Banana Seifert

In[•]:=
```
SetDirectory["C:\\drorbn\\AcademicPensieve\\People\\VanDerVeen"]
Once[<< KnotTheory`]
```

Out[•]=
```
C:\drorbn\AcademicPensieve\People\VanDerVeen

Loading KnotTheory` version of October 29, 2024, 10:29:52.1301.
Read more at http://katlas.org/wiki/KnotTheory.
```

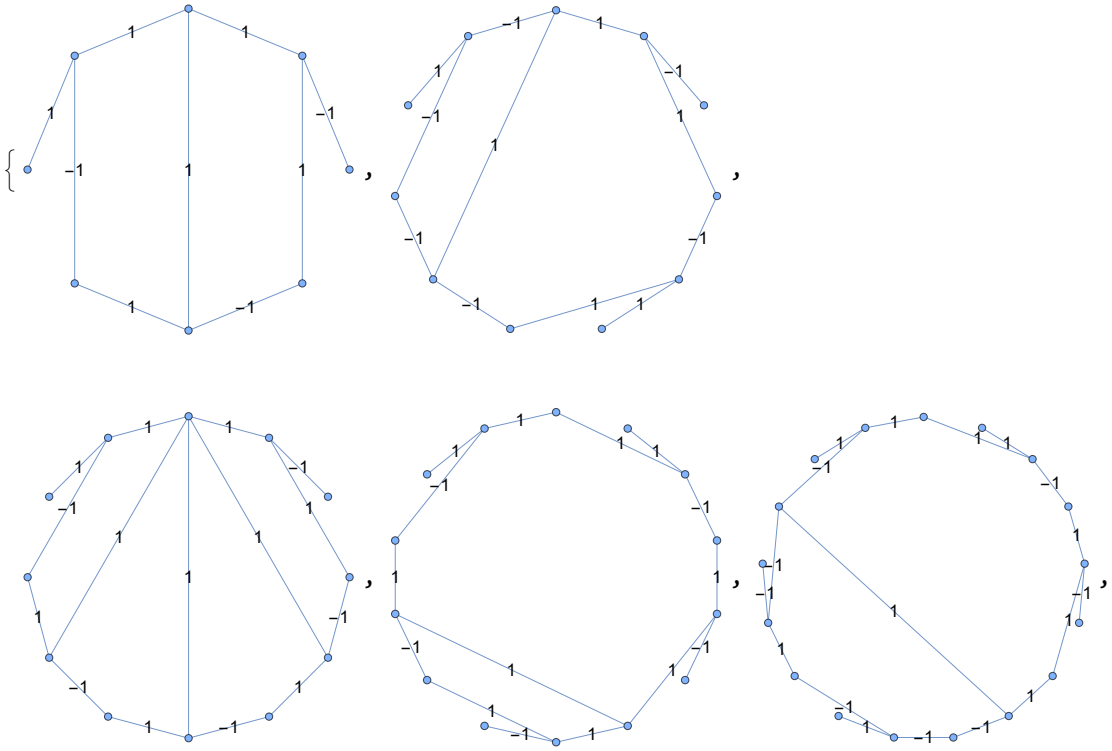
In[•]:=
```
SetAttributes[P, Orderless]
ProcessSigns[pd_] :=
 pd /. X[a_, b_, c_, d_] :> If[PositiveQ[X[a, b, c, d]], Xp[a, b, c, d], Xm[a, b, c, d]]
SeifertCycles[pd_] := (Times @@ pd) /.
   {Xp[a_, b_, c_, d_] :> P[a, b] P[c, d], Xm[a_, b_, c_, d_] :> P[a, d] P[c, b]} //.
  {P[a___, b_] P[b_, c___] :> P[a, b, c], x_^2 -> x}
SeifertBycles[pd_] := (Times @@ pd) /.
   {Xp[a_, b_, c_, d_] :> Q[a] Q[b] Q[d, c], Xm[a_, b_, c_, d_] :> Q[a, d] Q[c] Q[b]} //.
  {Q[a___, b_] Q[b_, c___] :> Q[a, b, c]}
CutList[pd_] := First /@ List @@ (SeifertCycles[pd])
IsIncoming_z_[XX_] :=
 If[(z == 1) || (Head[XX] === Xp && (z == 4)) || (Head[XX] === Xm && (z == 2)), True, False]
CutPD[pd_] := Module[{pd2 = pd, pos},
  Do[
   pos = Position[pd, c];
   If[IsIncoming_pos[[1,2]][pd[[pos[[1, 1]]]]],
    Part[pd2, Sequence @@ pos[[1]]] = $[c];
    Part[pd2, Sequence @@ pos[[2]]] = $$[c],
    Part[pd2, Sequence @@ pos[[2]]] = $[c];
    Part[pd2, Sequence @@ pos[[1]]] = $$[c]];

   , {c, CutList[pd]}];
  pd2]
SeifertBGraph[K_] :=
 Module[{pd2 = CutPD[ProcessSigns@PD[K]], Edges, Signs = <||>, XV, OV, V},
  XV =
   (List @@ pd2) /. {Xp[a_, b_, c_, d_] :> {-a, b, -d}, Xm[a_, b_, c_, d_] :> {-a, -b, c}};
  Edges = XV // Flatten;
  (List @@ pd2) /. {Xp[a_, b_, c_, d_] :> (Signs = Append[Signs, {-a -> -1, b -> 1, -d -> -1}]),
    Xm[a_, b_, c_, d_] :> (Signs = Append[Signs, {-a -> 1, c -> 1, -b -> -1}])};
  OV = If[Length[#] == 1, Switch[Head[#[[1]]], Integer, {-#[[1]], #[[1]]}, $, -#, $$, #],
      Join[If[IntegerQ[#[[1]]], {#[[1]]}, {}],
       -Most[#],
       If[IntegerQ[#[[-1]]], {-#[[-1]]}, {}]
```

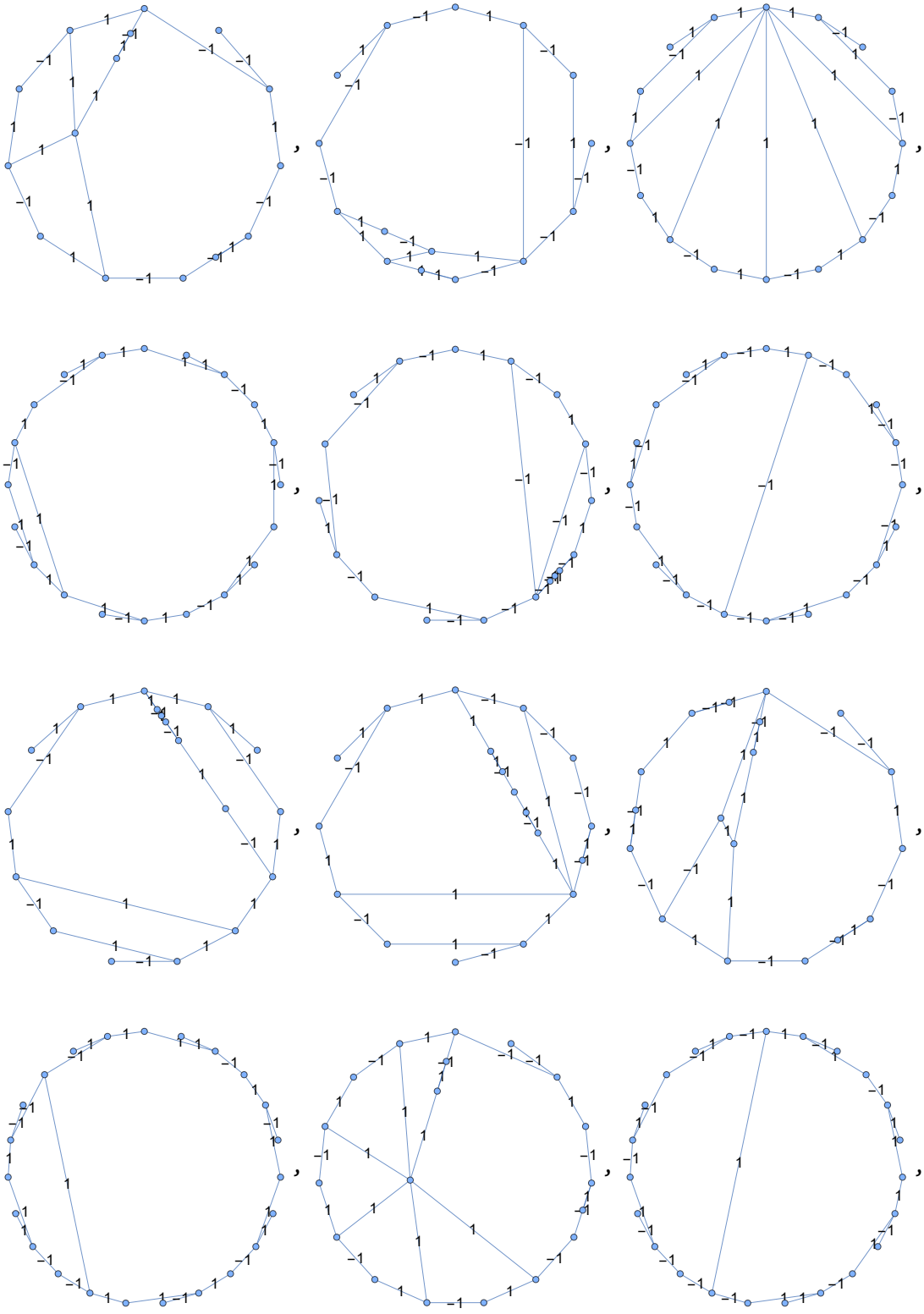
```
      ]

    ] & /@ (List @@ (SeifertCycles[pd2] /. x_^2 → x) /. Q → List);
  {V = Join[OV, XV], Signs}
 ]

(*Warning! misrepresents the labels of multi-edges*)
DrawGraph[sb_] :=
 PlanarGraph[Table[Labeled[
    UndirectedEdge @@ (First /@ Position[sb[[1]], e]), sb[[2]][e]], {e, sb[[2]] // Keys}]
 ]
```

