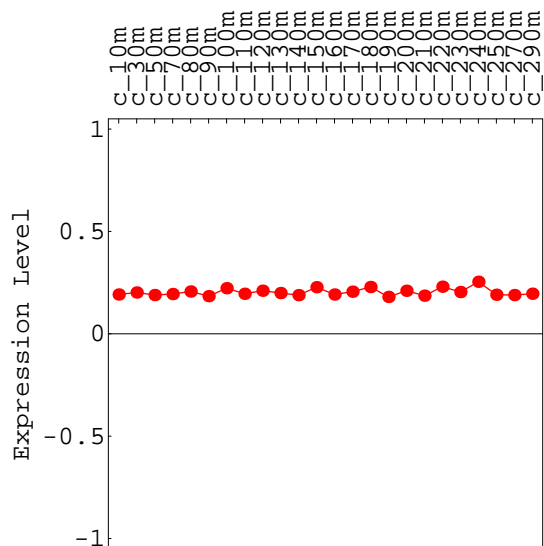
$$0.159377 \cos\left[\frac{1}{10} \pi (-3 + x)\right] - 0.151925 \sin\left[\frac{1}{10} \pi (-3 + x)\right]$$

```

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
   Graphics[{RGBColor[1, 0, 0], line}]},
  Frame -> True,
  FrameLabel -> {None, labely, labelx, None},
  GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
  FrameTicks -> {None, framey, framex, None},
  PlotRange -> {-1.05, 1.05},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p1 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(c) Arrays



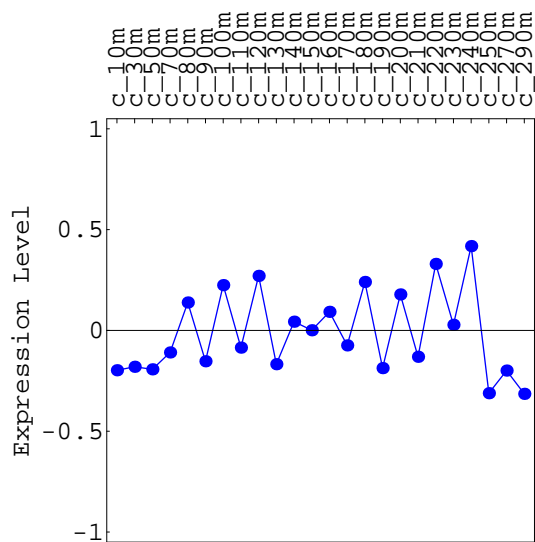


```

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
   Graphics[{RGBColor[0, 0, 1], line}]},
  Frame -> True,
  FrameLabel -> {None, labely, labelx, None},
  GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
  FrameTicks -> {None, framey, framex, None},
  PlotRange -> {-1.05, 1.05},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p2 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(c) Arrays

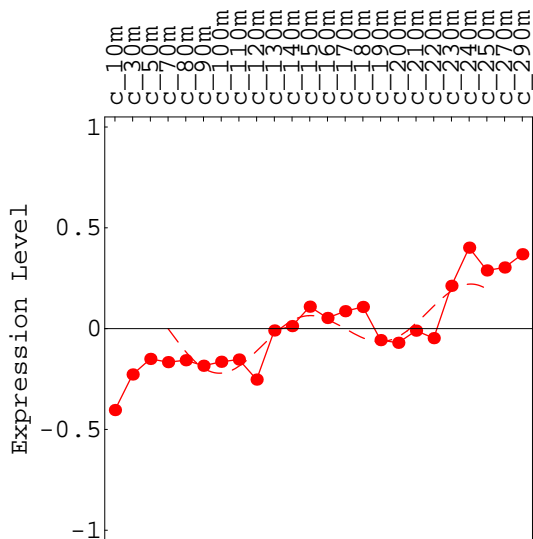


```

graph = Plot[
  eigengenes3,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(d) Arrays", Center];
labely = ColumnForm[{" ", "Expression Level", Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[3, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}},
  Graphics[{RGBColor[1, 0, 0], line}},
  graph],
Frame -> True,
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
FrameTicks -> {None, framey, framex, None},
PlotRange -> {-1.05, 1.05},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p3 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(d) Arrays

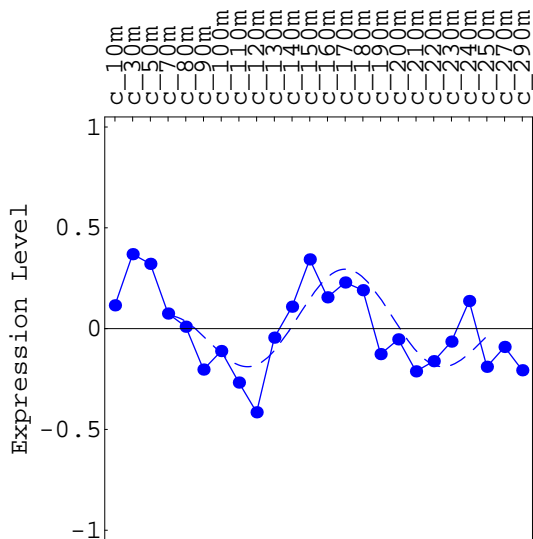


```

graph = Plot[
  eigengenes4,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[4, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}},
  Graphics[{RGBColor[0, 0, 1], line}],
  graph},
Frame -> True,
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
FrameTicks -> {None, framey, framex, None},
PlotRange -> {-1.05, 1.05},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p4 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(d) Arrays

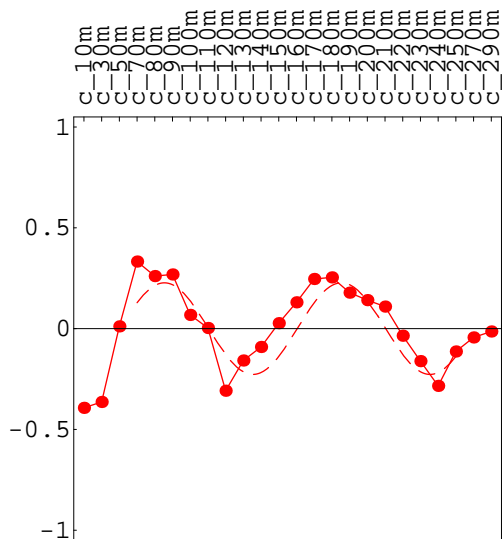


```

graph = Plot[
  eigengenes5,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[5, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
  Graphics[{RGBColor[1, 0, 0], line}],
  graph},
  Frame -> True,
  FrameLabel -> {None, labely, labelx, None},
  GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
  FrameTicks -> {None, framey, framex, None},
  PlotRange -> {-1.05, 1.05},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p5 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(e) Arrays

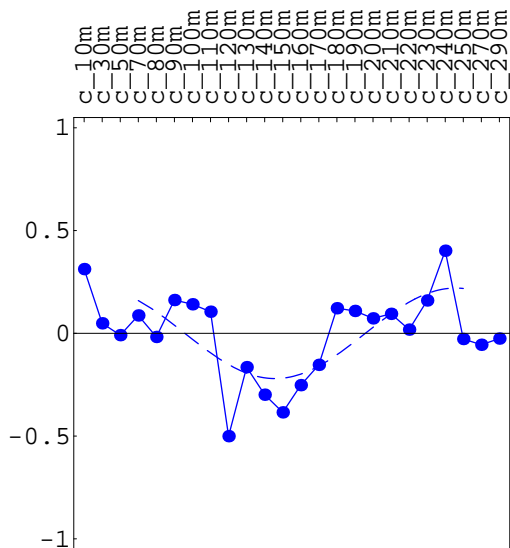


```

graph = Plot[
  eigengenes6,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[6, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}},
  Graphics[{RGBColor[0, 0, 1], line}],
  graph},
Frame -> True,
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
FrameTicks -> {None, framey, framex, None},
PlotRange -> {-1.05, 1.05},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p6 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(e) Arrays



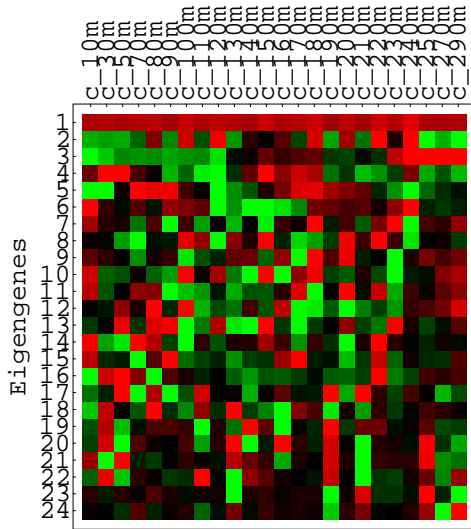
(\* Display Selected Eigengenes \*)

```
g3 = Show[{p2, p1},
  DisplayFunction -> Identity];
g4 = Show[{p4, p3},
  DisplayFunction -> Identity];
g5 = Show[{p6, p5},
  DisplayFunction -> Identity];
```

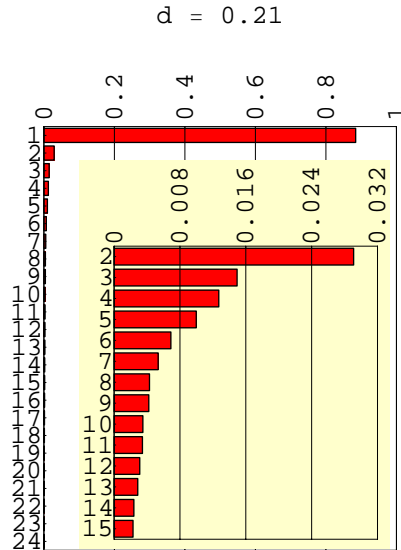
(\* Display Eigengenes, Probabilities and Selected Eigengenes \*)

```
Show[GraphicsArray[{g1, g2, g3}],
  GraphicsSpacing -> -0.175];
```

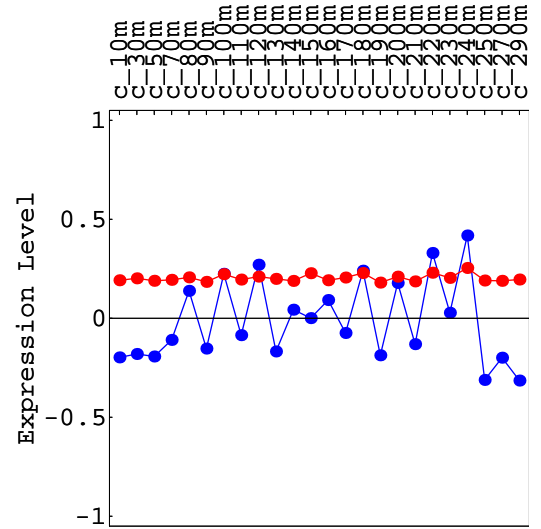
(a) Arrays



(b) Eigenexpression Probability

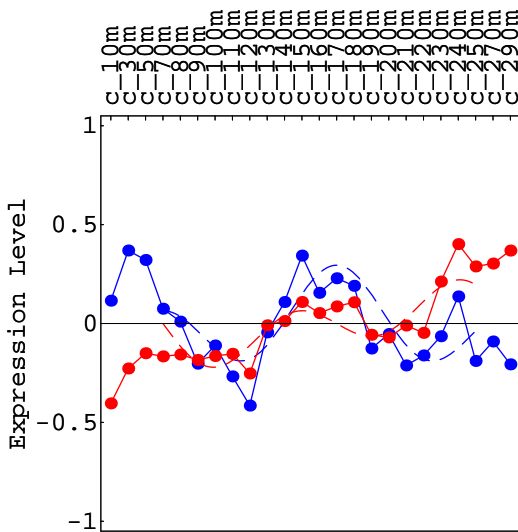


(c) Arrays

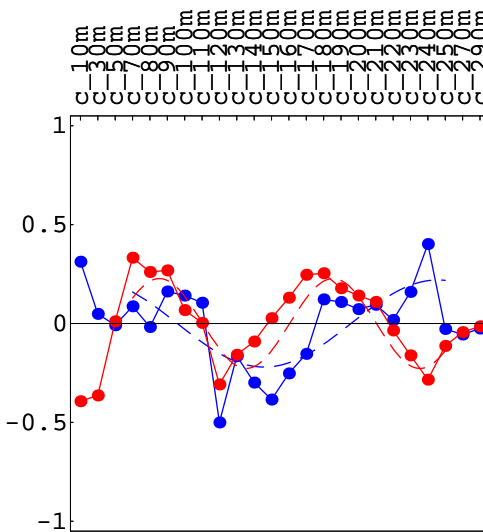


```
Show[GraphicsArray[{g4, g5}],
  GraphicsSpacing -> -0.125];
```

(d) Arrays



(e) Arrays



(\* Choose Subset of Eigengenes for Estimation \*)

```
eigengenes = TakeRows[eigengenes, {1, 6}];
```

```
(* Estimate Missing Data *)
```

```
Do[  
missingmatrix1[[a, locator1[[a, 1]]]] =  
N[Round[Flatten[Dot[Dot[  
Transpose[Drop[  
Transpose[{missingmatrix1[[a]]}],  
{locator1[[a, 1]]}],  
PseudoInverse[Transpose[Drop[  
Transpose[eigengenes],  
{locator1[[a, 1]]}],  
eigengenes]][[locator1[[a, 1]]] * 100] / 100],  
{a, 1, numbers[[2]]}]
```

```
Do[Do[  
missingmatrix2[[a, locator2[[a, b]]]] =  
N[Round[Flatten[Dot[Dot[  
Transpose[Drop[Drop[  
Transpose[{missingmatrix2[[a]]}],  
{locator2[[a, 2]]}], {locator2[[a, 1]]}],  
PseudoInverse[Transpose[Drop[Drop[  
Transpose[eigengenes],  
{locator2[[a, 2]]}], {locator2[[a, 1]]}],  
eigengenes]][[locator2[[a, b]]] * 100] / 100],  
{b, 1, 2}],  
{a, 1, numbers[[3]]}]
```

```
genenames = AppendColumns[fullgenenames, missinggenenames1, missinggenenames2];  
matrix = AppendColumns[fullmatrix, missingmatrix1, missingmatrix2];  
{genes, arrays} = Dimensions[matrix]  
  
{6026, 24}
```

```
(* Normalize Raw Data *)
```

```
(* Calculate Singular Value Decomposition *)
```

```
correlation = Dot[Transpose[matrix], matrix] / (arrays - 1);  
{eigenexpressions, eigengenes} = Eigensystem[correlation];  
eigenexpressions = Sqrt[(arrays - 1) * eigenexpressions];  
Clear[correlation];  
eigengenes[[2]] = -eigengenes[[2]];  
eigengenes[[3]] = -eigengenes[[3]];  
eigengenes[[6]] = -eigengenes[[6]];  
eigenarrays = Dot[eigengenes, Transpose[matrix]];  
Do[  
eigenarrays[[a]] = eigenarrays[[a]] / eigenexpressions[[a]],  
{a, 1, arrays}];  
eigenarrays = Transpose[eigenarrays];  
arraycorrelations = Dot[DiagonalMatrix[eigenexpressions], eigengenes];  
genecorrelations = Dot[eigenarrays, DiagonalMatrix[eigenexpressions]];  
genecorrelations = Transpose[genecorrelations];  
probabilities = eigenexpressions^2 / Sum[eigenexpressions[[a]]^2, {a, 1, arrays}];  
entropy = -N[Sum[probabilities[[a]] * Log[probabilities[[a]]], {a, 1, arrays}] / Log[arrays];  
entropy = N[Round[100 * entropy] / 100]
```

```
0.21
```

```
(* Create Probabilities Bar Charts Displays *)
```

```
probabilities[[2]]
```

```
0.0311036
```

```

limit = 0.032;

Clear[gridx, framex, framey, sizes];
gridx = Table[a, {a, 0, limit, N[limit/4]}];
framex = gridx;
sizes = Flatten[
  Table[
    Dimensions[
      Characters[
        ToString[framex[[a]]]
      ]
    ], {a, 1, 5}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " ",
    {b, 1, 5 - sizes[[a]]}],
  {a, 1, 5}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 5};
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 5};
framey = Table[{a + 1, arrays - a - 9}, {a, 0, 15 - 2};
table = Table[probabilities[[arrays - a]], {a, 9, arrays - 2};
g = BarChart[
  table,
  BarOrientation -> Horizontal,
  PlotRange -> {{0, limit * 1.0001}, {0.5, 15 - 1 + 0.5}},
  AspectRatio -> 1,
  Axes -> False,
  Frame -> True,
  FrameTicks -> {None, framey, framex, None},
  FrameLabel -> {None, None, None, None},
  GridLines -> {gridx, None},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 1.75}, {0, 0}, {0, 1}];
g1 = Show[g,
  AspectRatio -> 1.25,
  PlotRange -> All,
  DisplayFunction -> Identity];

