

Pensieve header: Plotting the eigenvalues of the Temperley-Lieb inner product.

```

SetAttributes[p, Orderless];
CLP[{}] = {1};
CLP[l_List] := CLP[l] = Flatten[Table[
  Flatten[Outer[Times, CLP[l[[2 ;; k-1]]], CLP[l[[k+1 ;; Length[l]]]]] *
    p[l[[1]], l[[k]],
    {k, 2, Length[l], 2}
  ]];
DrawPairing[P_] := Graphics[{
  Line[{{0, 0}, {1+Max[Flatten[List@@P /. p->List]], 0}}],
  List@@P /. p[i_, j_] => BezierCurve[{{i, 0}, {(i+j)/2, (j-i)/2}, {j, 0}}]
}]

```

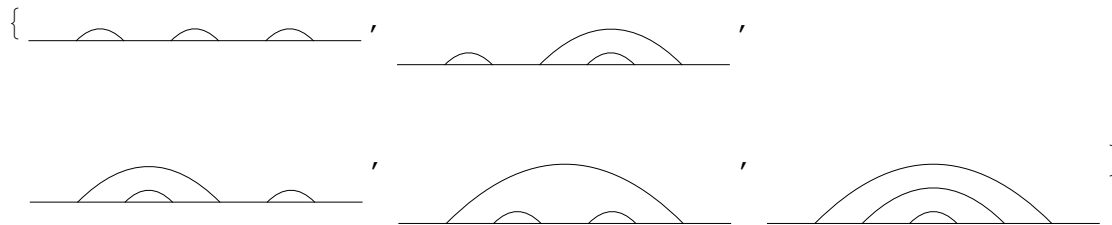
CLP[Range[8]]

```

{p[1, 2] p[3, 4] p[5, 6] p[7, 8], p[1, 2] p[3, 4] p[5, 8] p[6, 7],
 p[1, 2] p[3, 6] p[4, 5] p[7, 8], p[1, 2] p[3, 8] p[4, 5] p[6, 7],
 p[1, 2] p[3, 8] p[4, 7] p[5, 6], p[1, 4] p[2, 3] p[5, 6] p[7, 8],
 p[1, 4] p[2, 3] p[5, 8] p[6, 7], p[1, 6] p[2, 3] p[4, 5] p[7, 8],
 p[1, 6] p[2, 5] p[3, 4] p[7, 8], p[1, 8] p[2, 3] p[4, 5] p[6, 7],
 p[1, 8] p[2, 3] p[4, 7] p[5, 6], p[1, 8] p[2, 5] p[3, 4] p[6, 7],
 p[1, 8] p[2, 7] p[3, 4] p[5, 6], p[1, 8] p[2, 7] p[3, 6] p[4, 5]}

```

DrawPairing /@ CLP[Range[6]]



CLP[Range[8]] // Length

14

Hom[n\_, m\_] := CLP[Join[-Range[n], Range[m]]]

Hom[3, 5]

```

{p[-3, 1] p[-2, -1] p[2, 3] p[4, 5], p[-3, 1] p[-2, -1] p[2, 5] p[3, 4],
 p[-3, 3] p[-2, -1] p[1, 2] p[4, 5], p[-3, 5] p[-2, -1] p[1, 2] p[3, 4],
 p[-3, 5] p[-2, -1] p[1, 4] p[2, 3], p[-3, -2] p[-1, 1] p[2, 3] p[4, 5],
 p[-3, -2] p[-1, 1] p[2, 5] p[3, 4], p[-3, -2] p[-1, 3] p[1, 2] p[4, 5],
 p[-3, 1] p[-2, 2] p[-1, 3] p[4, 5], p[-3, -2] p[-1, 5] p[1, 2] p[3, 4],
 p[-3, -2] p[-1, 5] p[1, 4] p[2, 3], p[-3, 1] p[-2, 2] p[-1, 5] p[3, 4],
 p[-3, 1] p[-2, 4] p[-1, 5] p[2, 3], p[-3, 3] p[-2, 4] p[-1, 5] p[1, 2]}