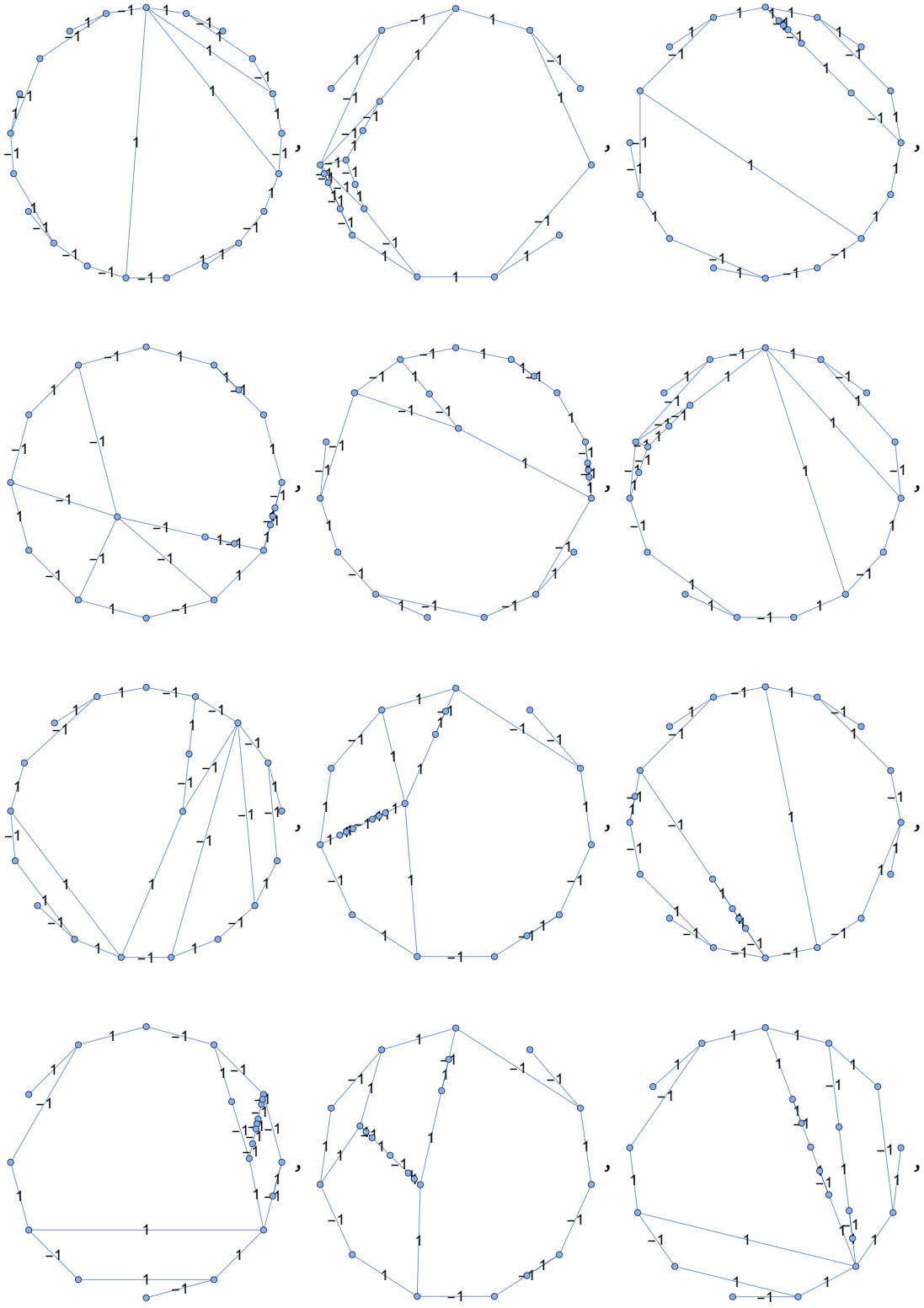
In[•]:= `DrawGraph[SeifertBGraph[#]] & /@ AllKnots[{3, 8}]`

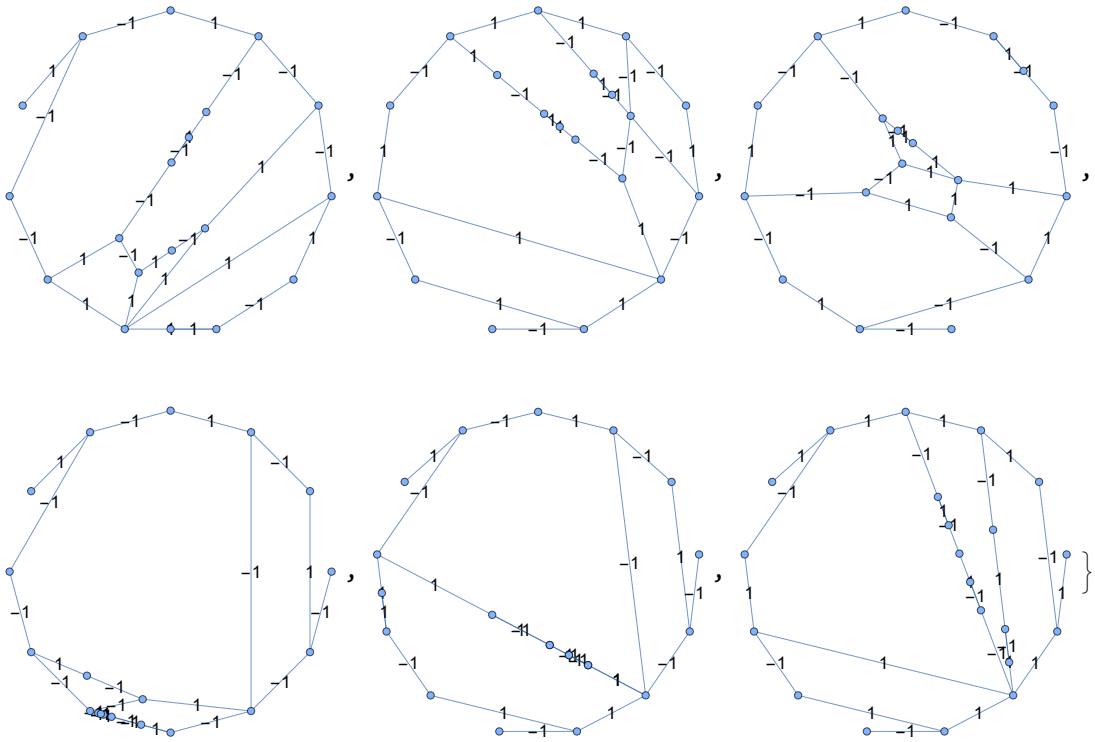
KnotTheory: Loading precomputed data in PD4Knots`.

Out[•]=



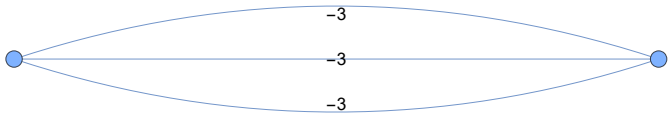






In[•]:=
```
(*Get rid of leaves and degree 2 vertices*)
Prune[sb_] := Module[{sbnew = sb, Leaves = Flatten@Select[sb[[1]], Length[#] == 1 &]},
  Do[
   sbnew[[1]] = DeleteCases[sbnew[[1]], lv, {2}];
   sbnew[[2]] = Delete[sbnew[[2]], Key[lv]]
   , {lv, Leaves}];
  sbnew /. {{} → Nothing}]
Contract[sb_] :=
 Module[{sbnew = sb, SmallV = First@Select[sb[[1]], Length[#] == 2 &], asso},
  asso = sbnew[[2]];
  asso [First@SmallV] = asso[First@SmallV] + asso[Last@SmallV];
  sbnew[[2]] = Delete[asso, Key[Last@SmallV]];

  sbnew[[1]] = DeleteCases[sbnew[[1]], SmallV];
  sbnew[[1]] = sbnew[[1]] /. {Last@SmallV → First@SmallV};
  sbnew]
```

```
In[•]:= (*Not correct!*)
        DrawGraph@{{{6, -$[2], -4}, {-$[2], 6, -4}}, ⟨|-4 → -3, 6 → 1, -$[2] → 1|⟩}
Out[•]=
```

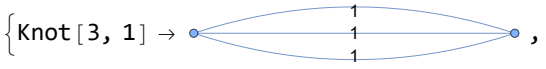


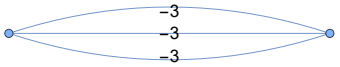

```
In[•]:= (# → (Quiet@FixedPoint[Contract, Prune[SeifertBGraph[#]]])) & /@ AllKnots[{3, 7}]
Out[•]=
```