```



```

gridx = Table[a, {a, 0, 1, 0.2}];
framex = gridx;
sizes = Flatten[
  Table[
    Dimensions[
      Characters[
        ToString[framex[[a]]]
      ]
    ], {a, 1, 6}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " ",
    {b, 1, size - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]],
  framex[[a]]}, {a, 1, 6}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 6}];
framey = Table[{a + 1, arrays - a}, {a, 0, arrays - 1}];
labelx = ColumnForm[
  {"(b) Eigenexpression Probability", StringJoin["d = ", ToString[entropy]], " "}, Center];
g = BarChart[
  Table[probabilities[[arrays - a]], {a, 0, arrays - 1}],
  BarOrientation -> Horizontal,
  PlotRange -> {{0, 1.0001}, {0.5, arrays + 0.5}},
  AspectRatio -> 1,
  Axes -> False,
  Frame -> True,
  FrameTicks -> {None, framey, framex, None},
  FrameLabel -> {None, None, labelx, None},
  GridLines -> {gridx, None},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g2 = Show[{g,
  Graphics[{RGBColor[1, 1, 0.8], Rectangle[{0.1, 0.6}, {0.98, 22.6}]},
  Graphics[{Rectangle[{0.1, 0.6}, {0.98, 22.6}, g1}]}],
  AspectRatio -> 1.35,
  PlotRange -> All,
  DisplayFunction -> Identity];

```

(\* Create Eigengenes 2D Red & Green Raster Display \*)

```

contrast = 3.5;
displaying = Table[
  If[contrast * eigengenes[[i, j]] > 0,
    If[contrast * eigengenes[[i, j]] < 1, {contrast * eigengenes[[i, j]], 0}, {1, 0}],
    If[contrast * eigengenes[[i, j]] > -1, {0, -contrast * eigengenes[[i, j]]}, {0, 1}]],
  {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = "Eigengenes";
labelx = ColumnForm[{"(a) Arrays", " ", " "}, Center];
g = Show[
  Graphics[
    RasterArray[
      Table[
        RGBColor[
          displaying[[i, j, 1]], displaying[[i, j, 2]], 0
        ],
        {i, arrays, 1, -1}, {j, 1, arrays}
      ]],
    AspectRatio -> 1, Frame -> True,
    FrameTicks -> {None, framey, framex, None},
    FrameLabel -> {None, labely, labelx, None},
    DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 3, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g1 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All,
  DisplayFunction -> Identity];

```

(\* Create Selected Eigengenes Graph Display \*)

```

eigengenes1 = Chop[TrigFit[eigengenes[[1]], 2, {x, arrays - 1}], 0.05]
eigengenes3 = Chop[TrigFit[Drop[Drop[eigengenes[[3]], {23, 24}], {1, 3}], 2, {x - 3, arrays - 4}], 0.1]
eigengenes4 = Chop[TrigFit[Drop[Drop[eigengenes[[4]], {23, 24}], {1, 3}], 3, {x - 3, arrays - 4}], 0.1]
eigengenes5 = Chop[TrigFit[Drop[Drop[eigengenes[[5]], {23, 24}], {1, 3}], 3, {x - 3, arrays - 4}], 0.1]
eigengenes6 = Chop[TrigFit[Drop[Drop[eigengenes[[6]], {23, 24}], {1, 3}], 3, {x - 3, arrays - 4}], 0.1]
0.203075

```

$$-0.116815 \sin\left[\frac{1}{10} \pi (-3 + x)\right] - 0.141508 \sin\left[\frac{1}{5} \pi (-3 + x)\right]$$

$$-0.108177 \cos\left[\frac{1}{10} \pi (-3 + x)\right] + 0.172705 \cos\left[\frac{1}{5} \pi (-3 + x)\right]$$

$$0.126348 \cos\left[\frac{1}{5} \pi (-3 + x)\right] + 0.183233 \sin\left[\frac{1}{5} \pi (-3 + x)\right]$$

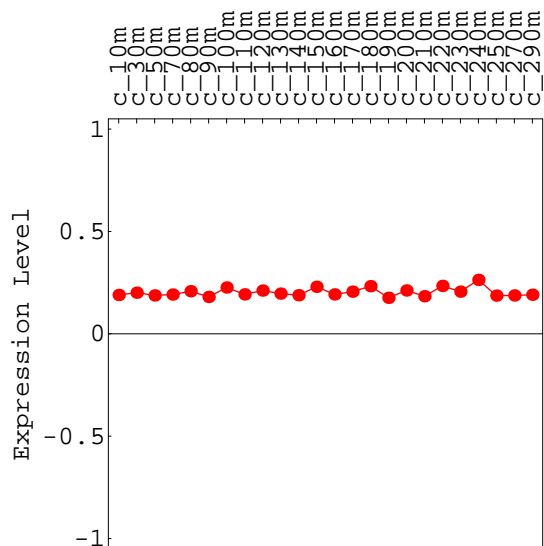
$$0.164701 \cos\left[\frac{1}{10} \pi (-3 + x)\right] - 0.141079 \sin\left[\frac{1}{10} \pi (-3 + x)\right] + 0.109276 \sin\left[\frac{1}{5} \pi (-3 + x)\right]$$

```

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
   Graphics[{RGBColor[1, 0, 0], line}]},
  Frame -> True,
  FrameLabel -> {None, labely, labelx, None},
  GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
  FrameTicks -> {None, framey, framex, None},
  PlotRange -> {-1.05, 1.05},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p1 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(c) Arrays

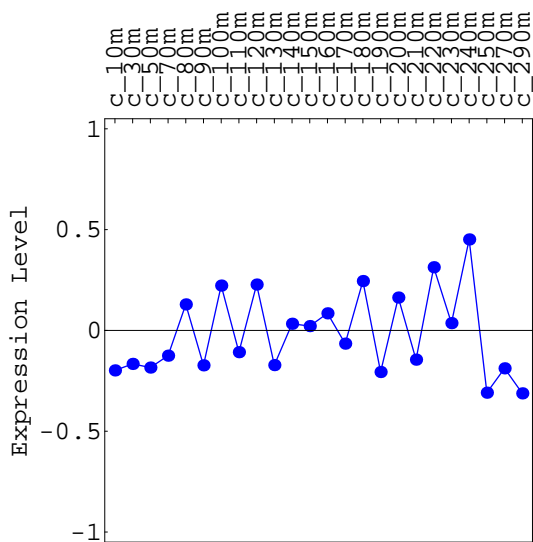


```

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
   Graphics[{RGBColor[0, 0, 1], line}]},
  Frame -> True,
  FrameLabel -> {None, labely, labelx, None},
  GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
  FrameTicks -> {None, framey, framex, None},
  PlotRange -> {-1.05, 1.05},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p2 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(c) Arrays

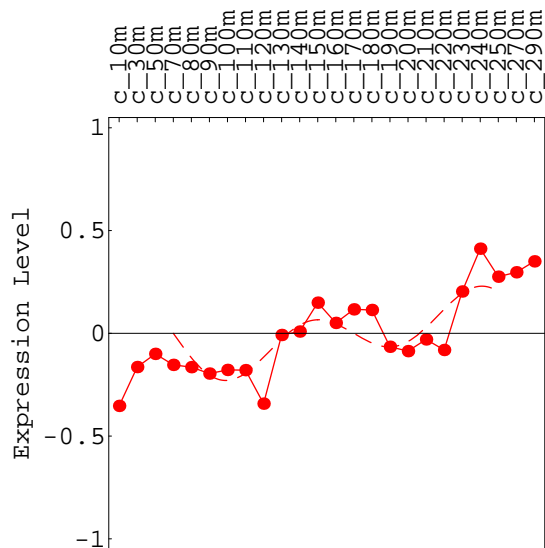


```

graph = Plot[
  eigengenes3,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[3, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
  Graphics[{RGBColor[1, 0, 0], line}],
  graph},
Frame -> True,
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
FrameTicks -> {None, framey, framex, None},
PlotRange -> {-1.05, 1.05},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p3 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(d) Arrays

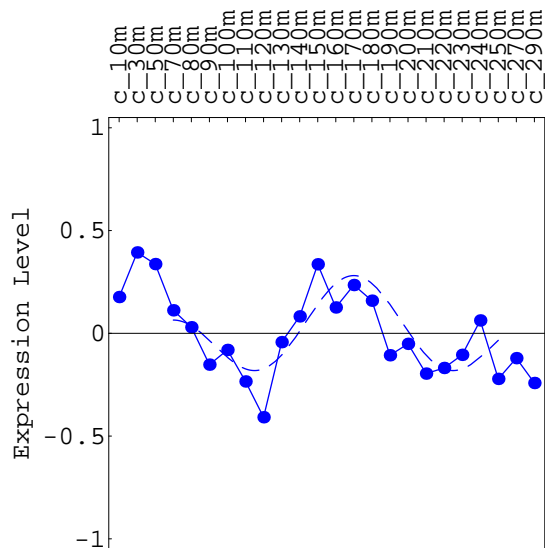


```

graph = Plot[
  eigengenes4,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[4, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
  Graphics[{RGBColor[0, 0, 1], line}],
  graph},
Frame -> True,
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
FrameTicks -> {None, framey, framex, None},
PlotRange -> {-1.05, 1.05},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p4 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(d) Arrays

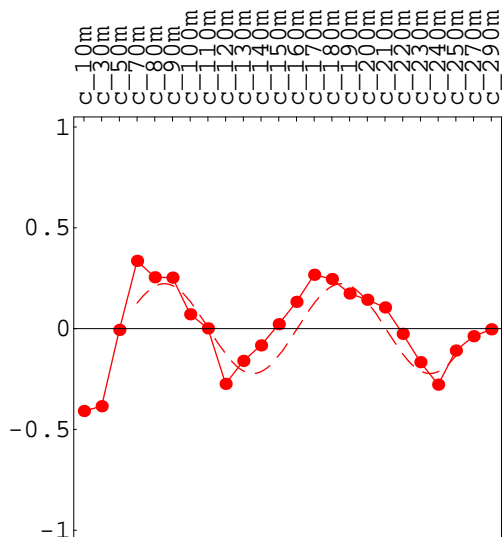


```

graph = Plot[
  eigengenes5,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[5, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
  Graphics[{RGBColor[1, 0, 0], line}],
  graph},
  Frame -> True,
  FrameLabel -> {None, labely, labelx, None},
  GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
  FrameTicks -> {None, framey, framex, None},
  PlotRange -> {-1.05, 1.05},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p5 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(e) Arrays

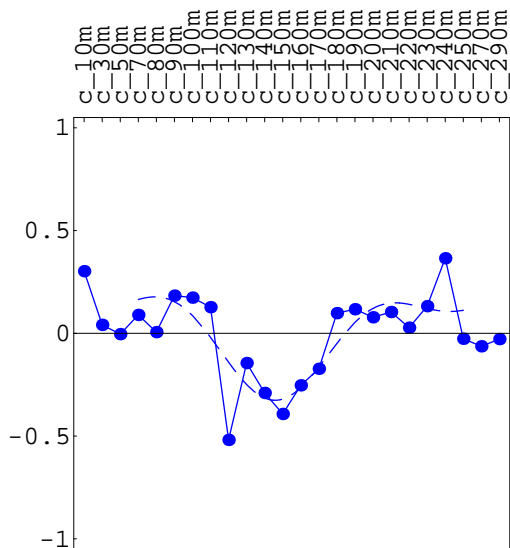


```

graph = Plot[
  eigengenes6,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[6, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}},
  Graphics[{RGBColor[0, 0, 1], line}],
  graph},
Frame -> True,
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
FrameTicks -> {None, framey, framex, None},
PlotRange -> {-1.05, 1.05},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p6 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(e) Arrays





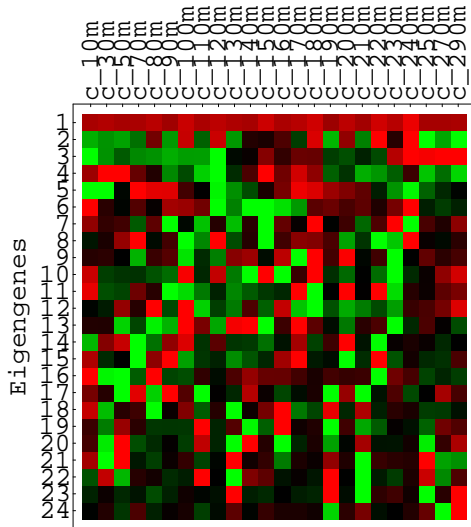
(\* Display Selected Eigengenes \*)

```
g3 = Show[{p2, p1},
  DisplayFunction -> Identity];
g4 = Show[{p4, p3},
  DisplayFunction -> Identity];
g5 = Show[{p6, p5},
  DisplayFunction -> Identity];
```

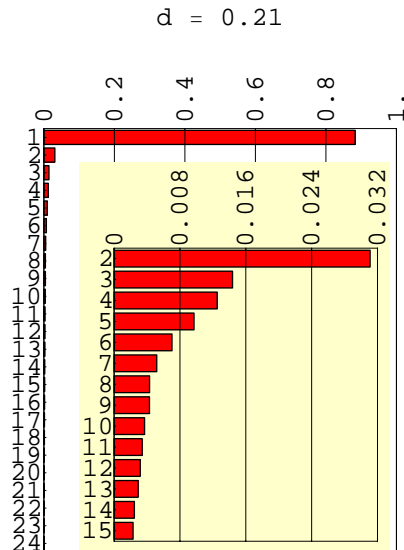
(\* Display Eigengenes, Probabilities and Selected Eigengenes \*)

```
Show[GraphicsArray[{g1, g2, g3}],
  GraphicsSpacing -> -0.175];
```

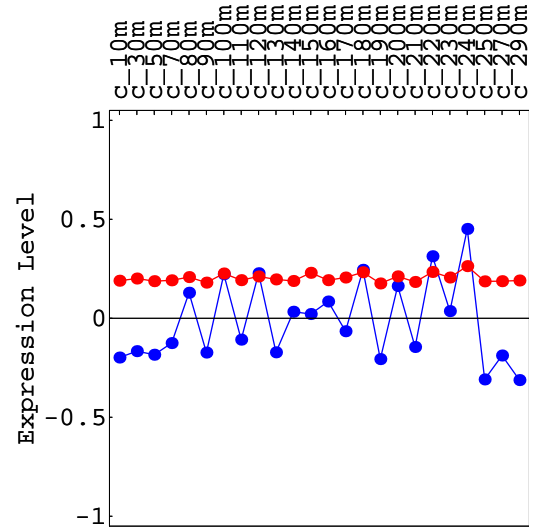
(a) Arrays



(b) Eigenexpression Probability

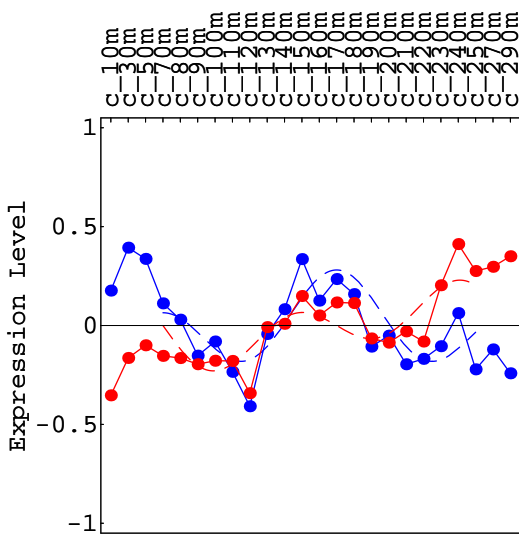


(c) Arrays

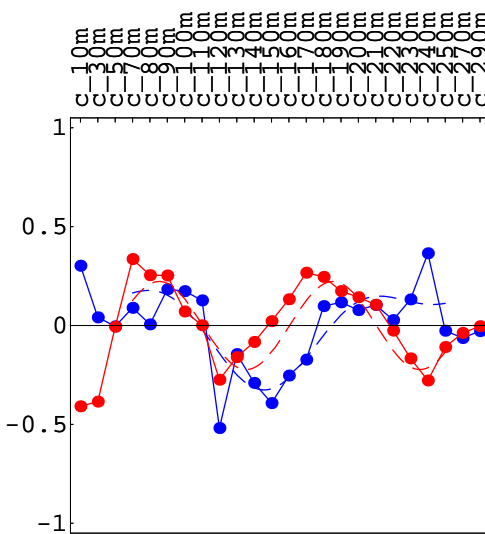


```
Show[GraphicsArray[{g4, g5}],
  GraphicsSpacing -> -0.125];
```