```

**Hom[5, 3]**

```
{p[-5, 1] p[-4, -3] p[-2, -1] p[2, 3], p[-5, 3] p[-4, -3] p[-2, -1] p[1, 2],
 p[-5, -4] p[-3, 1] p[-2, -1] p[2, 3], p[-5, -4] p[-3, 3] p[-2, -1] p[1, 2],
 p[-5, 1] p[-4, 2] p[-3, 3] p[-2, -1], p[-5, 1] p[-4, -1] p[-3, -2] p[2, 3],
 p[-5, 3] p[-4, -1] p[-3, -2] p[1, 2], p[-5, -4] p[-3, -2] p[-1, 1] p[2, 3],
 p[-5, -2] p[-4, -3] p[-1, 1] p[2, 3], p[-5, -4] p[-3, -2] p[-1, 3] p[1, 2],
 p[-5, 1] p[-4, 2] p[-3, -2] p[-1, 3], p[-5, -2] p[-4, -3] p[-1, 3] p[1, 2],
 p[-5, 1] p[-4, -3] p[-2, 2] p[-1, 3], p[-5, -4] p[-3, 1] p[-2, 2] p[-1, 3]}
```

```
Comp[p1_, p2_] := Module[
  {t1, t2, t3},
  t1 = p1 * (p2 /. p[a_, b_] => p[If[a < 0, -a, 100 + a], If[b < 0, -b, 100 + b]]);
  t2 = t1 /. p[a_, b_] p[b_, c_] => p[a, c];
  t3 = t2 /. {p[a_, a_] -> δ, p[a_, b_] ^ 2 -> δ};
  t3 /. p[a_, b_] => p[If[a > 100, a - 100, a], If[b > 100, b - 100, b]]
]
```

```
Comp[p[-3, 3] p[-1, -2] p[1, 2] p[4, 5], p[-5, -4] p[-3, -2] p[-1, 1] p[2, 3]]
δ p[-3, 1] p[-2, -1] p[2, 3]
```

```
IP[p1_, p2_] := Module[
  {t1, t2},
  t2 = (p1 p2) /. p[a_, b_] p[b_, c_] => p[a, c];
  t2 /. {p[a_, a_] -> δ, p[a_, b_] ^ 2 -> δ}
]
```

```
IP[p[-3, 3] p[-1, -2] p[1, 2] p[4, 5], p[-5, -4] p[-3, -2] p[-1, 1] p[2, 3]]
δ p[-5, -4] p[4, 5]
```

```
M[n_] := Outer[IP, Hom[n, n], Hom[n, n]]
```

```
M[2] // MatrixForm
```

$$\begin{pmatrix} \delta^2 & \delta \\ \delta & \delta^2 \end{pmatrix}$$

```
M[3] // MatrixForm
```

$$\begin{pmatrix} \delta^3 & \delta^2 & \delta^2 & \delta & \delta^2 \\ \delta^2 & \delta^3 & \delta & \delta^2 & \delta \\ \delta^2 & \delta & \delta^3 & \delta^2 & \delta \\ \delta & \delta^2 & \delta^2 & \delta^3 & \delta^2 \\ \delta^2 & \delta & \delta & \delta^2 & \delta^3 \end{pmatrix}$$