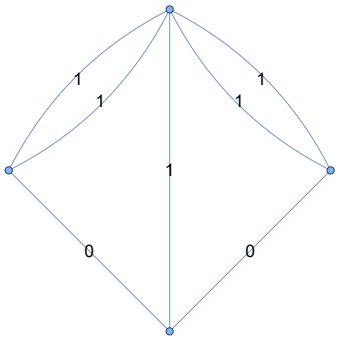
```
{Knot[3, 1] → {{{-$[1], -5, -3}, {-3, -5, -$[1]}}, ⟨|-$[1] → 1, -3 → 1, -5 → 1|⟩},
 Knot[4, 1] → {{{6, -$[2], -4}, {-$[2], 6, -4}}, ⟨|-4 → -3, 6 → 1, -$[2] → 1|⟩},
 Knot[5, 1] → {{{-$[1], -7, -3, -9, -5}, {-3, -7, -4}, {-5, -10, -$[1]}, {-9, -4, -10}},
   ⟨|-$[1] → 1, -3 → 1, -5 → 1, -10 → 0, -7 → 1, -9 → 1, -4 → 0|⟩},
 Knot[5, 2] → {{{-$[3], -9, -7}, {-$[3], -7, -9}}, ⟨|-$[3] → 1, -9 → 3, -7 → 1|⟩},
 Knot[6, 1] → {{{8, -9, -$[7]}, {-$[7], -9, 8}}, ⟨|-$[7] → 3, 8 → 1, -9 → -3|⟩}, Knot[6, 2] →
  {{{8, -9, -$[1]}, {-$[1], -5, -11, -7}, {-5, -9, -6}, {-7, -12, 8}, {-11, -6, -12}},
   ⟨|-$[1] → 0, -5 → 1, -9 → -3, -7 → 1, 8 → 1, -12 → 0, -11 → 1, -6 → 0|⟩}, Knot[6, 3] →
  {{{7, -8, -3, -12}, {-$[6], -12, -10}, {-8, -4, -3}, {-10, -4, -11}, {-$[6], -11, 7}},
   ⟨|-4 → -2, -8 → -1, -3 → -1, -12 → 0, -10 → 1, -$[6] → 1, 7 → 1, -11 → 0|⟩},
 Knot[7, 1] → {{{-$[1], -9, -3, -11, -5, -13, -7}, {-3, -9, -4}, {-5, -12, -6},
    {-7, -14, -$[1]}, {-11, -4, -12}, {-13, -6, -14}}, ⟨|-$[1] → 1, -3 → 1,
   -5 → 1, -12 → 0, -7 → 1, -14 → 0, -9 → 1, -11 → 1, -4 → 0, -13 → 1, -6 → 0|⟩},
 Knot[7, 2] → {{{-$[3], -11, -9}, {-$[3], -9, -11}}, ⟨|-$[3] → 1, -11 → 5, -9 → 1|⟩},
 Knot[7, 3] → {{{-$[3], -11, -5, -14, -10}, {-10, -4, -$[3]}, {-12, -14, -5},
    {-4, -12, -11}}, ⟨|-10 → -1, -$[3] → -1, -14 → -3, -12 → 0, -5 → -1, -4 → 0, -11 → -1|⟩},
 Knot[7, 4] → {{{-$[5], -14, -10}, {-10, -14, -$[5]}}, ⟨|-$[5] → -1, -14 → -3, -10 → -3|⟩},
 Knot[7, 5] → {{{-$[3], -11, -9}, {-$[1], -5, -13, -7}, {-$[3], -9, -$[1]}, {-7, -13, -8},
    {-11, -8, -5}}, ⟨|-$[1] → 1, -$[3] → 1, -5 → 1, -7 → 1, -13 → 1, -11 → 1, -8 → 0, -9 → 1|⟩},
 Knot[7, 6] → {{{-$[1], -11, -13}, {11, -11, -7, -3, -9}, {-3, -7, -$[1]}, {-13, 11, -9}},
   ⟨|-$[1] → 1, -3 → 1, -9 → -3, -13 → -1, 11 → 1, -11 → 2, -7 → 1|⟩}, Knot[7, 7] →
  {{{6, -13, -14}, {12, -13, -9, -$[1]}, {-$[1], -5, -11}, {-5, -9, 6}, {-11, -14, 12}},
   ⟨|-$[1] → 0, -5 → 1, 6 → 1, -9 → -3, -11 → 1, 12 → 1, -14 → -1, -13 → -2|⟩}}
```

Seifert surfaces for the Rolfsen table (warning twists on multi-edges are displayed incorrectly!)

```
In[•]:= (# → (DrawGraph@Quiet@FixedPoint[Contract, Prune[SeifertBGraph[#]]])) & /@
         AllKnots[{3, 10}]
Out[•]=
```



Knot[4, 1] → 

, Knot[5, 1] → 

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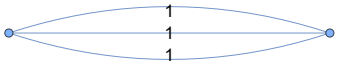
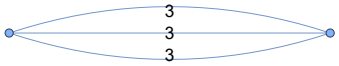
Knot[5, 2] → 

, Knot[6, 1] → 

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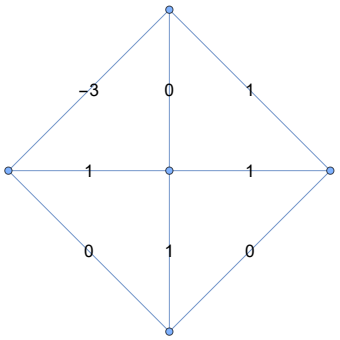
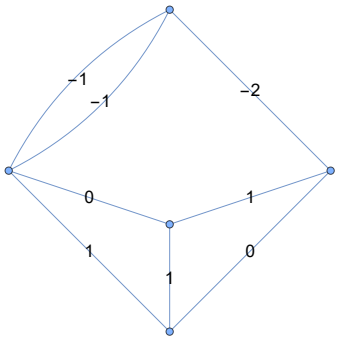
Knot[6, 2] → 

, Knot[6, 3] → 

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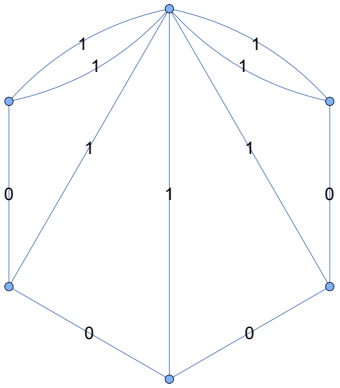
Knot[7, 1] → 

, Knot[7, 2] → 

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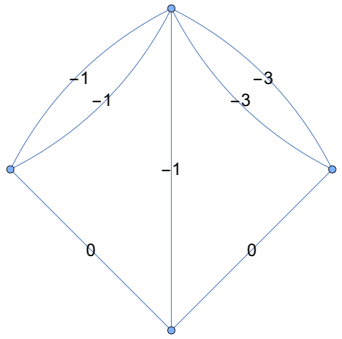
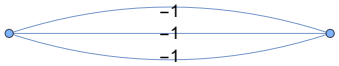
Knot[7, 3] → 

, Knot[7, 4] → 

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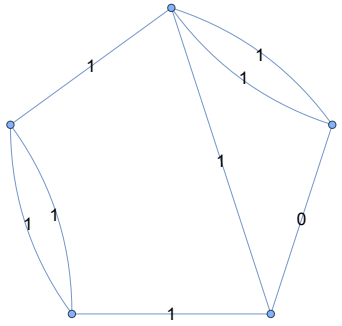
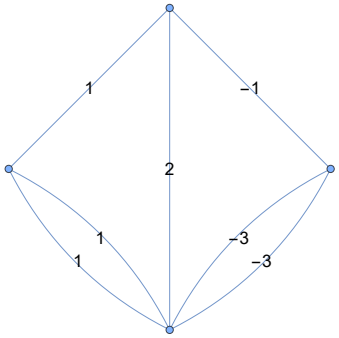
Knot[7, 5] → 

, Knot[7, 6] → 

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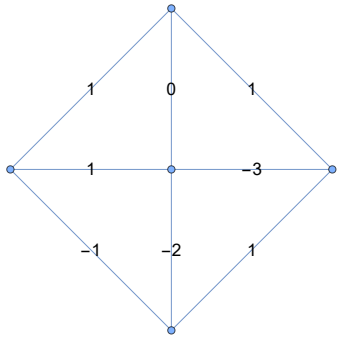
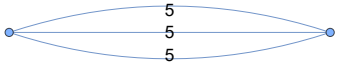
Knot[7, 7] → 

, Knot[8, 1] → 

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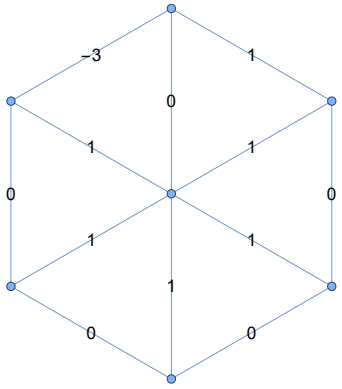
Knot[8, 2] → 