(d) Arrays



(e) Arrays



```
(* and Remove the Additive Constant *)
```

```
(* Reconstruct Data Without Additive Constant *)
```

```
eigenexpressions[[1]] = 0;  
eigenexpressions[[2]] = 0;  
Do[eigenexpressions[[a]] = 0,  
  {a, 7, arrays}];  
matrix = Dot[eigenarrays, DiagonalMatrix[eigenexpressions], eigengenes];
```

```
(* Remove the Multiplicative Constant *)
```

```
(* Calculate Singular Value Decomposition *)
```

```
normalization = Log[matrix^2];  
correlation = Dot[Transpose[normalization], normalization] / (arrays - 1);  
{eigenexpressions, eigengenes} = Eigensystem[correlation];  
eigenexpressions = Sqrt[(arrays - 1) * eigenexpressions];  
Clear[correlation];  
eigengenes[[1]] = -eigengenes[[1]];  
eigengenes[[2]] = -eigengenes[[2]];  
eigengenes[[3]] = -eigengenes[[3]];  
eigengenes[[5]] = -eigengenes[[5]];  
eigenarrays = Dot[eigengenes, Transpose[normalization]];  
Do[  
  eigenarrays[[a]] = eigenarrays[[a]] / eigenexpressions[[a]],  
  {a, 1, arrays}];  
eigenarrays = Transpose[eigenarrays];  
probabilities = eigenexpressions^2 / Sum[eigenexpressions[[a]]^2, {a, 1, arrays}];  
entropy = -N[Sum[probabilities[[a]] * Log[probabilities[[a]]], {a, 1, arrays}] / Log[arrays];  
entropy = N[Round[100 * entropy] / 100]
```

```
0.22
```

```
(* Create Probabilities Bar Charts Displays *)
```

```
probabilities[[2]]  
  
0.020597  
  
limit = 0.024;  
  
Clear[gridx, framex, framey, sizes];  
gridx = Table[a, {a, 0, limit, N[limit/4]}];  
framex = gridx;  
sizes = Flatten[  
  Table[  
    Dimensions[  
      Characters[  
        ToString[framex[[a]]]  
      ]  
    ], {a, 1, 5}];  
Do[  
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " "],  
    {b, 1, 5 - sizes[[a]]},  
    {a, 1, 5}];  
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 5};  
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 5};  
framey = Table[{a + 1, arrays - a - 9}, {a, 0, 15 - 2}];  
table = Table[probabilities[[arrays - a]], {a, 9, arrays - 2}];
```

```

g = BarChart[
  table,
  BarOrientation -> Horizontal,
  PlotRange -> {{0, limit*1.0001}, {0.5, 15 - 1 + 0.5}},
  AspectRatio -> 1,
  Axes -> False,
  Frame -> True,
  FrameTicks -> {None, framey, framex, None},
  FrameLabel -> {None, None, None, None},
  GridLines -> {gridx, None},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 1.75}, {0, 0}, {0, 1}];

g1 = Show[g,
  AspectRatio -> 1.25,
  PlotRange -> All,
  DisplayFunction -> Identity];

gridx = Table[a, {a, 0, 1, 0.2}];
framex = gridx;
sizes = Flatten[
  Table[
    Dimensions[
      Characters[
        ToString[framex[[a]]]
      ]
    ], {a, 1, 6}]];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " ",
    {b, 1, size - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]],
  framex[[a]]}, {a, 1, 6}];
gridx = Table[{gridx[[a]], RGBColor[0, 0, 0]}, {a, 1, 6}];
framey = Table[{a + 1, arrays - a}, {a, 0, arrays - 1}];
labelx = ColumnForm[
  {"(b) Eigenexpression Probability", StringJoin["d = ", ToString[entropy]], " "}, Center];
g = BarChart[
  Table[probabilities[[arrays - a]], {a, 0, arrays - 1}],
  BarOrientation -> Horizontal,
  PlotRange -> {{0, 1.0001}, {0.5, arrays + 0.5}},
  AspectRatio -> 1,
  Axes -> False,
  Frame -> True,
  FrameTicks -> {None, framey, framex, None},
  FrameLabel -> {None, None, labelx, None},
  GridLines -> {gridx, None},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g2 = Show[g,
  Graphics[{RGBColor[1, 1, 0.8], Rectangle[{0.1, 0.6}, {0.98, 22.6}]},
  Graphics[{Rectangle[{0.1, 0.6}, {0.98, 22.6}, g1]}],
  AspectRatio -> 1.35,
  PlotRange -> All,
  DisplayFunction -> Identity];

```

(\* Create Eigengenes 2D Red & Green Raster Display \*)

```

contrast = 3.5;
displaying = Table[
  If[contrast * eigengenes[[i, j]] > 0,
    If[contrast * eigengenes[[i, j]] < 1, {contrast * eigengenes[[i, j]], 0}, {1, 0}],
    If[contrast * eigengenes[[i, j]] > -1, {0, -contrast * eigengenes[[i, j]]}, {0, 1}]],
  {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = "Eigengenes";
labelx = ColumnForm[{"(a) Arrays", " ", " "}, Center];
g = Show[
  Graphics[
    RasterArray[
      Table[
        RGBColor[
          displaying[[i, j, 1]], displaying[[i, j, 2]], 0
        ],
        {i, arrays, 1, -1}, {j, 1, arrays}
      ]],
    AspectRatio -> 1, Frame -> True,
    FrameTicks -> {None, framey, framex, None},
    FrameLabel -> {None, labely, labelx, None},
    DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 3, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g1 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All,
  DisplayFunction -> Identity];

```

(\* Create Selected Eigengenes Graph Display \*)

```

eigengenes1 = Chop[TrigFit[eigengenes[[1]], 2, {x, arrays - 1}], 0.05]
eigengenes3 = Chop[TrigFit[Drop[Drop[eigengenes[[3]], {23, 24}], {1, 3}], 4, {x - 3, arrays - 4}], 0.1]
eigengenes4 = Chop[TrigFit[Drop[Drop[eigengenes[[4]], {23, 24}], {1, 3}], 6, {x - 3, arrays - 4}], 0.1]
eigengenes5 = Chop[TrigFit[Drop[Drop[eigengenes[[5]], {23, 24}], {1, 3}], 6, {x - 3, arrays - 4}], 0.1]
eigengenes6 = Chop[TrigFit[Drop[Drop[eigengenes[[6]], {23, 24}], {1, 3}], 8, {x - 3, arrays - 4}], 0.1]
0.202101
0.141244 Cos[ $\frac{1}{10} \pi (-3 + x)$ ] + 0.141894 Cos[ $\frac{3}{10} \pi (-3 + x)$ ]
0.116688 Sin[ $\frac{1}{5} \pi (-3 + x)$ ] + 0.152691 Sin[ $\frac{3}{10} \pi (-3 + x)$ ] - 0.156478 Sin[ $\frac{2}{5} \pi (-3 + x)$ ]
-0.100015 Cos[ $\frac{1}{5} \pi (-3 + x)$ ] + 0.144233 Cos[ $\frac{3}{10} \pi (-3 + x)$ ] + 0.111465 Sin[ $\frac{2}{5} \pi (-3 + x)$ ]
0.141002 Cos[ $\frac{1}{10} \pi (-3 + x)$ ] - 0.149631 Cos[ $\frac{1}{5} \pi (-3 + x)$ ] - 0.139068 Cos[ $\frac{3}{5} \pi (-3 + x)$ ]

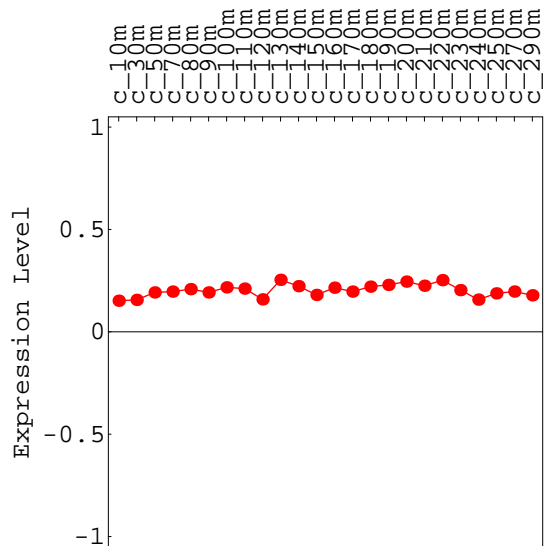
```

```

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
   Graphics[{RGBColor[1, 0, 0], line}]},
  Frame -> True,
  FrameLabel -> {None, labely, labelx, None},
  GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
  FrameTicks -> {None, framey, framex, None},
  PlotRange -> {-1.05, 1.05},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p1 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(c) Arrays

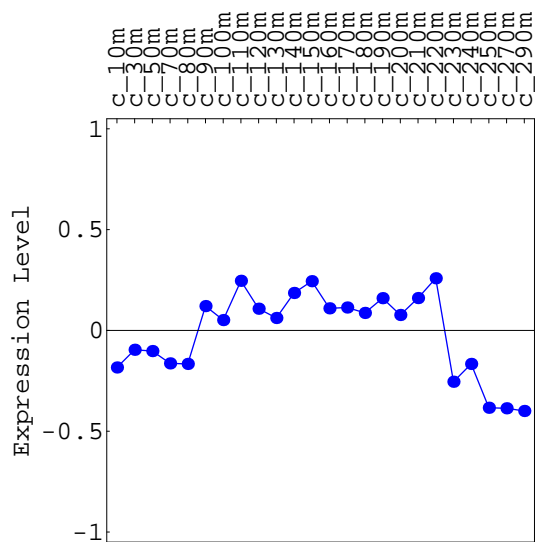


```

labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
   Graphics[{RGBColor[0, 0, 1], line}]},
  Frame -> True,
  FrameLabel -> {None, labely, labelx, None},
  GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
  FrameTicks -> {None, framey, framex, None},
  PlotRange -> {-1.05, 1.05},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p2 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(c) Arrays

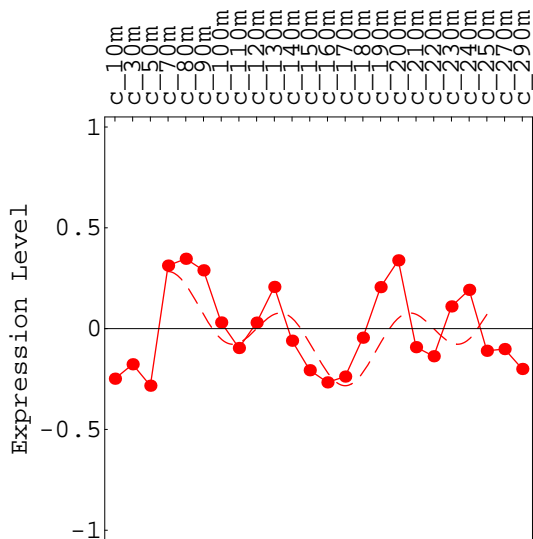


```

graph = Plot[
  eigengenes3,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[3, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}},
  Graphics[{RGBColor[1, 0, 0], line}},
  graph],
Frame -> True,
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
FrameTicks -> {None, framey, framex, None},
PlotRange -> {-1.05, 1.05},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p3 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(d) Arrays

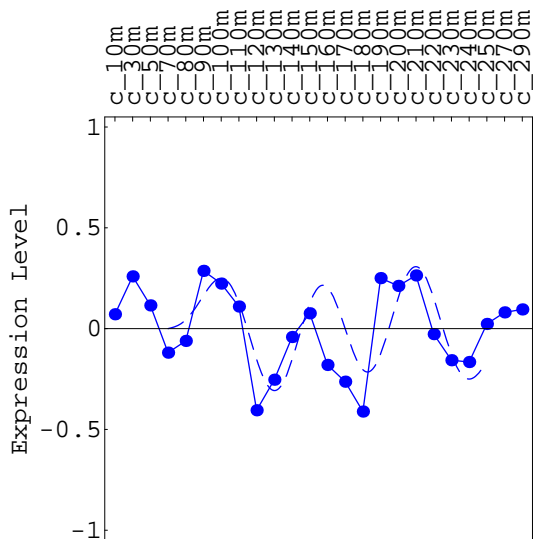


```

graph = Plot[
  eigengenes4,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(d) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[4, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
  Graphics[{RGBColor[0, 0, 1], line}],
  graph},
  Frame -> True,
  FrameLabel -> {None, labely, labelx, None},
  GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
  FrameTicks -> {None, framey, framex, None},
  PlotRange -> {-1.05, 1.05},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p4 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(d) Arrays



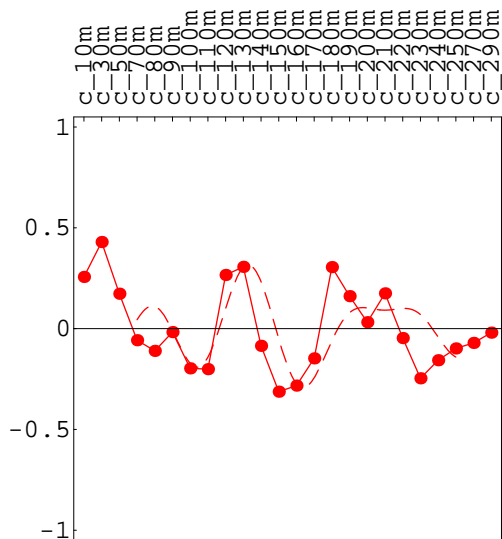


```

graph = Plot[
  eigengenes5,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[5, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
  Graphics[{RGBColor[1, 0, 0], line}],
  graph},
  Frame -> True,
  FrameLabel -> {None, labely, labelx, None},
  GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
  FrameTicks -> {None, framey, framex, None},
  PlotRange -> {-1.05, 1.05},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p5 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(e) Arrays

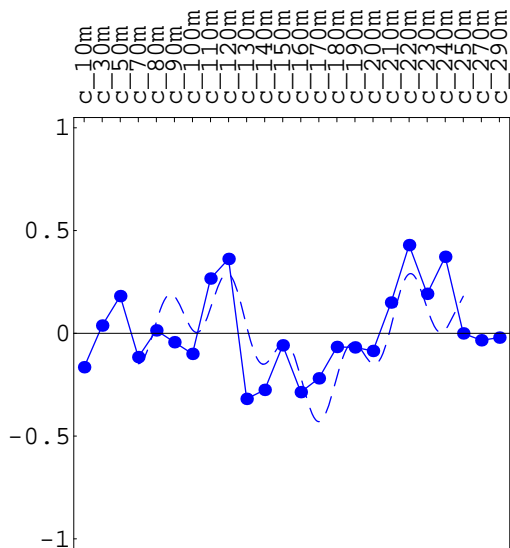