**M[4] // MatrixForm**

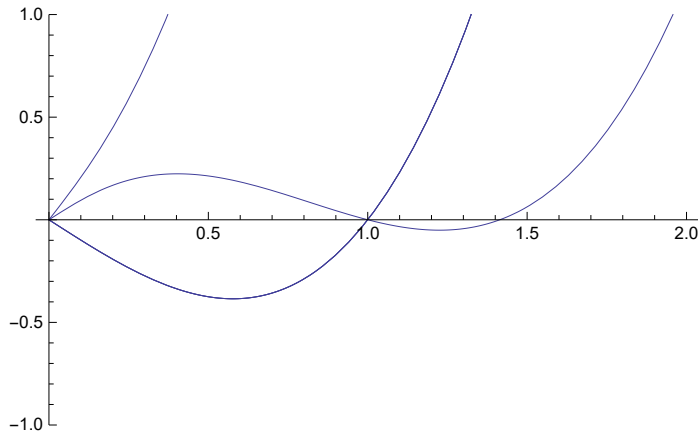
$$\begin{pmatrix} \delta^4 & \delta^3 & \delta^3 & \delta^2 & \delta^3 & \delta^3 & \delta^2 & \delta^2 & \delta^3 & \delta & \delta^2 & \delta^2 & \delta^3 & \delta^2 \\ \delta^3 & \delta^4 & \delta^2 & \delta^3 & \delta^2 & \delta^2 & \delta^3 & \delta & \delta^2 & \delta^2 & \delta & \delta^3 & \delta^2 & \delta \\ \delta^3 & \delta^2 & \delta^4 & \delta^3 & \delta^2 & \delta^2 & \delta & \delta^3 & \delta^2 & \delta^2 & \delta & \delta & \delta^2 & \delta^3 \\ \delta^2 & \delta^3 & \delta^3 & \delta^4 & \delta^3 & \delta & \delta^2 & \delta^2 & \delta & \delta^3 & \delta^2 & \delta^2 & \delta & \delta^2 \\ \delta^3 & \delta^2 & \delta^2 & \delta^3 & \delta^4 & \delta^2 & \delta & \delta & \delta^2 & \delta^2 & \delta^3 & \delta & \delta^2 & \delta \\ \delta^3 & \delta^2 & \delta^2 & \delta & \delta^2 & \delta^4 & \delta^3 & \delta^3 & \delta^2 & \delta^2 & \delta^3 & \delta & \delta^2 & \delta \\ \delta^2 & \delta^3 & \delta & \delta^2 & \delta & \delta^3 & \delta^4 & \delta^2 & \delta & \delta^3 & \delta^2 & \delta^2 & \delta & \delta^2 \\ \delta^2 & \delta & \delta^3 & \delta^2 & \delta & \delta^3 & \delta^2 & \delta^4 & \delta^3 & \delta^3 & \delta^2 & \delta^2 & \delta & \delta^2 \\ \delta^3 & \delta^2 & \delta^2 & \delta & \delta^2 & \delta^2 & \delta & \delta^3 & \delta^4 & \delta^2 & \delta & \delta^3 & \delta^2 & \delta \\ \delta & \delta^2 & \delta^2 & \delta^3 & \delta^2 & \delta^2 & \delta^3 & \delta^3 & \delta^2 & \delta^4 & \delta^3 & \delta^3 & \delta^2 & \delta^3 \\ \delta^2 & \delta & \delta & \delta^2 & \delta^3 & \delta^3 & \delta^2 & \delta^2 & \delta & \delta^3 & \delta^4 & \delta^2 & \delta^3 & \delta^2 \\ \delta^2 & \delta^3 & \delta & \delta^2 & \delta & \delta & \delta^2 & \delta^2 & \delta^3 & \delta^3 & \delta^2 & \delta^4 & \delta^3 & \delta^2 \\ \delta^3 & \delta^2 & \delta^2 & \delta & \delta^2 & \delta^2 & \delta & \delta & \delta^2 & \delta^2 & \delta^3 & \delta^3 & \delta^4 & \delta^3 \\ \delta^2 & \delta & \delta^3 & \delta^2 & \delta & \delta & \delta^2 & \delta^2 & \delta & \delta^3 & \delta^2 & \delta^2 & \delta^3 & \delta^4 \end{pmatrix}$$