, Knot[8, 3] → 

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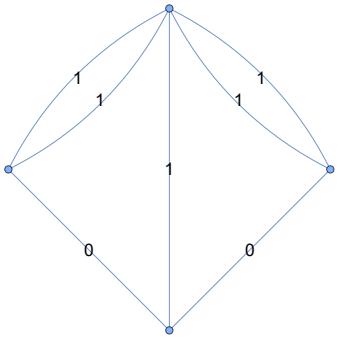
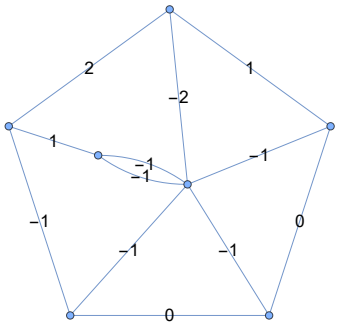
Knot[8, 4] → 

, Knot[8, 5] → 

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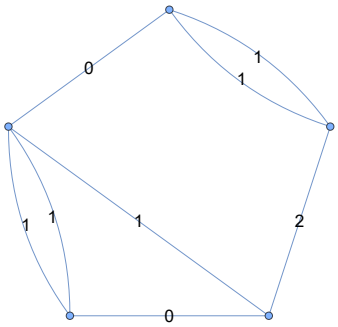
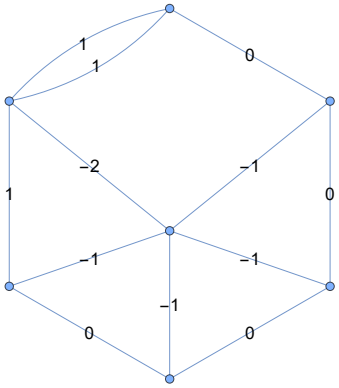
Knot[8, 6] → 

, Knot[8, 7] → 

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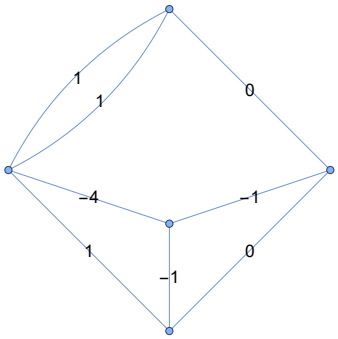
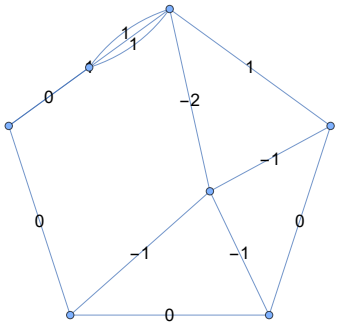
Knot[8, 8] → 

, Knot[8, 9] → 

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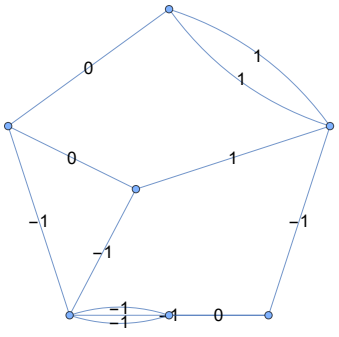
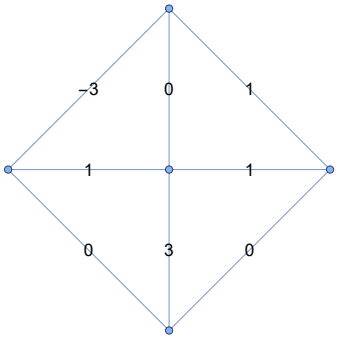
Knot[8, 10] → 

, Knot[8, 11] → 

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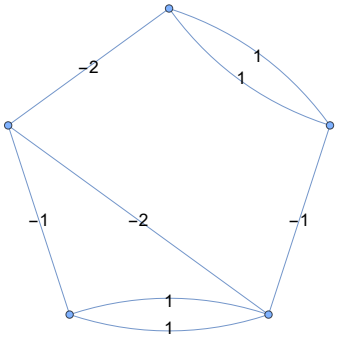
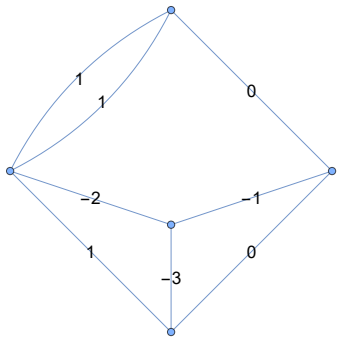
Knot[8, 12] → 

, Knot[8, 13] → 

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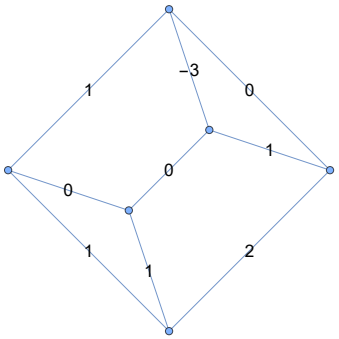
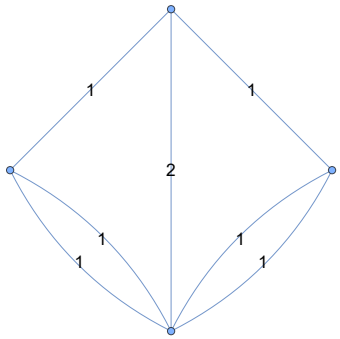
Knot[8, 14] → 

, Knot[8, 15] → 

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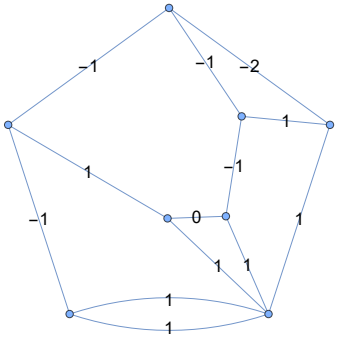
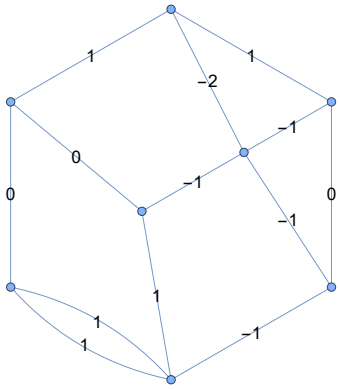
Knot[8, 16] → 

, Knot[8, 17] → 

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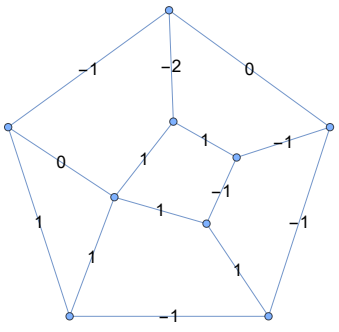
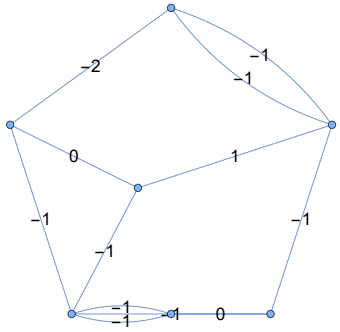
Knot[8, 18] → 

, Knot[8, 19] → 

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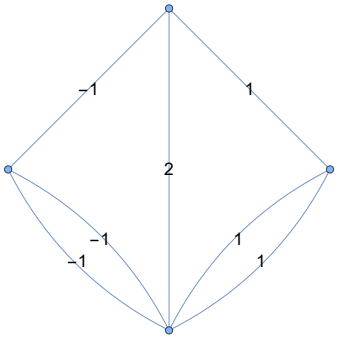
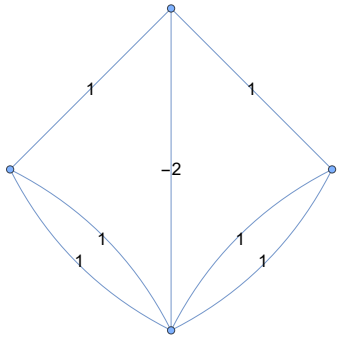
Knot[8, 20] → 

, Knot[8, 21] → 

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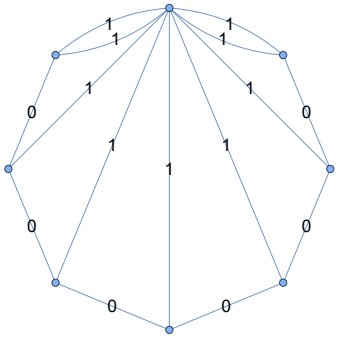
Knot[9, 1] → 

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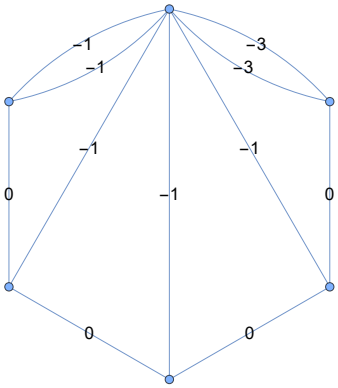
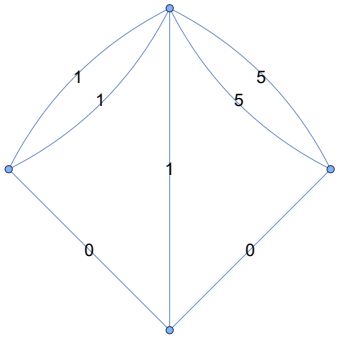
Knot[9, 3] → 