```

graph = Plot[
  eigengenes6,
  {x, 3, arrays - 3},
  PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(e) Arrays"}, Center];
labely = ColumnForm[{" ", " "}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[6, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
  Graphics[{RGBColor[0, 0, 1], line}],
  graph},
Frame -> True,
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
FrameTicks -> {None, framey, framex, None},
PlotRange -> {-1.05, 1.05},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p6 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(e) Arrays



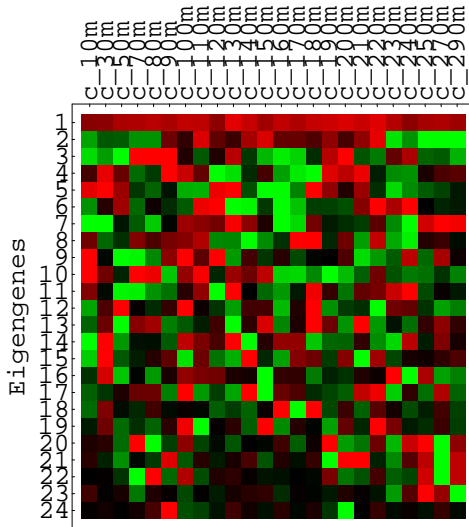
(\* Display Selected Eigengenes \*)

```
g3 = Show[{p1, p2},
  DisplayFunction -> Identity];
g4 = Show[{p4, p3},
  DisplayFunction -> Identity];
g5 = Show[{p6, p5},
  DisplayFunction -> Identity];
```

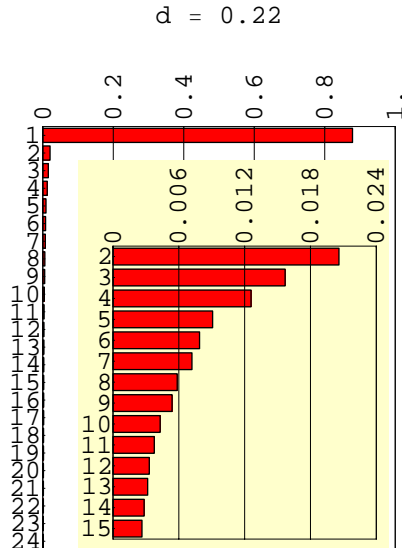
(\* Display Eigengenes, Probabilities and Selected Eigengenes \*)

```
Show[GraphicsArray[{g1, g2, g3}],
  GraphicsSpacing -> -0.175];
```

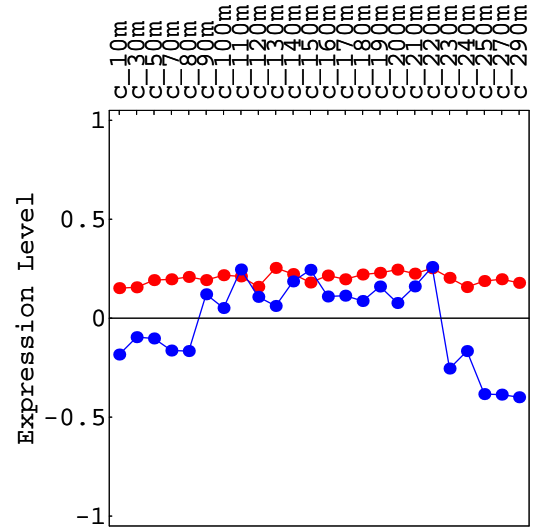
(a) Arrays



(b) Eigenexpression Probability

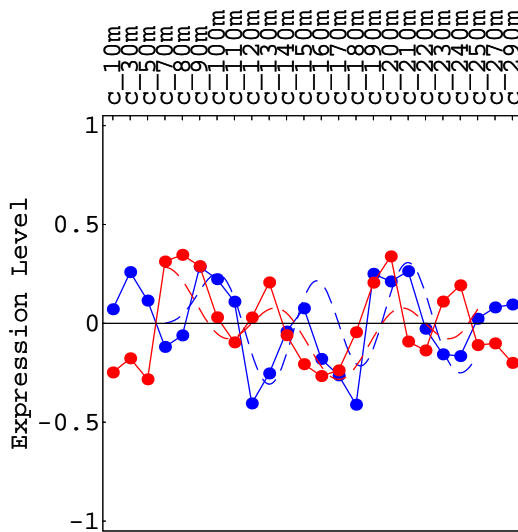


(c) Arrays

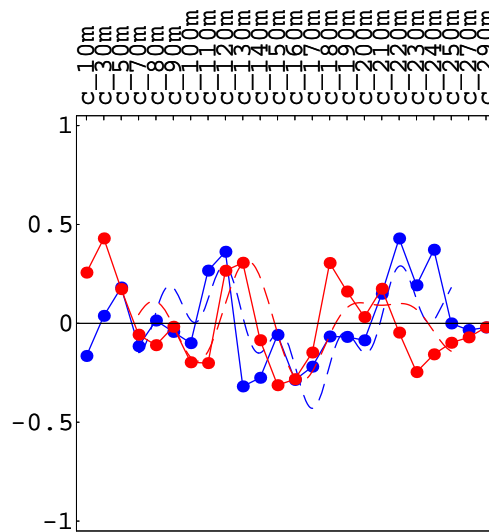


```
Show[GraphicsArray[{g4, g5}],
  GraphicsSpacing -> -0.125];
```

(d) Arrays



(e) Arrays



```
(* Reconstruct the Data Without Multiplicative Constant *)
```

```
eigenexpressions[[1]] = 0;  
eigenexpressions[[2]] = 0;  
normalization = Dot[eigenarrays, DiagonalMatrix[eigenexpressions], eigengenes];  
normalization = Sqrt[Exp[normalization]];  
matrix = Sign[matrix];  
matrix = N[matrix*normalization];  
Clear[normalization];
```

```
(* Examine Normalized Data *)
```

```
(* Calculate Singular Value Decomposition *)
```

```
correlation = Dot[Transpose[matrix], matrix] / (arrays - 1);  
{eigenexpressions, eigengenes} = Eigensystem[correlation];  
eigenexpressions = Sqrt[(arrays - 1) * eigenexpressions];  
Clear[correlation];  
eigenarrays = Dot[eigengenes, Transpose[matrix]];  
Do[  
  eigenarrays[[a]] = eigenarrays[[a]] / eigenexpressions[[a]],  
  {a, 1, arrays}];  
eigenarrays = Transpose[eigenarrays];  
arraycorrelations = Dot[DiagonalMatrix[eigenexpressions], eigengenes];  
genecorrelations = Dot[eigenarrays, DiagonalMatrix[eigenexpressions]];  
genecorrelations = Transpose[genecorrelations];  
probabilities = eigenexpressions^2 / Sum[eigenexpressions[[a]]^2, {a, 1, arrays}];  
entropy = -N[Sum[probabilities[[a]] * Log[probabilities[[a]]], {a, 1, arrays}] / Log[arrays];  
entropy = N[Round[100 * entropy] / 100]
```

0.52

```
(* Create Probabilities Bar Charts Displays *)
```

```
probabilities[[1]]
```

0.29024

```
limit = 0.3;
```

```

Clear[gridx, framex, framey, sizes];
gridx = Table[a, {a, 0, limit, N[limit/5]}];
framex = gridx;
sizes = Flatten[
  Table[
    Dimensions[
      Characters[
        ToString[framex[[a]]]
      ]
    ], {a, 1, 6}];
Do[
  Do[framex[[a]] = StringJoin[ToString[framex[[a]]], " ",
    {b, 1, size - sizes[[a]]}],
  {a, 1, 6}];
framex = Table[{gridx[[a]], framex[[a]]}, {a, 1, 6}];
framey = Table[{a + 1, arrays - a}, {a, 0, arrays - 1}];
labelx = ColumnForm[
  {"(b) Eigenexpression Probability", StringJoin["d = ", ToString[entropy]], " "}, Center];
g = BarChart[
  Table[probabilities[[arrays - a]], {a, 0, arrays - 1}],
  BarOrientation -> Horizontal,
  PlotRange -> {{0, limit * 1.0001}, {0.5, arrays + 0.5}},
  AspectRatio -> 1,
  Axes -> False,
  Frame -> True,
  FrameTicks -> {None, framey, framex, None},
  FrameLabel -> {None, None, labelx, None},
  GridLines -> {gridx, None},
  DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g2 = Show[g,
  AspectRatio -> 1.35,
  PlotRange -> All,
  DisplayFunction -> Identity];

```

(\* Create Eigengenes 2D Red & Green Raster Display \*)

```

contrast = 3.5;
displaying = Table[
  If[contrast * eigengenes[[i, j]] > 0,
    If[contrast * eigengenes[[i, j]] < 1, {contrast * eigengenes[[i, j]], 0}, {1, 0}],
    If[contrast * eigengenes[[i, j]] > -1, {0, -contrast * eigengenes[[i, j]]}, {0, 1}]],
  {i, 1, arrays}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = Table[{a + 1 - 0.5, arrays - a}, {a, 0, arrays - 1}];
labely = "Eigengenes";
labelx = ColumnForm[{"(a) Arrays", " ", " "}, Center];
g = Show[
  Graphics[
    RasterArray[
      Table[
        RGBColor[
          displaying[[i, j, 1]], displaying[[i, j, 2]], 0
        ],
        {i, arrays, 1, -1}, {j, 1, arrays}
      ]],
    AspectRatio -> 1, Frame -> True,
    FrameTicks -> {None, framey, framex, None},
    FrameLabel -> {None, labely, labelx, None},
    DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 3, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 3}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 2.7}, {0, 0}, {0, 1}];
g1 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All,
  DisplayFunction -> Identity];

```

(\* Create Selected Eigengenes Graph Display \*)

```

eigengenes1 = Chop[TrigFit[Drop[Drop[eigengenes[[1]], {23, 24}], {1, 3}], 2, {x - 3, arrays - 4}], 0.1]
eigengenes2 = Chop[TrigFit[Drop[Drop[eigengenes[[2]], {23, 24}], {1, 3}], 2, {x - 3, arrays - 4}], 0.175]

-0.237492 Sin[ $\frac{1}{5} \pi (-3 + x)$ ]

0.245014 Cos[ $\frac{1}{5} \pi (-3 + x)$ ]

zerophase = N[ArcTan[arraycorrelations[[2, 1]] / arraycorrelations[[1, 1]]] / Pi];
eigengenes1 = 0.295 * Cos[Pi * x / 5 + (0.5 - zerophase) * 5 / 2 * Pi];
eigengenes2 = 0.295 * Sin[Pi * x / 5 + (0.5 - zerophase) * 5 / 2 * Pi];

```

```

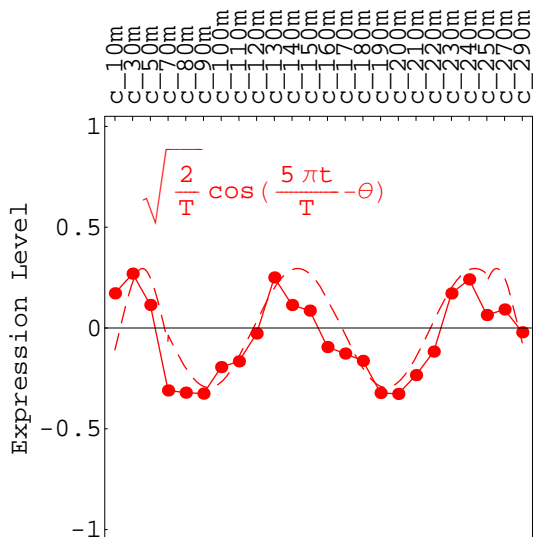
graph = Plot[
  If[3 <= x <= 21, eigengenes1, 0.295 * Cos[4 * Pi * (x - 2.8) / 10 + Pi / 2]],
  {x, 0, arrays - 1},
  PlotStyle -> {RGBColor[1, 0, 0], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[1, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], PointSize[0.022], points}],
  Graphics[{RGBColor[1, 0, 0], line}],
  graph,

  Graphics[{RGBColor[1, 0, 0], Text[" $\sqrt{\frac{2}{T}} \cos(\frac{5 \pi t}{T} - \theta)$ ", {8.5, 0.7}]}]},

Frame -> True,
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
FrameTicks -> {None, framey, framex, None},
PlotRange -> {-1.05, 1.05},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p1 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(c) Arrays



```

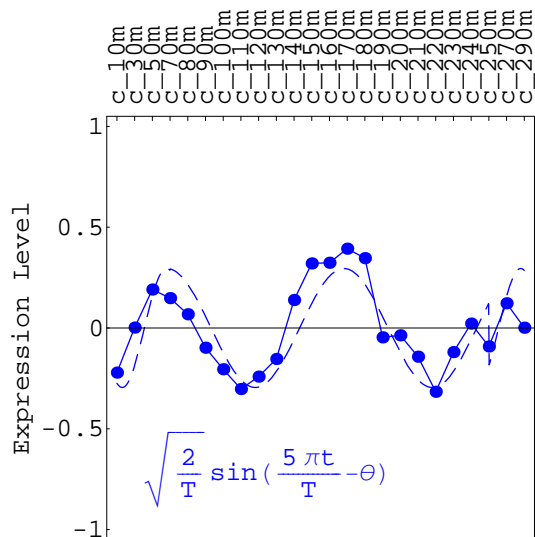
graph = Plot[
  If[3 <= x <= 21, eigengenes2, 0.295 * Sin[4 * Pi * (x - 2.8) / 10 + Pi / 2]],
  {x, 0, arrays - 1},
  PlotStyle -> {RGBColor[0, 0, 1], Dashing[{0.03, 0.02}]},
  DisplayFunction -> Identity];
labelx = ColumnForm[{"(c) Arrays"}, Center];
labely = ColumnForm[{" ", "Expression Level"}, Center];
framex = Table[{a - 1, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {-1, -0.5, 0, 0.5, 1};
coordinates = Table[{a - 1, eigengenes[[2, a]]}, {a, 1, arrays}];
points = Table[Point[coordinates[[a]]], {a, 1, arrays}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0, 1], PointSize[0.022], points}],
  Graphics[{RGBColor[0, 0, 1], line}],
  graph,

  Graphics[{RGBColor[0, 0, 1], Text[" $\sqrt{\frac{2}{T}} \sin(\frac{5 \pi t}{T} - \theta)$ ", {8.5, -0.7}]}]},

Frame -> True,
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, {{0, RGBColor[0, 0, 0]}}},
FrameTicks -> {None, framey, framex, None},
PlotRange -> {-1.05, 1.05},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b - 5.4, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 0.625}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 0.25}, {0, 0}, {0, 1}];
p2 = Show[g,
  AspectRatio -> 1.05,
  PlotRange -> All];

```

(c) Arrays





(\* Display Selected Eigengenes \*)

```
g3 = Show[{p2, p1},
  DisplayFunction -> Identity];
```

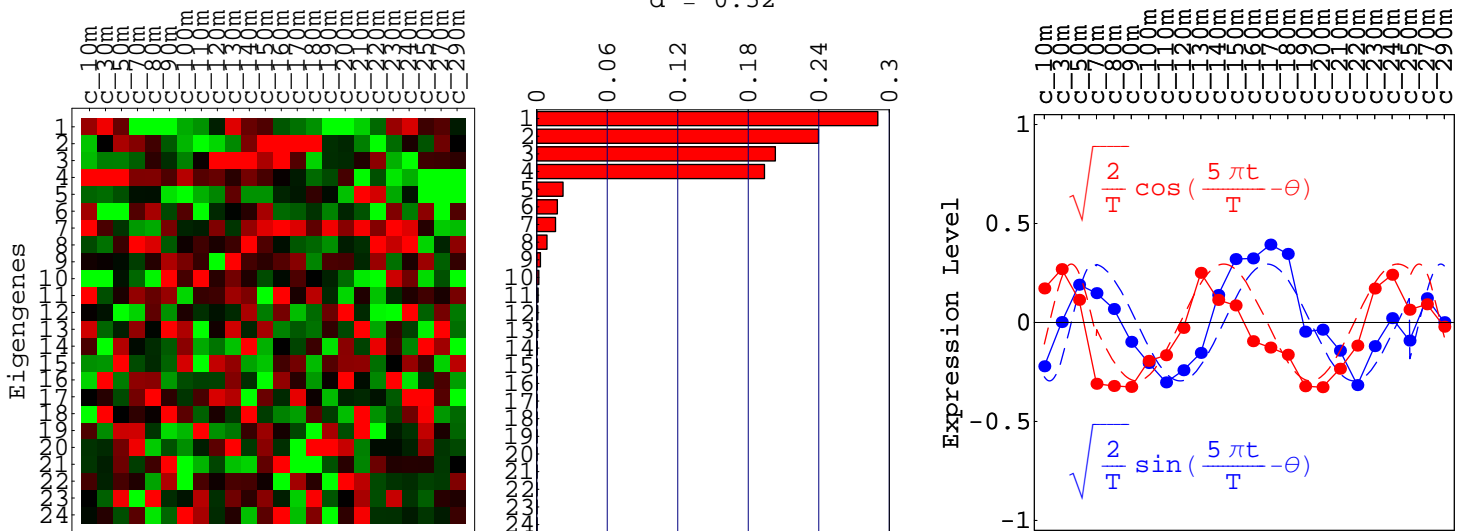
(\* Display Eigengenes, Probabilities and Selected Eigengenes \*)