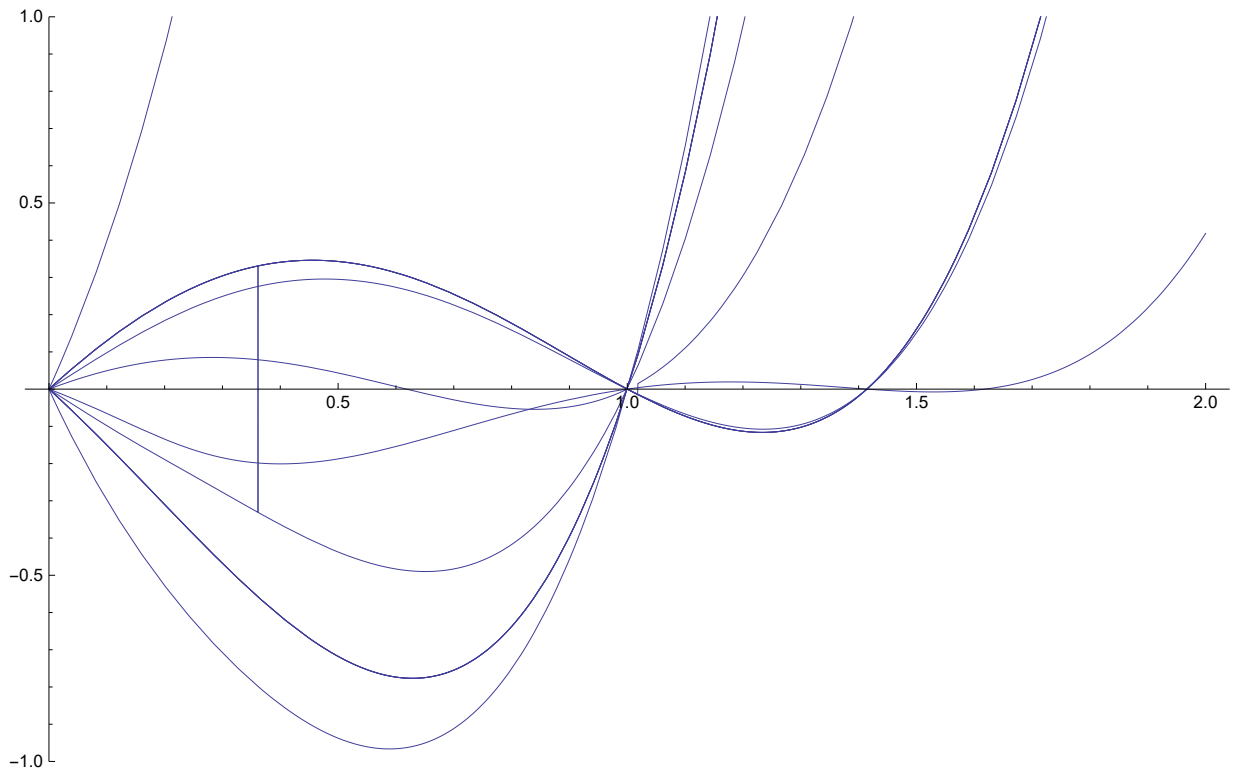
```
ColumnForm[StringJoin /@ (M[5] /.  $\delta^k$  -> ToString[k] <> " ")]
```

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3 2 2 1 2 2 1 3 4 2 1 3 2 1 2 3 1 2 1 1 2 2 3 2 3 1 2 3 2 2 1 2 4 3 3 2 3 3 2 4 3 4 5 4

```
Plot[Eigenvalues[M[3]], { $\delta$ , 0, 2}, PlotRange -> {-1, 1}]
```



`Plot[Eigenvalues[M[4]], { $\delta$ , 0, 2}, PlotRange  $\rightarrow$  {-1, 1}]`



`Plot[Eigenvalues[M[5]], { $\delta$ , 0, 2}, PlotRange  $\rightarrow$  {-1, 1}/10]`