, Knot[9, 4] → 

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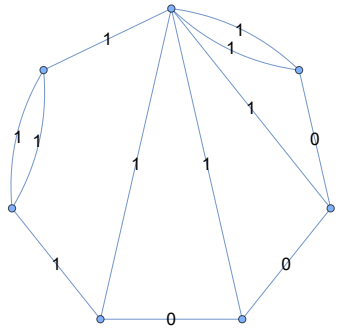
, Knot[9, 6] → 

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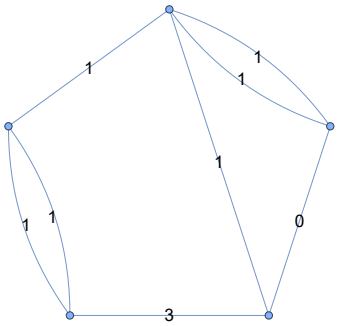
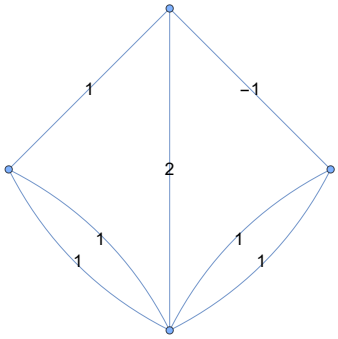
Knot[9, 7] → 

, Knot[9, 8] → 

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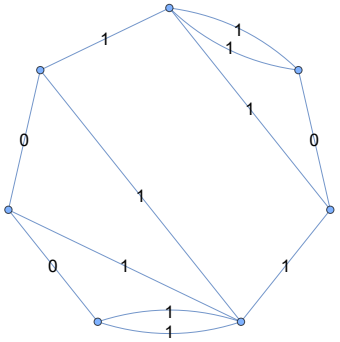
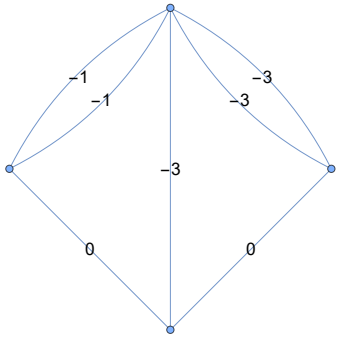
Knot[9, 9] → 

, Knot[9, 10] → 

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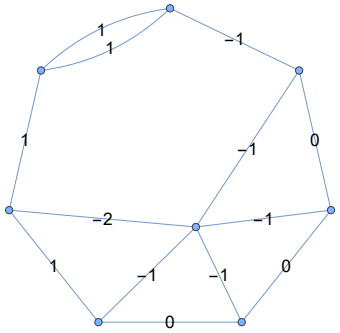
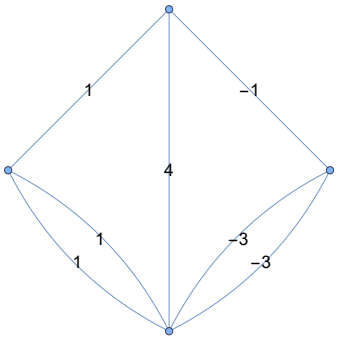
Knot[9, 11] → 

, Knot[9, 12] → 

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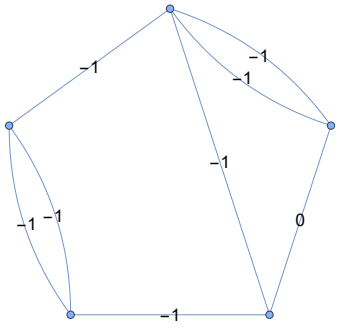
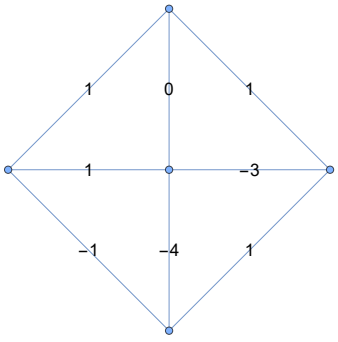
Knot[9, 13] → 

, Knot[9, 14] → 

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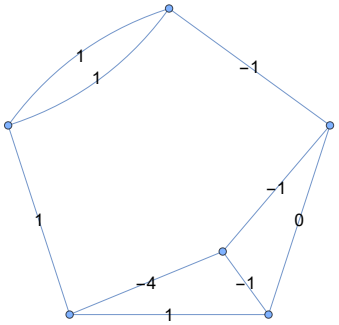
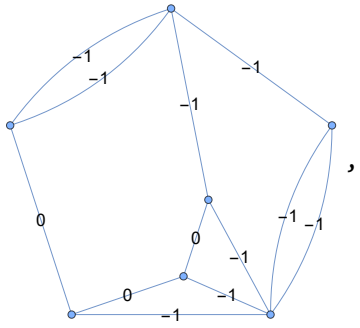
Knot[9, 15] → 

, Knot[9, 16] → 

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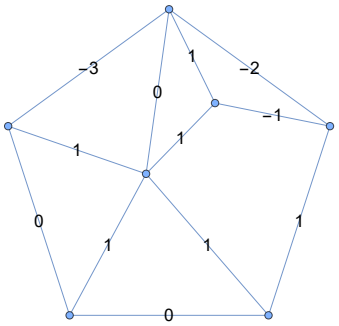
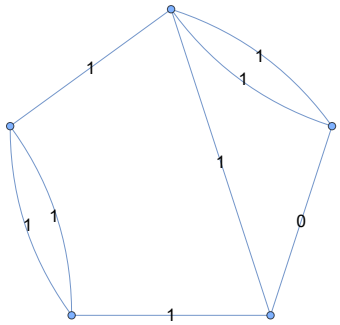
Knot[9, 17] → 

, Knot[9, 18] → 

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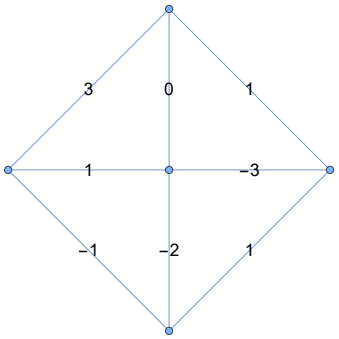
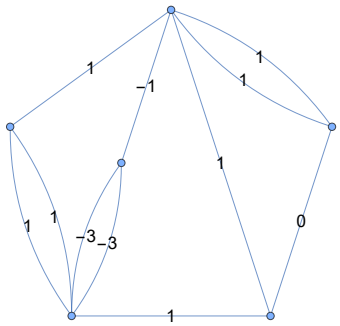
Knot[9, 19] → 

, Knot[9, 20] → 

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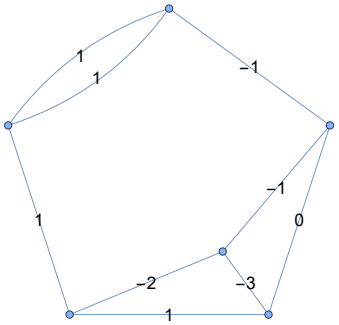
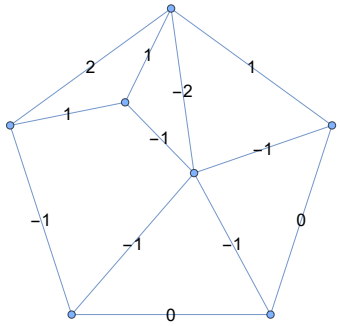
Knot[9, 21] → 

, Knot[9, 22] → 

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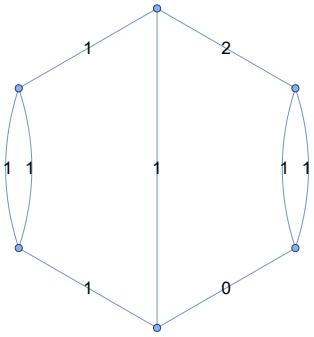
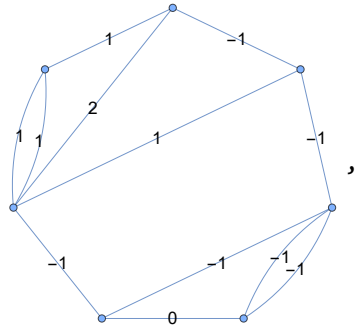
Knot[9, 23] → 

, Knot[9, 24] → 

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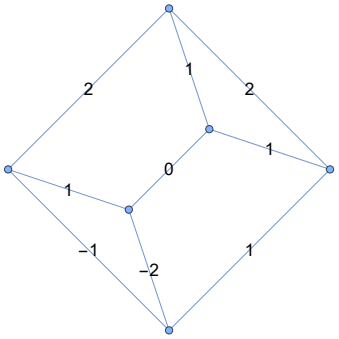
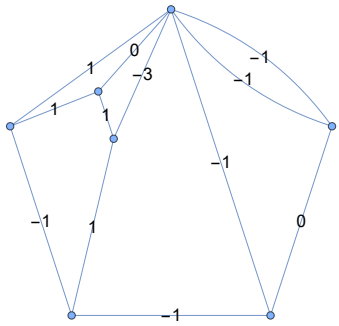
Knot[9, 25] → 