```
Show[GraphicsArray[{g1, g2, g3}],
  GraphicsSpacing -> -0.175];
```

(a) Arrays

(b) Eigenexpression Probability

(c) Arrays



(\* Create Parameter Graphs of Arrays According to Projections on Eigenarrays \*)

```
labelx = ColumnForm[{"Array Correlation with  $|\alpha_1\rangle$ "}, Center];
labely = ColumnForm[{"Array Correlation with  $|\alpha_2\rangle$ "}, Center];
matrix = Transpose[matrix];
coordinates = Table[
  {arraycorrelations[[1, a]] / Sqrt[Dot[matrix[[a]], matrix[[a]]],
  arraycorrelations[[2, a]] / Sqrt[Dot[matrix[[a]], matrix[[a]]]}],
  {a, 1, arrays}];
matrix = Transpose[matrix];
points1 = {Point[coordinates[[1]]], Point[coordinates[[2]]], Point[coordinates[[9]]],
  Point[coordinates[[10]]], Point[coordinates[[21]]], Point[coordinates[[22]]]};
points2 = {Point[coordinates[[3]]], Point[coordinates[[4]]], Point[coordinates[[11]]],
  Point[coordinates[[12]]], Point[coordinates[[13]]], Point[coordinates[[23]]],
  Point[coordinates[[24]]]};
points3 = {Point[coordinates[[5]]], Point[coordinates[[14]]], Point[coordinates[[15]]]};
points4 = {Point[coordinates[[6]]], Point[coordinates[[16]]], Point[coordinates[[17]]]};
points5 = {Point[coordinates[[7]]], Point[coordinates[[8]]], Point[coordinates[[18]]],
  Point[coordinates[[19]]], Point[coordinates[[20]]]};
textcoordinates = coordinates;
Do[textcoordinates[[a, 1]] =
  If[textcoordinates[[a, 1]] > 0, textcoordinates[[a, 1]] - 0.085, textcoordinates[[a, 1]] + 0.085],
  {a, 1, 9}];
Do[textcoordinates[[a, 1]] =
  If[textcoordinates[[a, 1]] > 0, textcoordinates[[a, 1]] - 0.11, textcoordinates[[a, 1]] + 0.11],
  {a, 10, arrays}];
```

```

textcoordinates[[1]] = textcoordinates[[1]] + {0.11, -0.085};
textcoordinates[[2]] = textcoordinates[[2]] + {0.11, -0.085};
textcoordinates[[3]] = textcoordinates[[3]] + {0.15, 0.075};
textcoordinates[[6]] = textcoordinates[[6]] + {-0.05, -0.085};
textcoordinates[[7]] = textcoordinates[[7]] + {-0.17, 0};
textcoordinates[[8]] = textcoordinates[[8]] + {-0.085, 0.085};
textcoordinates[[9]] = textcoordinates[[9]] + {-0.15, 0.085};
textcoordinates[[10]] = textcoordinates[[10]] + {0.2, -0.085};
textcoordinates[[11]] = textcoordinates[[11]] + {0.135, -0.11};
textcoordinates[[13]] = textcoordinates[[13]] + {-0.11, -0.085};
textcoordinates[[15]] = textcoordinates[[15]] + {-0.22, 0};
textcoordinates[[16]] = textcoordinates[[16]] + {0, -0.05};
textcoordinates[[17]] = textcoordinates[[17]] + {0, 0.05};
textcoordinates[[20]] = textcoordinates[[20]] + {0.195, +0.085};
textcoordinates[[21]] = textcoordinates[[21]] + {0.11, 0.11};
textcoordinates[[24]] = textcoordinates[[24]] + {-0.11, 0.11};
texts = Table[Text[a, textcoordinates[[a]]], {a, 1, arrays}];
zerophase = N[ArcTan[arraycorrelations[[2, 1]] / (arraycorrelations[[1, 1]])];
radius = 0.275;
p = Show[{
  Graphics[{RGBColor[1, 1, 0], PointSize[0.035], points1}],
  Graphics[{RGBColor[0, 0.5, 0], PointSize[0.035], points2}],
  Graphics[{RGBColor[0, 0, 1], PointSize[0.035], points3}],
  Graphics[{RGBColor[1, 0, 0], PointSize[0.035], points4}],
  Graphics[{RGBColor[1, 0.5, 0], PointSize[0.035], points5}],
  Graphics[{RGBColor[1, 0.5, 0], Text["G2/M", {-0.6, -0.95}]}],
  Graphics[{RGBColor[0, 0, 0], Text["M/G1", {0.875, -0.775}]}],
  Graphics[{RGBColor[1, 0, 0], Text["S/G2", {-0.875, -0.75}]}],
  Graphics[{RGBColor[0, 0, 1], Text["S", {-0.8, 0.8}]}],
  Graphics[{RGBColor[0, 0.5, 0], Text["G1", {0.55, 0.95}]}],
  Graphics[{RGBColor[0, 0, 0], Text["(a)", {-0.9, 0.95}]}],
  Graphics[texts],
  Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
  Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}],
  Graphics[{RGBColor[0, 0, 0], Circle[{0, 0}, radius, {zerophase, 0}]}],
  Graphics[{RGBColor[0, 0, 0], Arrow[
    {radius * Cos[-0.05], radius * Sin[-0.05]}, {radius * Cos[0], radius * Sin[0]},
    HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75}]}],
  Graphics[{RGBColor[0, 0, 0], Circle[{0, 0}, 0.925, {zerophase, -0.5 * zerophase}]}],
  Graphics[{RGBColor[0, 0, 0], Arrow[
    {0.925 * Cos[-0.5 * zerophase - 0.05], 0.925 * Sin[-0.5 * zerophase - 0.05]},
    {0.925 * Cos[-0.5 * zerophase], 0.925 * Sin[-0.5 * zerophase]},
    HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75}]}],
  Graphics[{RGBColor[0, 0, 0], Arrow[{0, 0}, coordinates[[1]],
    HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75}]}],
  Graphics[{RGBColor[0, 0, 0], Text["r", {0.1, -0.4}]}],
  Graphics[{RGBColor[0, 0, 0], Text["θ", {0.175, -0.125}]}],
AspectRatio -> 1,
PlotRange -> {{-1.05, 1.05}, {-1.05, 1.05}},
Frame -> True,
FrameTicks -> False,
FrameLabel -> {labelx, labely, None, None},
GridLines -> {{0, RGBColor[0, 0, 0]}, {0, RGBColor[0, 0, 0]}},
DisplayFunction -> Identity];
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
p1 = Show[p,
  AspectRatio -> 1.,
  PlotRange -> All,
  DisplayFunction -> Identity];

```

```
(* Create Parameter Graphs of Genes According to Projections on Eigengenes *)
```

```
labelx = ColumnForm[{"Gene Correlation with  $|\gamma_1\rangle$ "}, Center];  
labely = ColumnForm[{"Gene Correlation with  $|\gamma_2\rangle$ "}, Center];  
coordinates = Table[  
  {genecorrelations[[1, a]] / Sqrt[Dot[matrix[[a]], matrix[[a]]]],  
   genecorrelations[[2, a]] / Sqrt[Dot[matrix[[a]], matrix[[a]]]]},  
  {a, 1, genes}];
```

```
(* Create Parameter Graphs of 799 Cell Cycle Genes According to Projections on Eigengenes *)
```

```
stream = StringJoin[name, ":Desktop Folder:SPIE Data:Spellman_Classify_Cycle.txt"];  
list = ReadList[stream, Word, RecordLists -> True, NullWords -> True];  
list = Drop[list, 2];  
stages = {"M/G1", "G1", "S", "S/G2", "G2/M"};  
points = {points1, points2, points3, points4, points5};  
radii = {radii1, radii2, radii3, radii4, radii5};  
Do[{  
  position = Position[list, stages[[b]]],  
  table = Table[list[[position[[a, 1]], 1]], {a, 1, Dimensions[position][[1]]},  
  position = Table[Position[genenames, table[[a]]], {a, 1, Dimensions[table][[1]]},  
  table = Flatten[Position[position, {}]],  
  Do[  
    position = Drop[position, {table[[a]], table[[a]]}, {a, Dimensions[table][[1]], 1, -1}],  
    points[[b]] = Table[Point[coordinates[[position[[a, 1, 1]]]], {a, 1, Dimensions[position][[1]]},  
    radii[[b]] = Table[  
      Sqrt[coordinates[[position[[a, 1, 1]], 1]]^2 + coordinates[[position[[a, 1, 1]], 2]]^2,  
      {a, 1, Dimensions[position][[1]]}],  
    {b, 1, Dimensions[stages][[1]]}]  
Dimensions[points[[1]][[1]]  
Dimensions[points[[2]][[1]]  
Dimensions[points[[3]][[1]]  
Dimensions[points[[4]][[1]]  
Dimensions[points[[5]][[1]]
```

```
112
```

```
296
```

```
70
```

```
121
```

```
192
```

```
radii = Sort[Flatten[radii], OrderedQ[{{#1}, {#2}}]&];  
N[Round[radii[[22]] * 100] / 100]  
N[Round[radii[[23]] * 100] / 100]
```

```
0.49
```

```
0.5
```

```
(* 791 cell cycle genes, 112 in M/G1, 296 in G1, 70 in S, 121 in S/G2, 192 in G2/M. *)
```

```
(* 769 with more than 25% of normalized expression in the cell cycle subspace. *)
```

```

clb2 = coordinates[Position[genenames, "YPR119W"][[1, 1]]];
cln3 = coordinates[Position[genenames, "YAL040C"][[1, 1]]];
p = Show[{
  Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], points[[5]]}],
  Graphics[{RGBColor[1, 1, 0], PointSize[0.02], points[[1]]}],
  Graphics[{RGBColor[1, 0, 0], PointSize[0.02], points[[4]]}],
  Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], points[[2]]}],
  Graphics[{RGBColor[0, 0, 1], PointSize[0.02], points[[3]]}],
  Graphics[{RGBColor[1, 0.5, 0], Text["G2/M", {-0.6, -0.95}]}],
  Graphics[{RGBColor[0, 0, 0], Text["M/G1", {0.875, -0.775}]}],
  Graphics[{RGBColor[1, 0, 0], Text["S/G2", {-0.875, -0.75}]}],
  Graphics[{RGBColor[0, 0, 1], Text["S", {-0.8, 0.8}]}],
  Graphics[{RGBColor[0, 0.5, 0], Text["G1", {0.55, 0.95}]}],
  Graphics[{RGBColor[0, 0, 0], Text["(b)", {-0.9, 0.95}]}],
  Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], Point[clb2]}],
  Graphics[{RGBColor[0, 0, 0], Arrow[{0.55, -0.95}, clb2,
    HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75}]}],
  Graphics[{RGBColor[0, 0, 0], Text["CLB2", {0.75, -0.95}]}],
  Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], Point[cln3]}],
  Graphics[{RGBColor[0, 0, 0], Arrow[{0.8, 0.7}, cln3,
    HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75}]}],
  Graphics[{RGBColor[0, 0, 0], Text["CLN3", {0.85, 0.8}]}],
  Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
  Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}]},
  AspectRatio -> 1,
  PlotRange -> {{-1.05, 1.05}, {-1.05, 1.05}},
  Frame -> True,
  FrameTicks -> False,
  FrameLabel -> {labelx, labely, None, None},
  GridLines -> {{0, RGBColor[0, 0, 0]}}, {{0, RGBColor[0, 0, 0]}},
  DisplayFunction -> Identity];
p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
p2 = Show[p,
  AspectRatio -> 1.,
  PlotRange -> All,
  DisplayFunction -> Identity];

```

(\* Create Parameter Graphs of 104 Cell Cycle Genes According to Projections on Eigengenes \*)

```

stream = StringJoin[name, ":Desktop Folder:SPIE Data:Traditional_Classify_Cycle.txt"];
list = ReadList[stream, Word, RecordLists -> True, NullWords -> True];
list = Drop[list, 2];
stages = {"M/G1", "G1", "S", "S/G2", "G2/M"};
points = {points1, points2, points3, points4, points5};
radii = {radii1, radii2, radii3, radii4, radii5};
Do[{
  position = Position[list, stages[[b]]],
  table = Table[list[[position[[a, 1]], 1]], {a, 1, Dimensions[position][[1]]},
  position = Table[Position[genenames, table[[a]], {a, 1, Dimensions[table][[1]]},
  table = Flatten[Position[position, {}]],
  Do[
  position = Drop[position, {table[[a]], table[[a]]}, {a, Dimensions[table][[1]], 1, -1}],
  points[[b]] = Table[Point[coordinates[[position[[a, 1, 1]]]], {a, 1, Dimensions[position][[1]]},
  radii[[b]] = Table[
  Sqrt[coordinates[[position[[a, 1, 1]], 1]]^2 + coordinates[[position[[a, 1, 1]], 2]]^2,
  {a, 1, Dimensions[position][[1]]},
  {b, 1, Dimensions[stages][[1]]}

```

```
Dimensions[points[[1]]][[1]]
Dimensions[points[[2]]][[1]]
Dimensions[points[[3]]][[1]]
Dimensions[points[[4]]][[1]]
Dimensions[points[[5]]][[1]]
```

18

52

8

9

15

```
radii = Sort[Flatten[radii], OrderedQ[{{#1}, {#2}}]&];
N[Round[radii[[4]] * 100] / 100]
N[Round[radii[[5]] * 100] / 100]
```

0.49

0.53

(\* 102 cell cycle genes, 18 in M/G1, 52 in G1, 8 in S, 9 in S/G2, 15 in G2/M. \*)

(\* 98 with more than 25% of normalized expression in the cell cycle subspace. \*)

```
cdc8 = coordinates[[Position[genenames, "YJR057W"]][[1, 1]]];
clb2 = coordinates[[Position[genenames, "YPR119W"]][[1, 1]]];
cln3 = coordinates[[Position[genenames, "YAL040C"]][[1, 1]]];
p = Show[{
  Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], points[[5]]}],
  Graphics[{RGBColor[1, 1, 0], PointSize[0.02], points[[1]]}],
  Graphics[{RGBColor[1, 0, 0], PointSize[0.02], points[[4]]}],
  Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], points[[2]]}],
  Graphics[{RGBColor[0, 0, 1], PointSize[0.02], points[[3]]}],
  Graphics[{RGBColor[1, 0.5, 0], Text["G2/M", {-0.6, -0.95}]}],
  Graphics[{RGBColor[0, 0, 0], Text["M/G1", {0.875, -0.775}]}],
  Graphics[{RGBColor[1, 0, 0], Text["S/G2", {-0.875, -0.75}]}],
  Graphics[{RGBColor[0, 0, 1], Text["S", {-0.8, 0.8}]}],
  Graphics[{RGBColor[0, 0.5, 0], Text["G1", {0.55, 0.95}]}],
  Graphics[{RGBColor[0, 0, 0], Text["(c)", {-0.9, 0.95}]}],
  Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], Point[cdc8]}],
  Graphics[{RGBColor[0, 0, 0], Arrow[{0.675, 0.9}, cdc8,
    HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75}]}],
  Graphics[{RGBColor[0, 0, 0], Text["CDC8", {0.85, 0.95}]}],
  Graphics[{RGBColor[1, 0.5, 0], PointSize[0.02], Point[clb2]}],
  Graphics[{RGBColor[0, 0, 0], Arrow[{0.55, -0.95}, clb2,
    HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75}]}],
  Graphics[{RGBColor[0, 0, 0], Text["CLB2", {0.75, -0.95}]}],
  Graphics[{RGBColor[0, 0.5, 0], PointSize[0.02], Point[cln3]}],
  Graphics[{RGBColor[0, 0, 0], Arrow[{0.8, 0.7}, cln3,
    HeadCenter -> 0.5, HeadLength -> 0.035, HeadWidth -> 0.75}]}],
  Graphics[{RGBColor[0, 0, 0], Text["CLN3", {0.85, 0.8}]}],
  Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 0.5]}],
  Graphics[{RGBColor[0, 0, 0], Dashing[{0.03, 0.02}], Circle[{0, 0}, 1]}]},
  AspectRatio -> 1,
  PlotRange -> {{-1.05, 1.05}, {-1.05, 1.05}},
  Frame -> True,
  FrameTicks -> False,
  FrameLabel -> {labelx, labely, None, None},
  GridLines -> {{0, RGBColor[0, 0, 0]}}, {{0, RGBColor[0, 0, 0]}},
  DisplayFunction -> Identity];
```

```

p = FullGraphics[p];
p[[1, 2]] = p[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {-1.18, 0}, {0, 0}, {0, 1}];
p3 = Show[p,
  AspectRatio -> 1.,
  PlotRange -> All,
  DisplayFunction -> Identity];

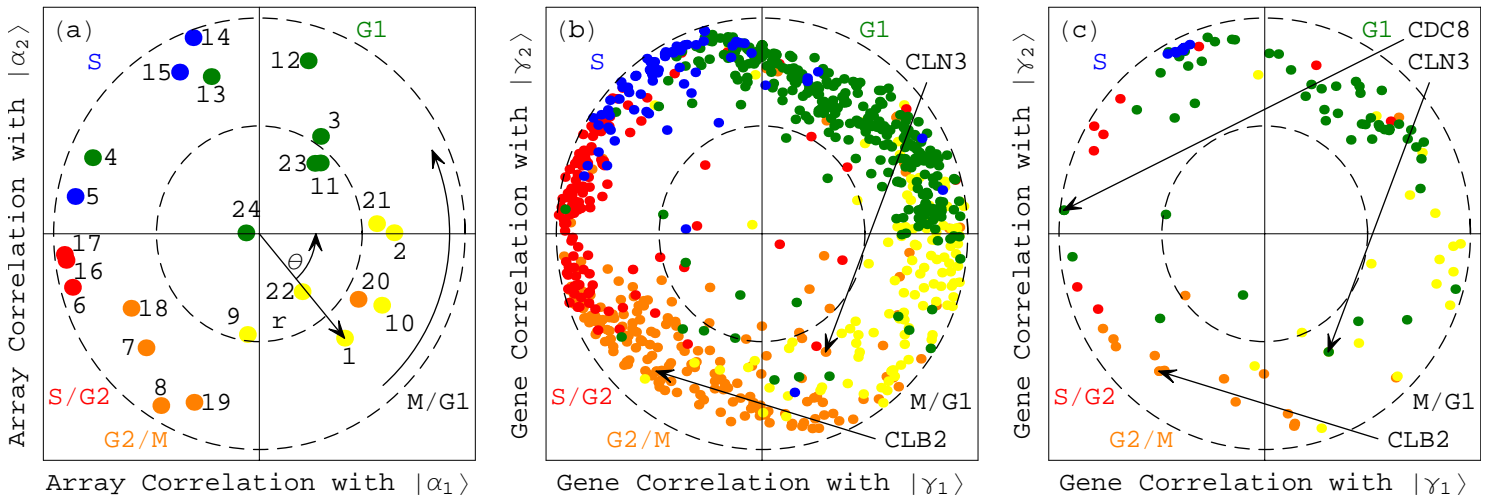
(* Display Both Arrays & Genes Parameter Graphs *)

```

```

Show[GraphicsArray[{p1, p2, p3}],
  GraphicsSpacing -> 0];

```



```

(* Sort Normalized Data *)

```

```

(* Define the Initial Phase According to the Initial Array *)

```

```

zerophase = N[ArcTan[arraycorrelations[[2, 1]] / (arraycorrelations[[1, 1]])] / Pi]
-0.274633

```

```

(* Sort Data by Phase *)

```

```

radii = Table[Sqrt[coordinates[[a, 1]]^2 + coordinates[[a, 2]]^2], {a, 1, genes}];
coordinates = Table[
  {-genecorrelations[[1, a]] / Sqrt[genecorrelations[[1, a]]^2 + genecorrelations[[2, a]]^2],
  -genecorrelations[[2, a]] / Sqrt[genecorrelations[[1, a]]^2 + genecorrelations[[2, a]]^2],
  N[ArcTan[genecorrelations[[2, a]] / (genecorrelations[[1, a]])] / Pi],
  radii[[a]]},
  {a, 1, genes}];
sortmatrix = AppendRows[coordinates, genenames, matrix];
sortmatrix = Sort[sortmatrix, OrderedQ[{{#1}, {#2}}]&];
negative1 = 2881;
positive1 = 2882;
sortmatrix[[negative1, 1]]
sortmatrix[[positive1, 1]]

-0.00165731
0.000254183

```

```

sortmatrix = Transpose[Drop[Transpose[sortmatrix], {1}]];
sortmatrix = AppendColumns[
  Sort[
    TakeRows[sortmatrix, {1, negative1}],
    OrderedQ[{{#2}, {#1}}]&],
  Sort[
    TakeRows[sortmatrix, {positive1, genes}],
    OrderedQ[{{#1}, {#2}}]&
  ]
];
sortmatrix = Transpose[Drop[Transpose[sortmatrix], {1}]];

(* Correct for the Phase & Calibrate According to the Initial Phase *)

Do[sortmatrix[[a, 1]] = sortmatrix[[a, 1]] - zerophase,
  {a, 1, negative1}];
Do[sortmatrix[[a, 1]] = sortmatrix[[a, 1]] + 1 - zerophase,
  {a, positive1, genes}];
negative2 = 634;
positive2 = 635;
sortmatrix[[negative2, 1]]
sortmatrix[[positive2, 1]]

-0.000741706

0.0000344019

sortmatrix = AppendColumns[
  TakeRows[sortmatrix, {positive2, genes}],
  TakeRows[sortmatrix, {1, negative2}]
];
positive3 = 5392;
negative3 = 5393;
sortmatrix[[positive3, 1]]
sortmatrix[[negative3, 1]]

1.7745

-0.224746

Do[sortmatrix[[a, 1]] = sortmatrix[[a, 1]] + 2,
  {a, negative3, genes}];

(* Reconstruct Data With Sorted Genes *)

matrix = TakeColumns[sortmatrix, {4, arrays + 3}];
eigenarrays = Dot[eigengenes, Transpose[matrix]];
Do[
  eigenarrays[[a]] = eigenarrays[[a]] / eigenexpressions[[a]],
  {a, 1, arrays}];
eigenarrays = Transpose[eigenarrays];
arraycorrelations = Dot[DiagonalMatrix[eigenexpressions], eigengenes];
genecorrelations = Dot[eigenarrays, DiagonalMatrix[eigenexpressions]];
genecorrelations = Transpose[genecorrelations];

```

(\* Classify Gene Phases into Cell Cycle Phases \*)

```
phases = TakeColumns[sortmatrix, {1, 1}];  
ph1 = -zerophase;  
ph2 = 0.5 - zerophase;  
ph3 = 1 - zerophase;  
ph4 = 1.25 - zerophase;  
ph5 = 1.5 - zerophase;
```

```
endph5 = 672;  
beginph1 = 673;  
phases[[endph5]] - ph1  
phases[[beginph1]] - ph1
```

```
{-0.000260875}
```

```
{0.0000955269}
```

```
endph1 = 2247;  
beginph2 = 2248;  
phases[[endph1]] - ph2  
phases[[beginph2]] - ph2
```

```
{-0.00052754}
```

```
{0.000080909}
```

```
endph2 = 3584;  
beginph3 = 3585;  
phases[[endph2]] - ph3  
phases[[beginph3]] - ph3
```

```
{-0.000120919}
```

```
{0.000382587}
```

```
endph3 = 4692;  
beginph4 = 4693;  
phases[[endph3]] - ph4  
phases[[beginph4]] - ph4
```

```
{-0.0000868128}
```

```
{0.0000193326}
```

```
endph4 = 5392;  
beginph5 = 5393;  
phases[[endph4]] - ph5  
phases[[beginph5]] - ph5
```

```
{-0.000136885}
```

```
{0.000620424}
```

(\* 6026 yeast genes, 1306 in M/G1, 1575 in G1, 1337 in S, 1108 in S/G2, 700 in G2/M. \*)



```
(* Create Classified Sorted Data 2D Red & Green Raster Display *)
```

```
contrast = 2;
displaying = Table[
  If[contrast*matrix[[i, j]] > 0,
    If[contrast*matrix[[i, j]] < 1, {contrast*matrix[[i, j]], 0}, {1, 0}],
    If[contrast*matrix[[i, j]] > -1, {0, -contrast*matrix[[i, j]]}, {0, 1}]],
  {i, 1, genes}, {j, 1, arrays}];
framex = Table[{a - 0.5, arraynames[[2, a]]}, {a, 1, arrays}];
framey = {
  {genes - endph5 / 2, "M/G1"},
  {genes - (endph5 + endph1) / 2, "G1"},
  {genes - (endph1 + endph2) / 2, "S"},
  {genes - (endph2 + endph3) / 2, "S/G2"},
  {genes - (endph3 + endph4) / 2, "G2/M"},
  {(genes - endph4) / 2, "M/G1"}];
gridy = {
  {genes - endph1 + 0.5, {RGBColor[0, 0, 0]}},
  {genes - endph2 + 0.5, {RGBColor[0, 0, 0]}},
  {genes - endph3 + 0.5, {RGBColor[0, 0, 0]}},
  {genes - endph4 + 0.5, {RGBColor[0, 0, 0]}},
  {genes - endph5 + 0.5, {RGBColor[0, 0, 0]}}];
labelx = "(a) Arrays";
labely = ColumnForm[{" ", "Genes", " ", " ", " ", " ", " ", " ", " "}, Center];
g = Show[
  Graphics[
    RasterArray[
      Table[
        RGBColor[
          displaying[[i, j, 1]], displaying[[i, j, 2]], 0
        ],
        {i, genes, 1, -1}, {j, 1, arrays}
      ]],
    AspectRatio -> 1,
    Frame -> True,
    FrameTicks -> {None, framey, framex, None},
    FrameLabel -> {None, labely, labelx, None},
    GridLines -> {None, gridy},
    DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {1., 0.}] ->
  Text[a, {b - 1.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 1100}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 450}, {0, 0}, {0, 1}];
g1 = Show[g,
  AspectRatio -> GoldenRatio * 1.15,
  PlotRange -> All,
  DisplayFunction -> Identity];
```

```
(* Create Classified Sorted Eigenarrays 2D Red & Green Raster Display *)
```

```
contrast = 50;
displaying = Table[
  If[contrast * eigenarrays[[i, j]] > 0,
    If[contrast * eigenarrays[[i, j]] < 1, {contrast * eigenarrays[[i, j]], 0}, {1, 0}],
    If[contrast * eigenarrays[[i, j]] > -1, {0, -contrast * eigenarrays[[i, j]]}, {0, 1}]],
  {i, 1, genes}, {j, 1, arrays}];
labelx = "(b) Eigenarrays";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = Table[{a - 0.5, ToString[a]}, {a, 1, arrays}];
sizes = Flatten[
  Table[
    Dimensions[
      Characters[
        framex[[a, 2]]
      ]
    ], {a, 1, arrays}]];
Do[
  framex[[a, 2]] = StringJoin[framex[[a, 2]], " "],
  {b, 1, size - sizes[[a]]},
  {a, 1, arrays}];
framey = {
  {genes - endph5 / 2, " ", 0},
  {genes - (endph5 + endph1) / 2, " ", 0},
  {genes - (endph1 + endph2) / 2, " ", 0},
  {genes - (endph2 + endph3) / 2, " ", 0},
  {genes - (endph3 + endph4) / 2, " ", 0},
  {(genes - endph4) / 2, " ", 0}};
gridy = {
  {genes - endph1 + 0.5, {RGBColor[0, 0, 0]}},
  {genes - endph2 + 0.5, {RGBColor[0, 0, 0]}},
  {genes - endph3 + 0.5, {RGBColor[0, 0, 0]}},
  {genes - endph4 + 0.5, {RGBColor[0, 0, 0]}},
  {genes - endph5 + 0.5, {RGBColor[0, 0, 0]}}};
```

```

g = Show[
Graphics[
RasterArray[
Table[
RGBColor[
displaying[[i, j, 1]], displaying[[i, j, 2]], 0
],
{i, genes, 1, -1}, {j, 1, arrays}
]],
AspectRatio -> 1,
Frame -> True,
FrameTicks -> {None, framey, framex, None},
FrameLabel -> {None, labely, labelx, None},
GridLines -> {None, gridy},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
Text[labely, {b_, c_}, {1., 0.}] ->
Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
Text[a_, {b_, c_}, {1., 0.}] ->
Text[a, {b-1.5, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
Text[labelx, {b_, c_}, {0., -1.}] ->
Text[labelx, {b, c + 1100}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
Text[a_, {b_, c_}, {0., -1.}] ->
Text[a, {b, c + 450}, {0, 0}, {0, 1}];
g2 = Show[g,
AspectRatio -> GoldenRatio * 1.15,
PlotRange -> All,
DisplayFunction -> Identity];

```

(\* Create Classified Selected Eigenarrays Graph Display \*)

```
eigenarrays = Transpose[eigenarrays];
```

```
eigenarrays1 = Chop[TrigFit[eigenarrays[[1]], 1, {x, genes - 1}], 0.0025]
```

```
eigenarrays2 = Chop[TrigFit[eigenarrays[[2]], 1, {x, genes - 1}], 0.0025]
```

$$0.012377 \cos\left[\frac{2\pi x}{6025}\right] + 0.0124056 \sin\left[\frac{2\pi x}{6025}\right]$$

$$-0.0122078 \cos\left[\frac{2\pi x}{6025}\right] + 0.0123446 \sin\left[\frac{2\pi x}{6025}\right]$$

```
zerophase = N[ArcTan[arraycorrelations[[2, 1]] / arraycorrelations[[1, 1]]] / Pi];
```

```
eigenarrays1 = -0.018 * Cos[2 * Pi * x / 6025 + (0.5 - zerophase) * Pi];
```

```
eigenarrays2 = -0.018 * Sin[2 * Pi * x / 6025 + (0.5 - zerophase) * Pi];
```

```

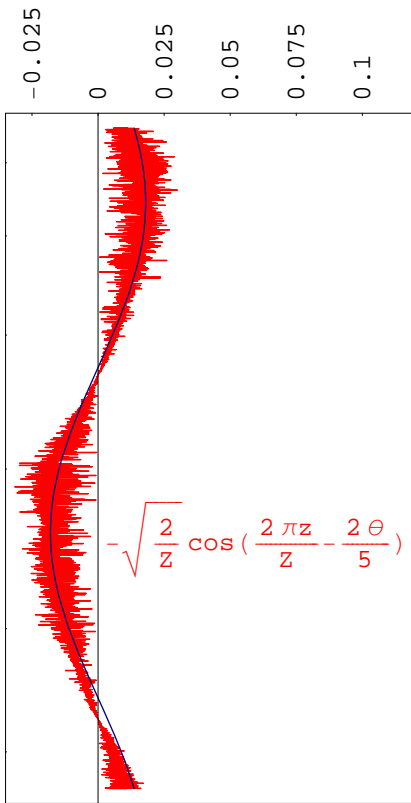
graph = ParametricPlot[{eigenarrays1, -x},
  {x, genes - 1, 0},
  PlotStyle -> {RGBColor[0, 0, 0.5]},
  DisplayFunction -> Identity];
labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " ", " ", " ", " ", " "}, Center];
framex = {
  {-0.025, "-0.025"}, {0, "0"}, {0.025, "0.025"},
  {0.05, "0.05"}, {0.075, "0.075"}, {0.1, "0.1"};
framey = {
  {-genes + endph5 / 2, " ", 0},
  {-genes + (endph5 + endph1) / 2, " ", 0},
  {-genes + (endph1 + endph2) / 2, " ", 0},
  {-genes + (endph2 + endph3) / 2, " ", 0},
  {-genes + (endph3 + endph4) / 2, " ", 0},
  {-(genes - endph4) / 2, " ", 0}};
coordinates = Table[{eigenarrays[[1, a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[1, 0, 0], line}],
  graph,