, Knot[9, 26] → 

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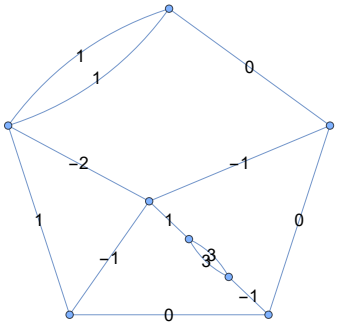
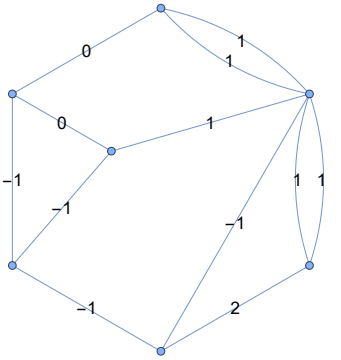
Knot[9, 27] → 

, Knot[9, 28] → 

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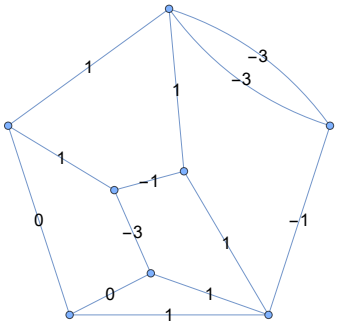
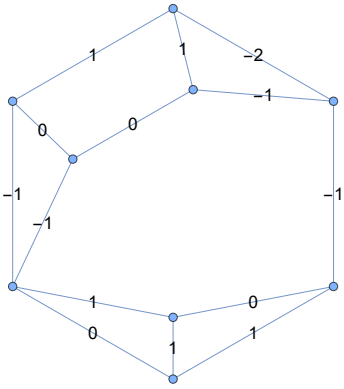
Knot[9, 29] → 

, Knot[9, 30] → 

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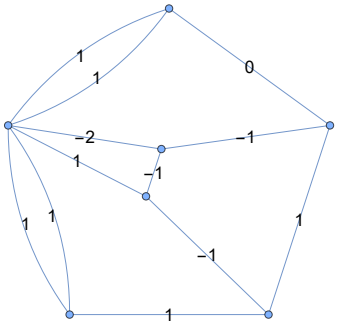
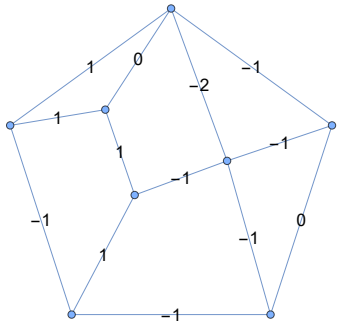
Knot[9, 31] → 

, Knot[9, 32] → 

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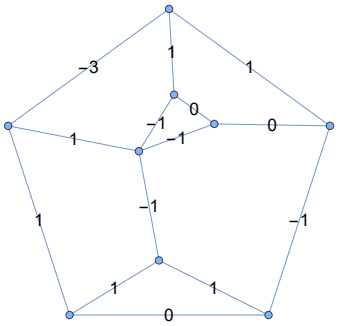
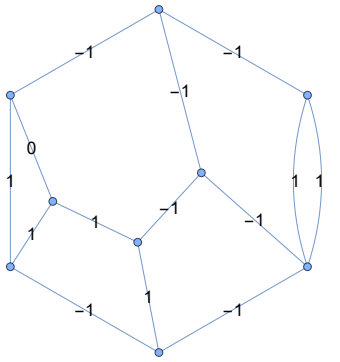
Knot[9, 33] → 

, Knot[9, 34] → 

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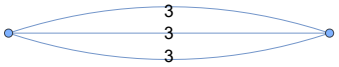
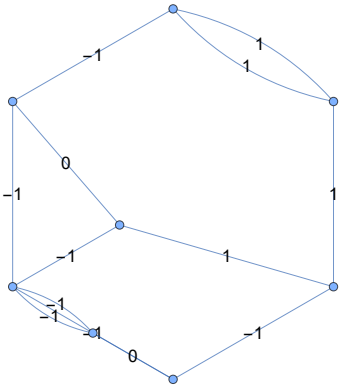
Knot[9, 35] → 

, Knot[9, 36] → 

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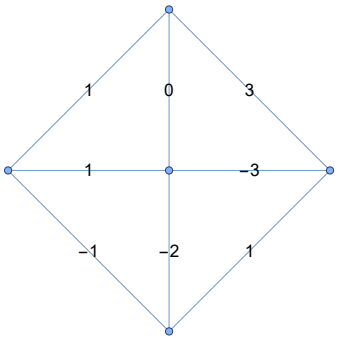
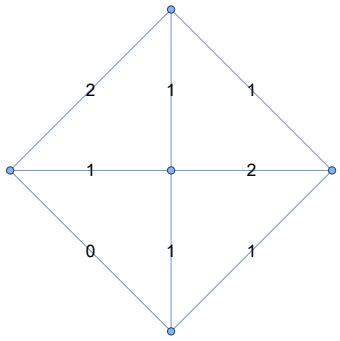
Knot[9, 37] → 

, Knot[9, 38] → 

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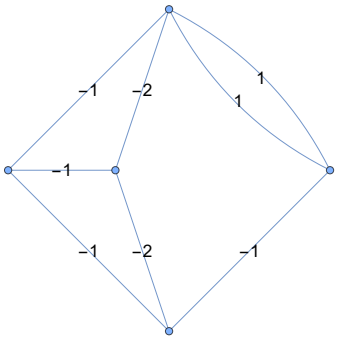
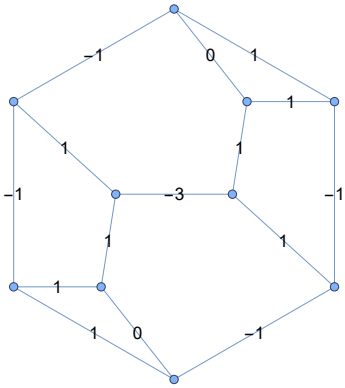
Knot[9, 39] → 

, Knot[9, 40] → 

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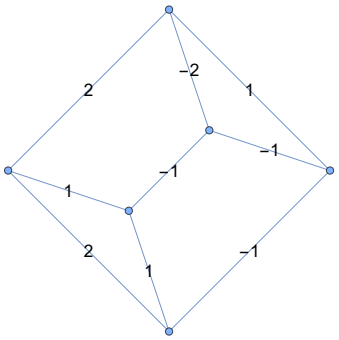
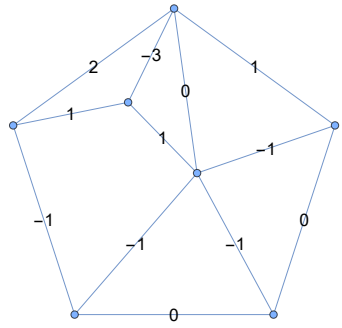
Knot[9, 41] → 

, Knot[9, 42] → 

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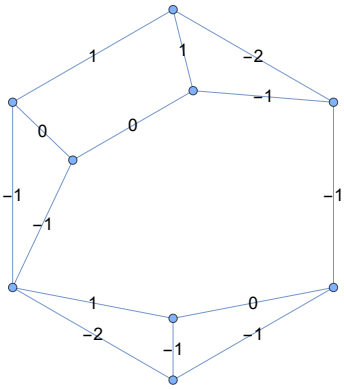
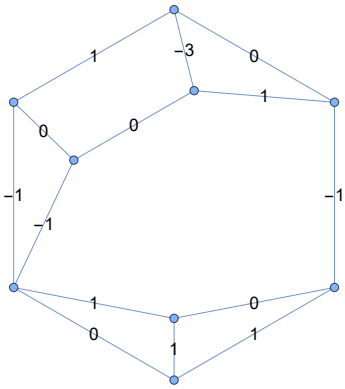
Knot[9, 43] → 

, Knot[9, 44] → 

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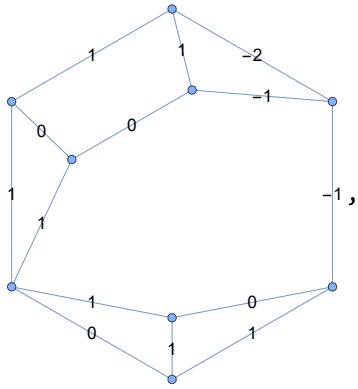
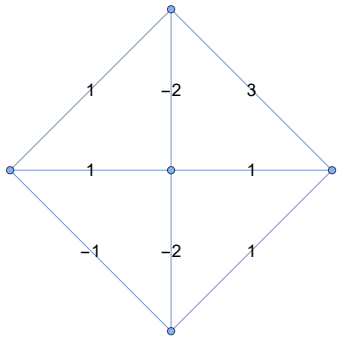
Knot[9, 45] → 

, Knot[9, 46] → 

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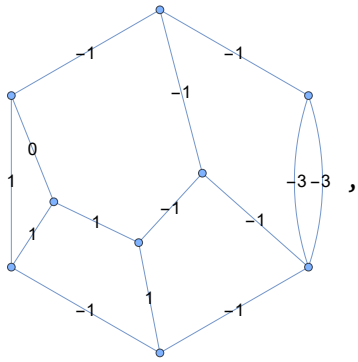
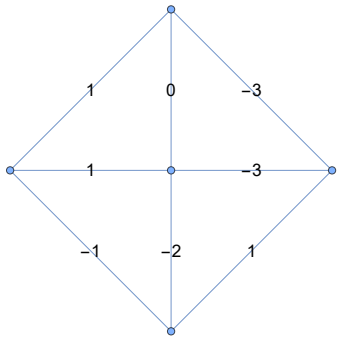
Knot[9, 47] → 