  Graphics[{RGBColor[1, 0, 0], Text[" $-\sqrt{\frac{2}{z}} \cos(\frac{2\pi z}{z} - \frac{2\theta}{5})$ ", {0.06, -3750}]}]},

Frame -> True,
FrameLabel -> {None, labely, labelx, None},
FrameTicks -> {None, framey, framex, None},
GridLines -> {{0, RGBColor[0, 0, 0]}, None},
AspectRatio -> GoldenRatio * 1.15,
PlotRange -> {{-0.035, 0.12}, {135, -genes + 1 - 135}},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {1., 0.}] ->
  Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 500}, {0, 0}, {0, 1}];
p1 = Show[g,
  AspectRatio -> GoldenRatio * 1.15,
  PlotRange -> All];

```

(c) Expression Level



```

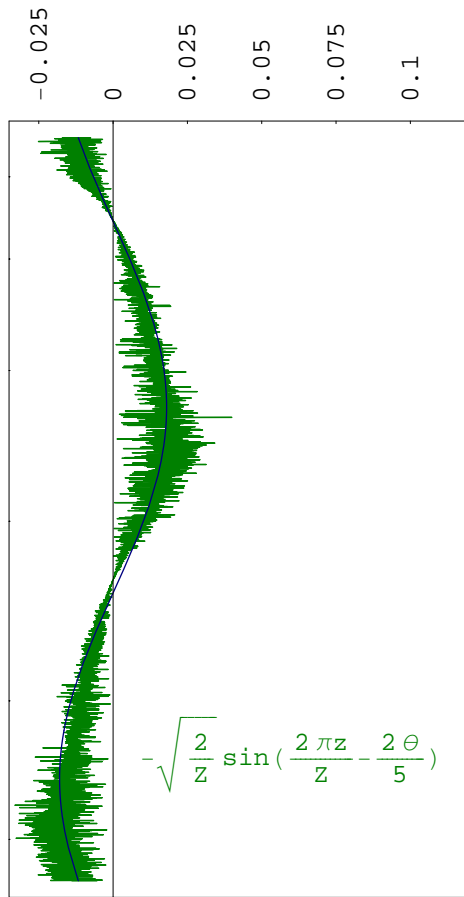
graph = ParametricPlot[{eigenarrays2, -x},
  {x, 0, genes - 1},
  PlotStyle -> {RGBColor[0, 0, 0.5]},
  DisplayFunction -> Identity];
labelx = "(c) Expression Level";
labely = ColumnForm[{" ", " ", " ", " ", " ", " "}, Center];
framex = {
  {-0.025, "-0.025"}, {0, "0"}, {0.025, "0.025"},
  {0.05, "0.05"}, {0.075, "0.075"}, {0.1, "0.1"};
framey = {
  {-genes + endph5 / 2, " ", 0},
  {-genes + (endph5 + endph1) / 2, " ", 0},
  {-genes + (endph1 + endph2) / 2, " ", 0},
  {-genes + (endph2 + endph3) / 2, " ", 0},
  {-genes + (endph3 + endph4) / 2, " ", 0},
  {-(genes - endph4) / 2, " ", 0};
coordinates = Table[{eigenarrays[[2, a]], -a + 1}, {a, 1, genes}];
line = Line[coordinates];
g = Show[
  {Graphics[{RGBColor[0, 0.5, 0], line}],
  graph,

  Graphics[{RGBColor[0, 0.5, 0], Text[" $-\sqrt{\frac{2}{z}} \sin(\frac{2\pi z}{z} - \frac{2\theta}{5})$ ", {0.06, -5000}]}]},

Frame -> True,
FrameLabel -> {None, labely, labelx, None},
FrameTicks -> {None, framey, framex, None},
GridLines -> {{0, RGBColor[0, 0, 0]}, None},
AspectRatio -> GoldenRatio * 1.15,
PlotRange -> {{-0.035, 0.12}, {135, -genes + 1 - 135}},
DisplayFunction -> Identity];
g = FullGraphics[g];
g[[1, 2]] = g[[1, 2]] /.
  Text[labely, {b_, c_}, {1., 0.}] ->
  Text[labely, {b, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {1., 0.}] ->
  Text[a, {b - 0.01, c}, {0, 0}, {0, 1}];
g[[1, 2]] = g[[1, 2]] /.
  Text[labelx, {b_, c_}, {0., -1.}] ->
  Text[labelx, {b, c + 1150}, {0, -1}, {1, 0}];
g[[1, 2]] = g[[1, 2]] /.
  Text[a_, {b_, c_}, {0., -1.}] ->
  Text[a, {b, c + 500}, {0, 0}, {0, 1}];
p2 = Show[g,
  AspectRatio -> GoldenRatio * 1.15,
  PlotRange -> All];

```

(c) Expression Level

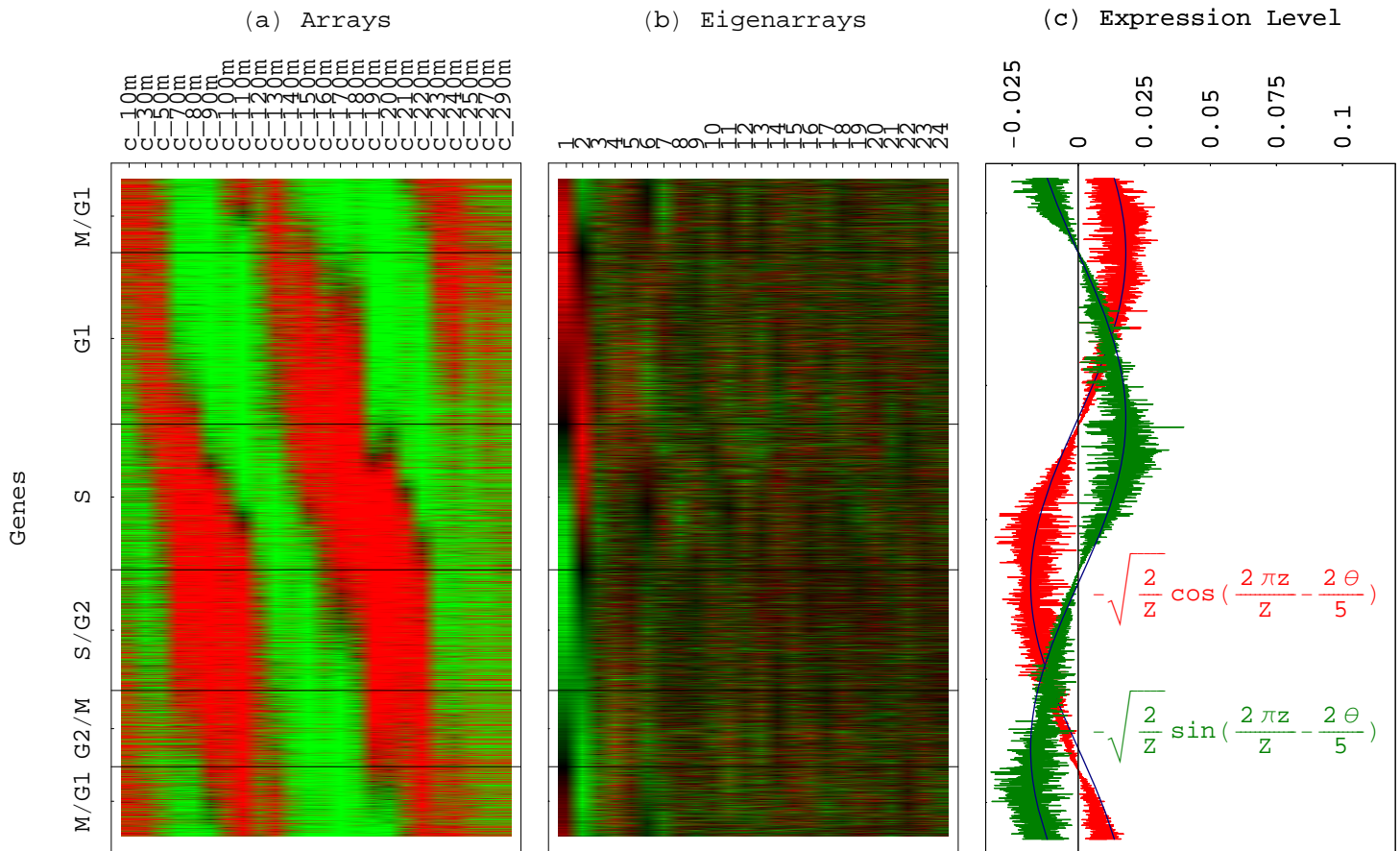


(\* Display Classified Selected Sorted Eigenarrays \*)

```
g3 = Show[{p1, p2},  
  DisplayFunction -> Identity];
```

(\* Display Classified Sorted Data, Eigenarrays and Selected Eigenarrays \*)

```
Show[GraphicsArray[{g1, g2, g3}],
GraphicsSpacing -> -0.225];
```



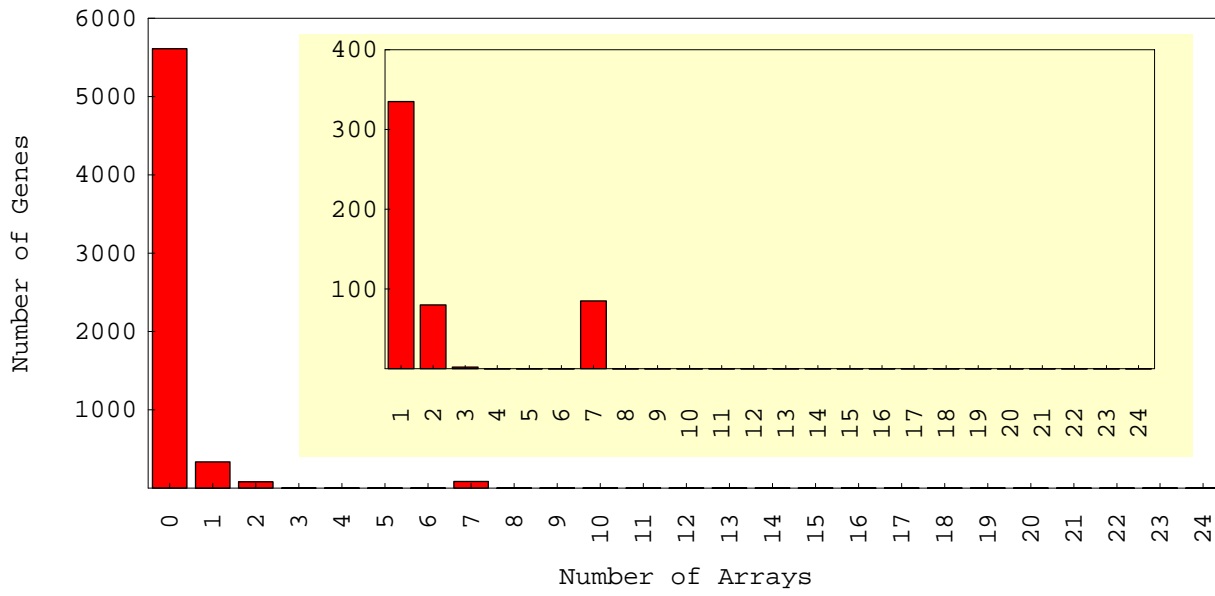
(\* Save Sorted Normalized Data in Sort\_Data.txt \*)