, Knot[9, 48] → 

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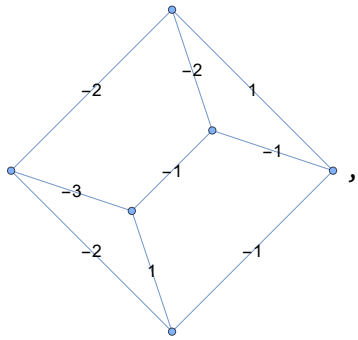
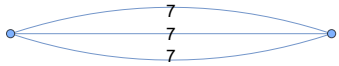
Knot[9, 49] → 

, Knot[10, 1] → 

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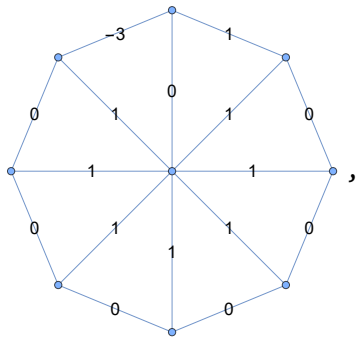
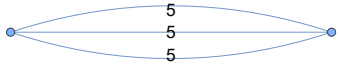
Knot[10, 2] → 

, Knot[10, 3] → 

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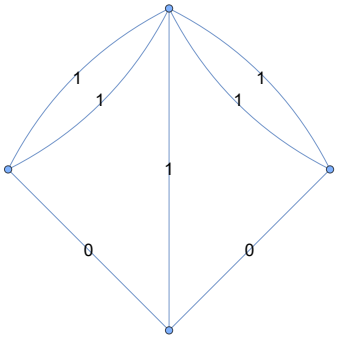
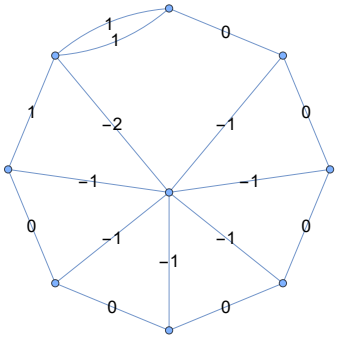
`Knot[10, 4]` → 

, `Knot[10, 5]` → 

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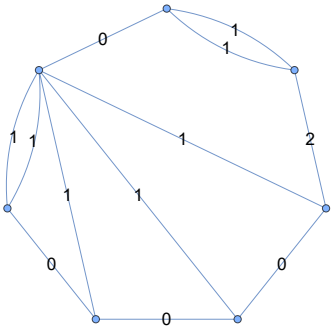
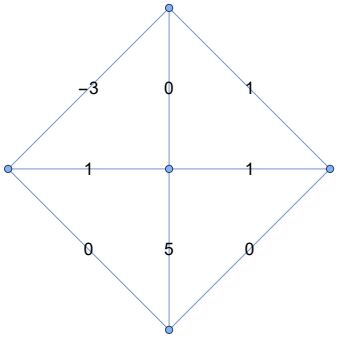
`Knot[10, 6]` → 

, `Knot[10, 7]` → 

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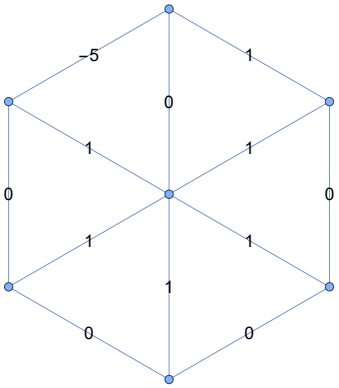
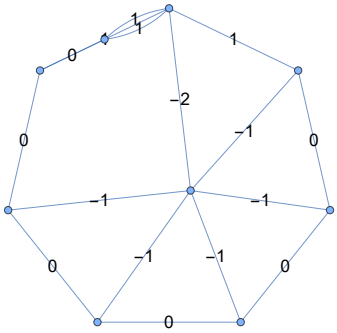
`Knot[10, 8]` → 

, `Knot[10, 9]` → 

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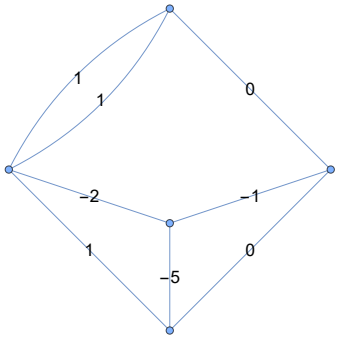
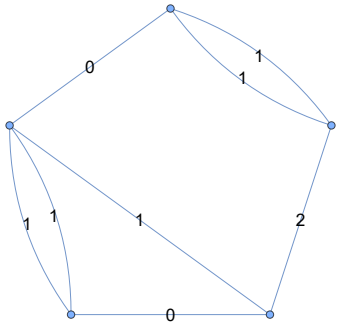
`Knot[10, 10]` → 

, `Knot[10, 11]` → 

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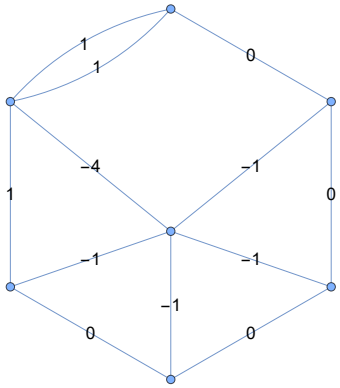

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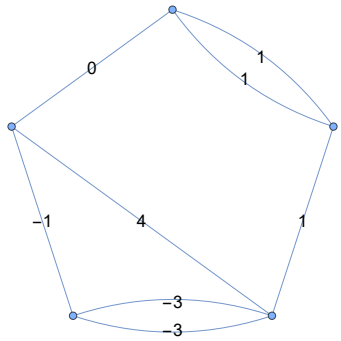

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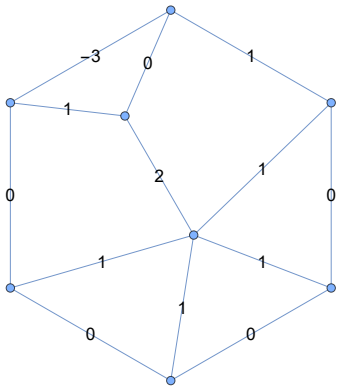

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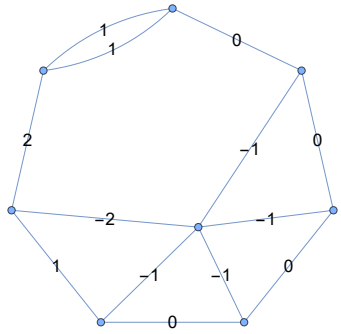

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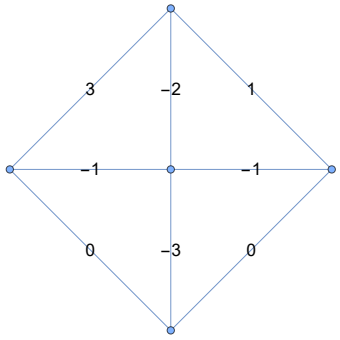

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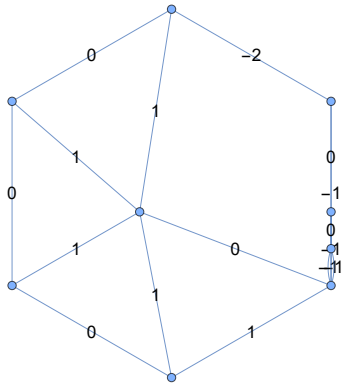

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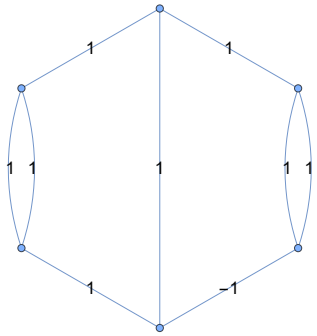
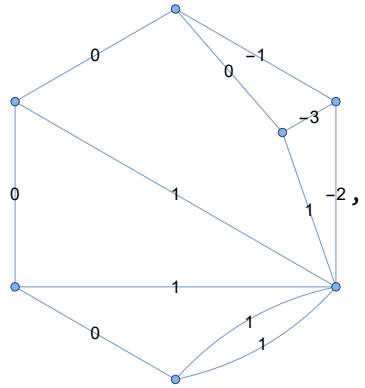
Knot[10, 18] → 

, Knot[10, 19] → 

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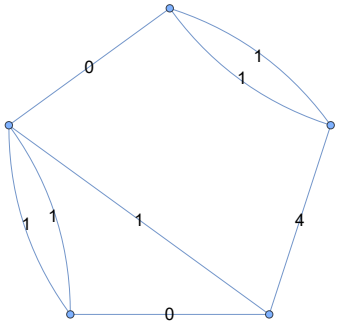
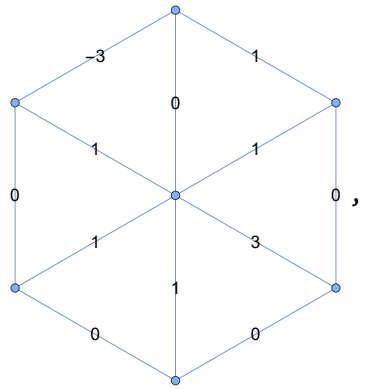
Knot[10, 20] → 