```
sortmatrix = AppendRows[
  Table[{a}, {a, 1, genes}],
  N[Round[TakeColumns[sortmatrix, {1, 2}] * 1000] / 1000],
  TakeColumns[sortmatrix, {3, 3}],
  N[Round[TakeColumns[sortmatrix, {4, arrays + 3}] * 100000] / 100000]];
sortmatrix = AppendColumns[
  AppendRows[{{" ", " ", " ", " "}, {" ", "Phase", "Radius", "UID"}], arraynames],
  sortmatrix];
stream = OpenWrite[
  StringJoin[name, ":Desktop Folder:SPIE Data:Sort_Cdc15.txt"],
  PageWidth -> Infinity];
Write[
  stream,
  OutputForm[
  TableForm[sortmatrix, TableSpacing -> {0, 1}]
  ]];
Close[stream];
Clear[sortmatrix];
```



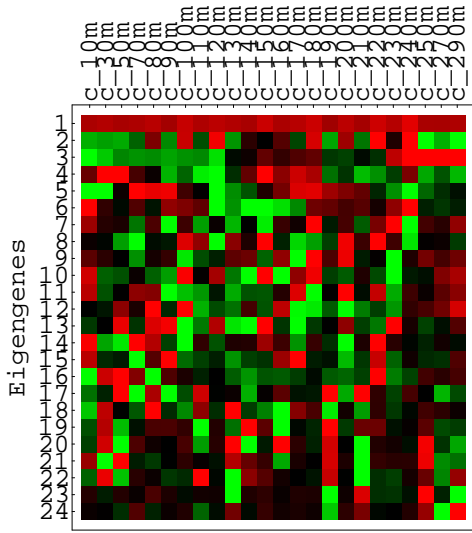
(\* Summarize Cdc15 Analysis \*)

(\* Locating Gene Position of Null Data \*)



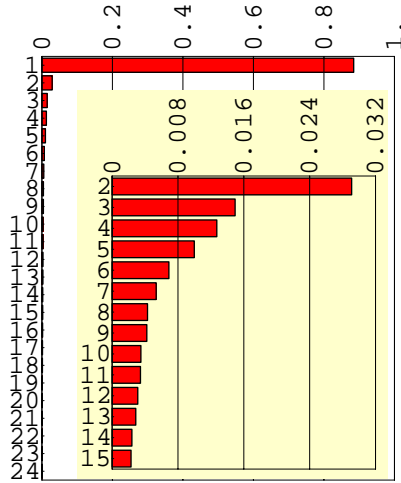
(\* Choosing Subset of Eigengenes for Estimation \*)

(a) Arrays

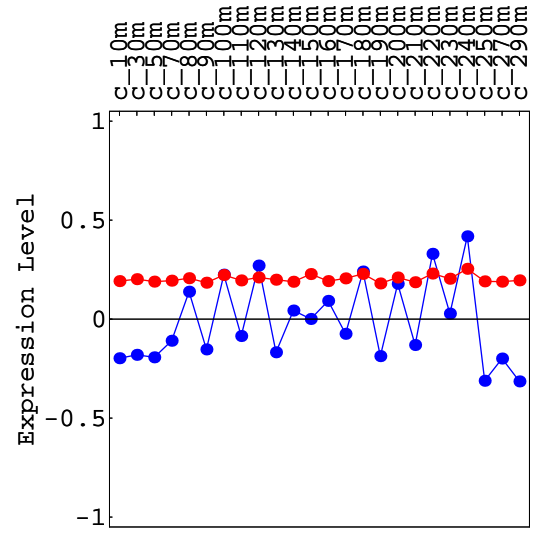


(b) Eigenexpression Probability

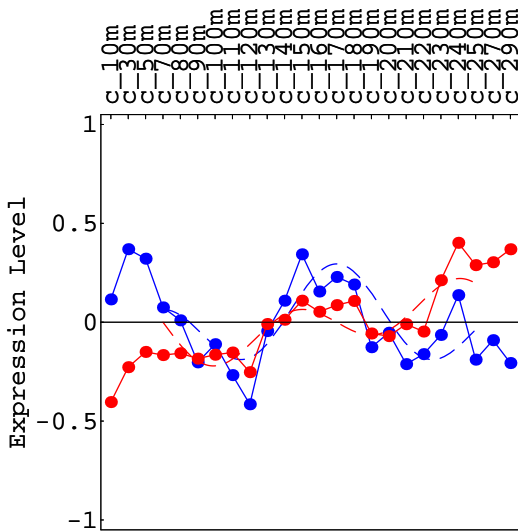
$d = 0.21$



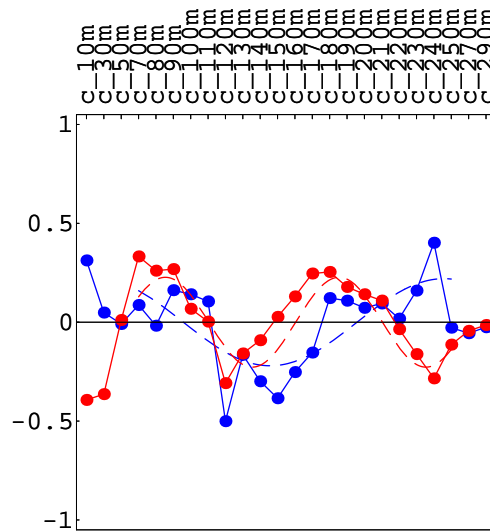
(c) Arrays



(d) Arrays

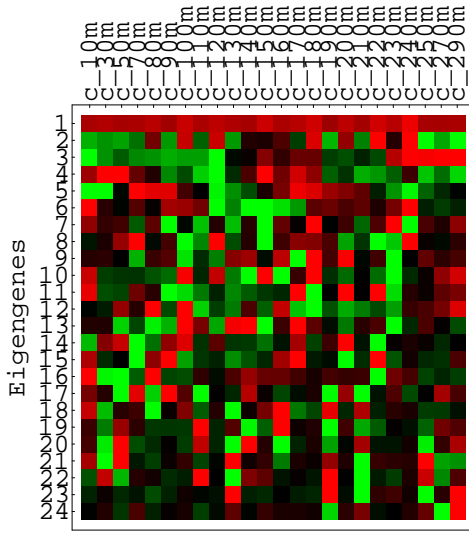


(e) Arrays



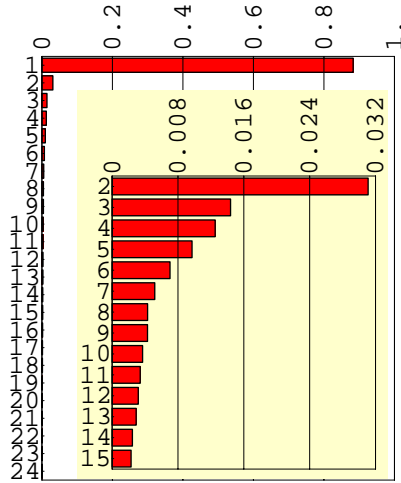
(\* Centering by Removing the Additive Constant, i.e., the Steady State \*)

(a) Arrays

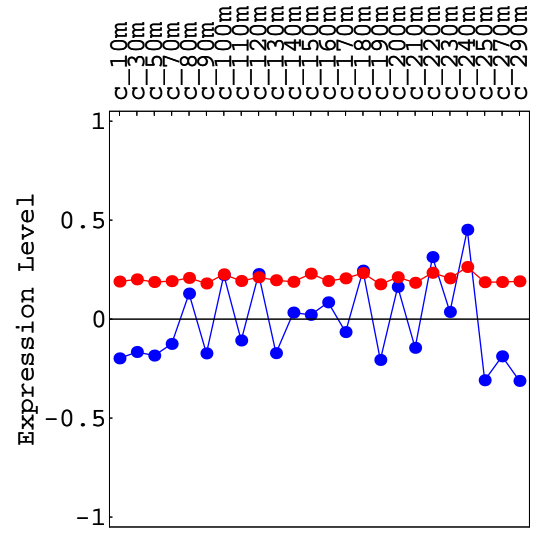


(b) Eigenexpression Probability

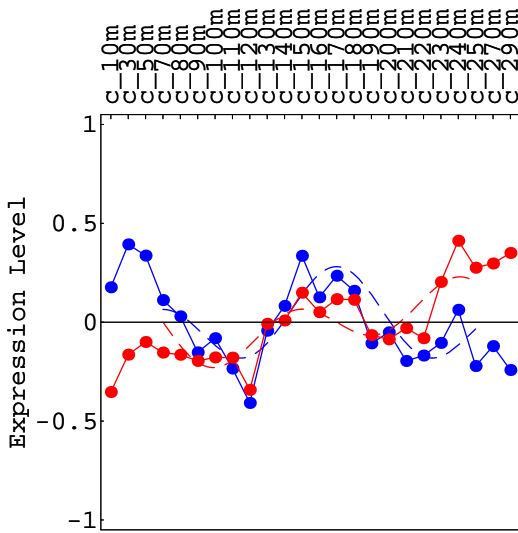
$d = 0.21$



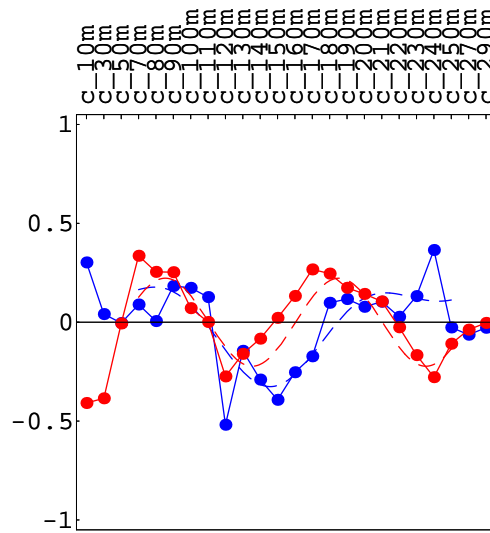
(c) Arrays



(d) Arrays

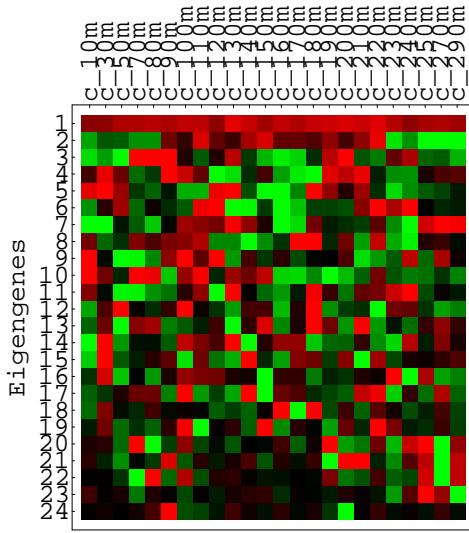


(e) Arrays



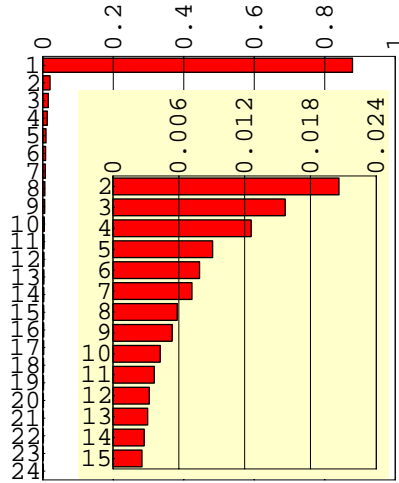
(\* Normalizing the Variances by Removing the Multiplicative Constant \*)

(a) Arrays

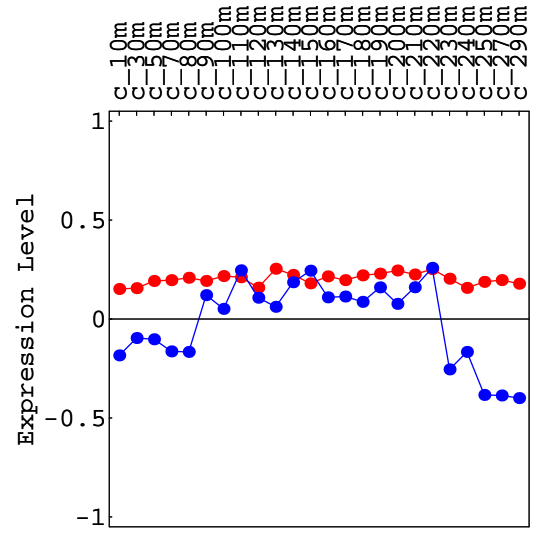


(b) Eigenexpression Probability

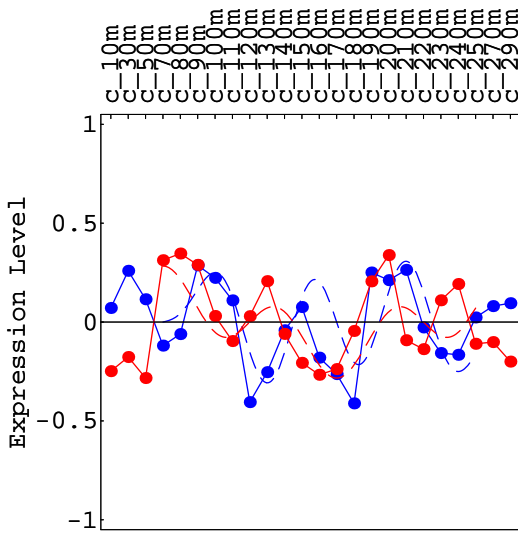
$d = 0.22$



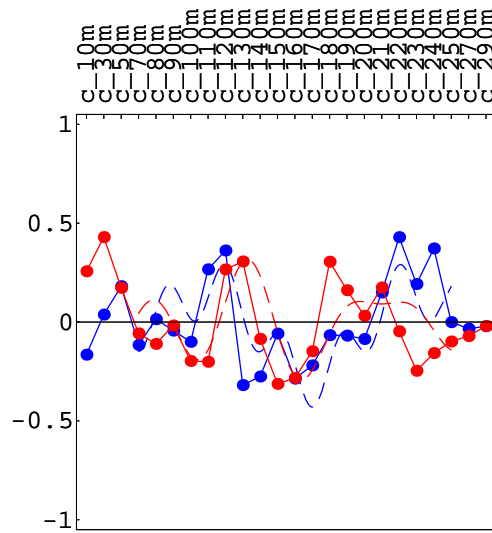
(c) Arrays



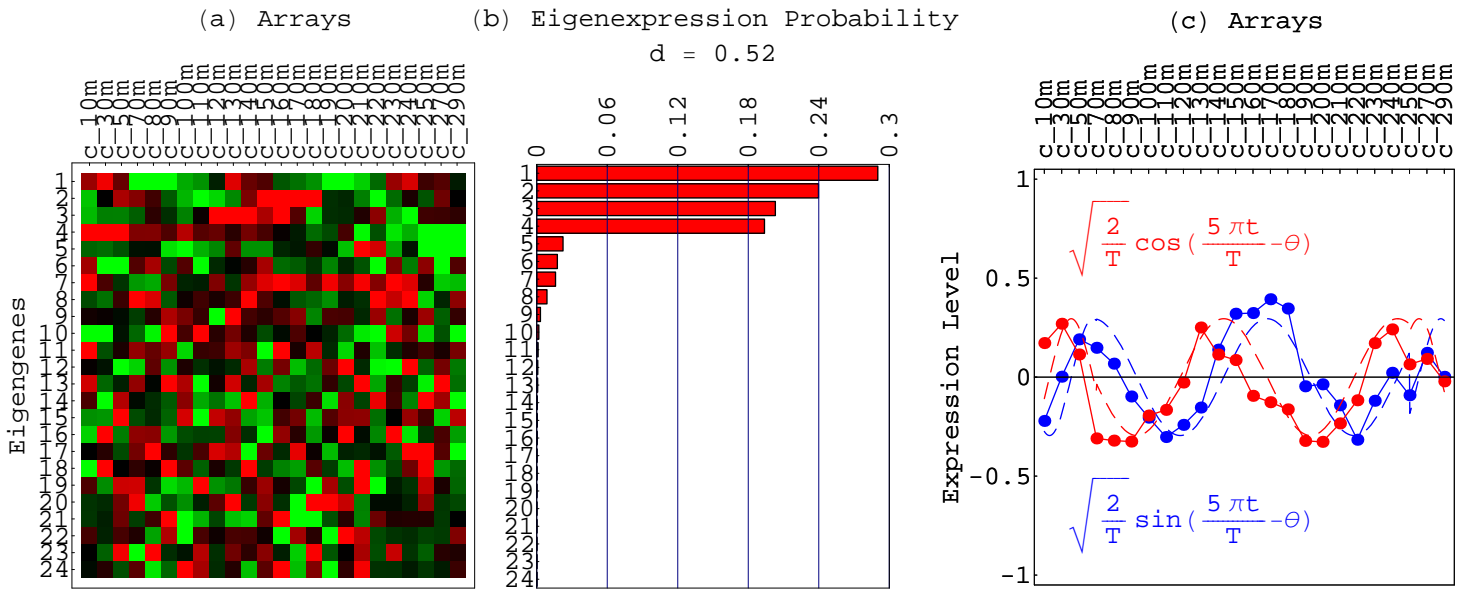
(d) Arrays



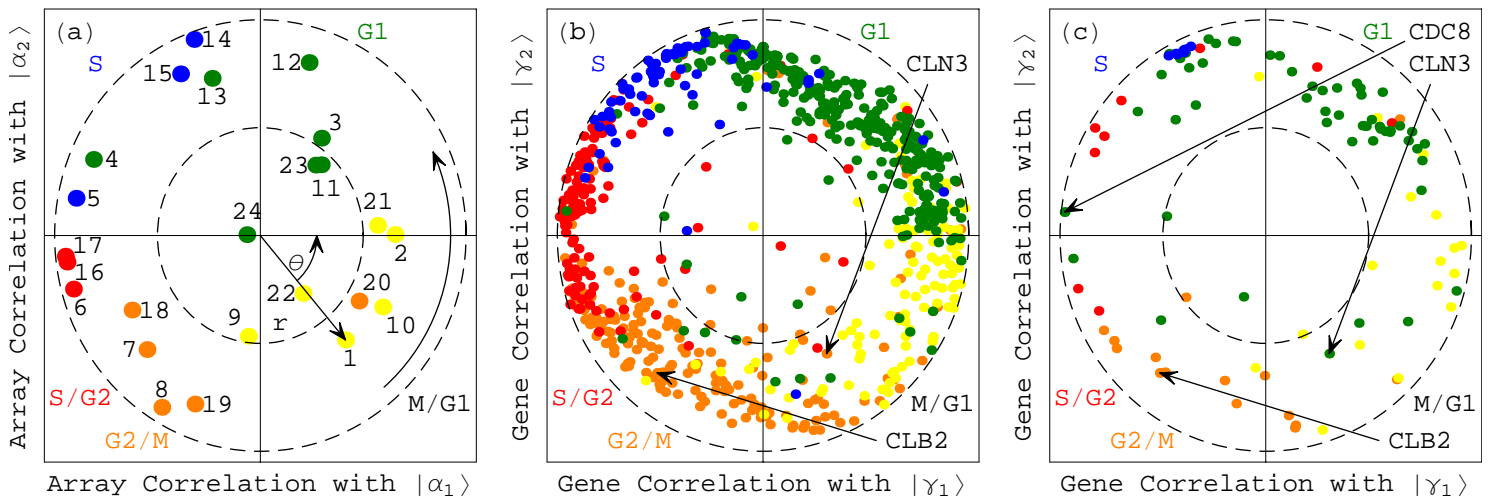
(e) Arrays



(\* Normalized Data \*)



(\* Sorting the Normalized Data \*)



(\* Classified Sorted Normalized Data \*)