, Knot[10, 21] → 

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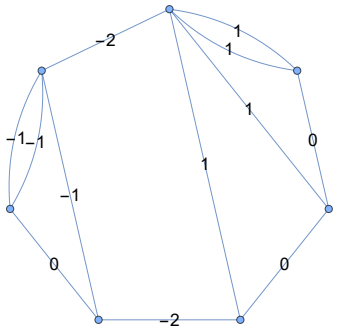
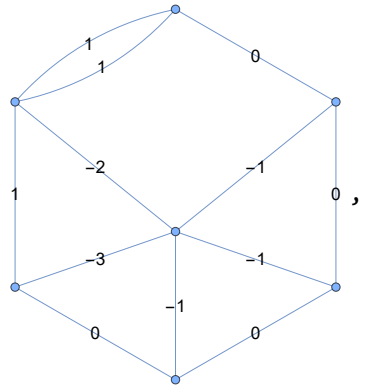
Knot[10, 22] → 

, Knot[10, 23] → 

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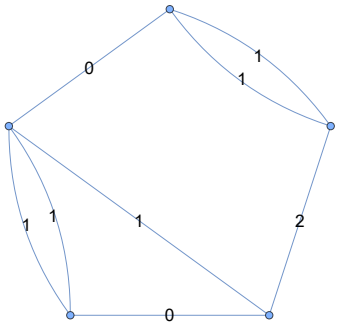
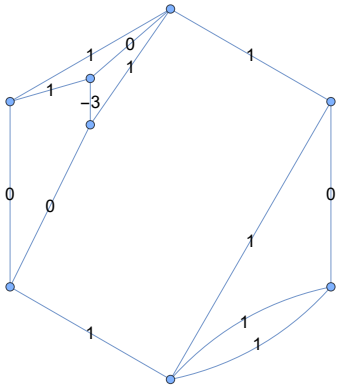
Knot[10, 24] → 

, Knot[10, 25] → 

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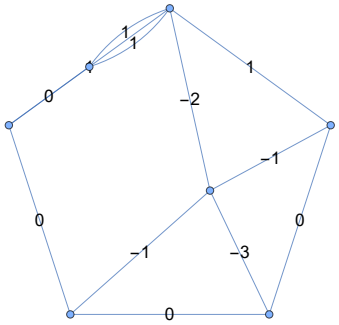
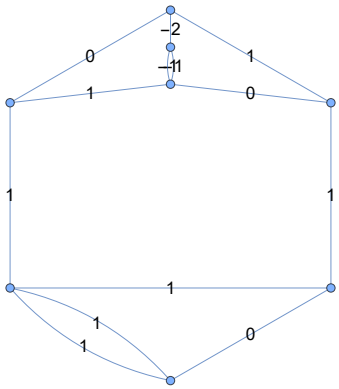
Knot[10, 26] → 

, Knot[10, 27] → 

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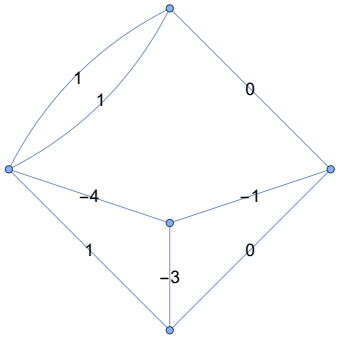
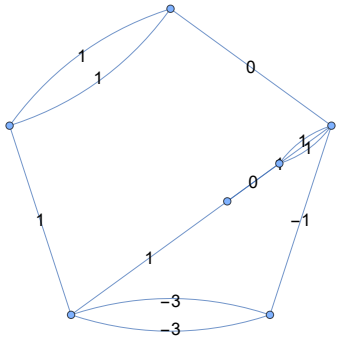
Knot[10, 28] → 

, Knot[10, 29] → 

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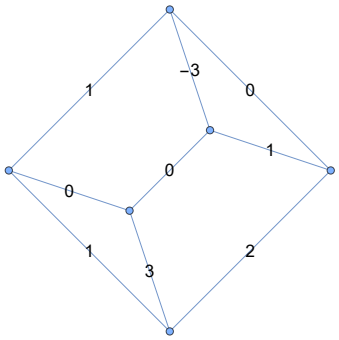
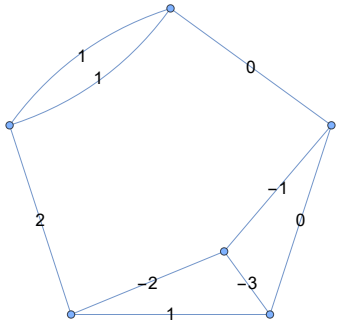
Knot[10, 30] → 

, Knot[10, 31] → 

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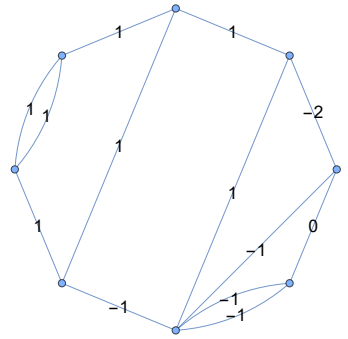
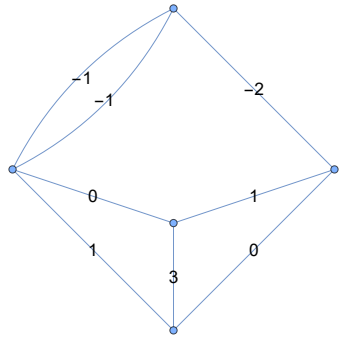
Knot[10, 32] → 

, Knot[10, 33] → 

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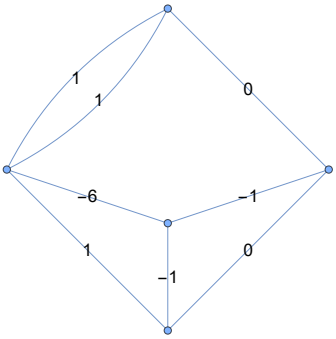
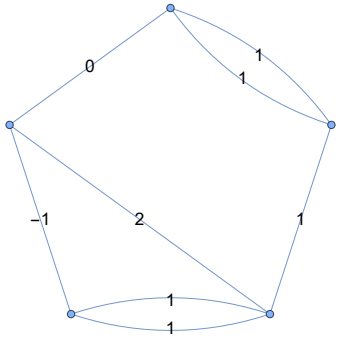
Knot[10, 34] → 

, Knot[10, 35] → 

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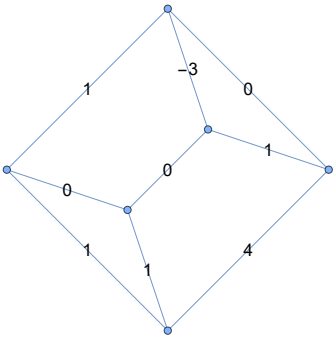
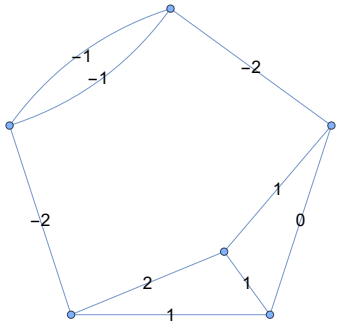
Knot[10, 36] → 

, Knot[10, 37] → 

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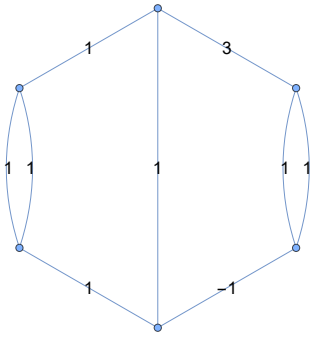
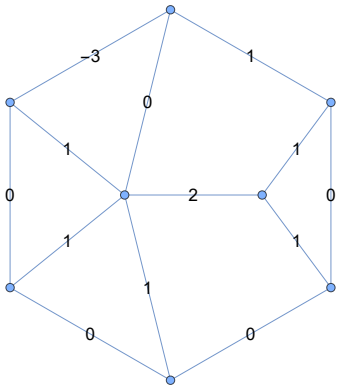
Knot[10, 38] → 

, Knot[10, 39] → 

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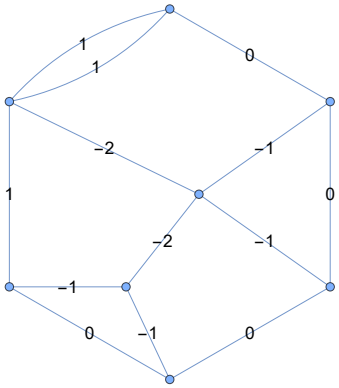
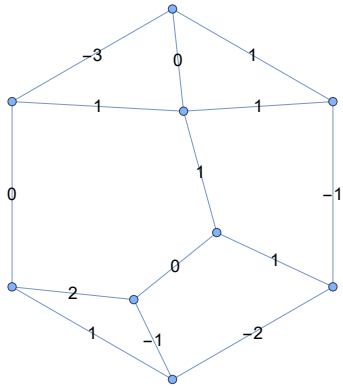
Knot[10, 40] → 

, Knot[10, 41] → 

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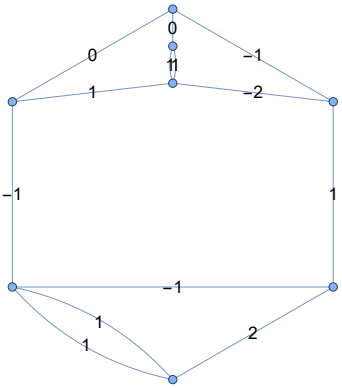
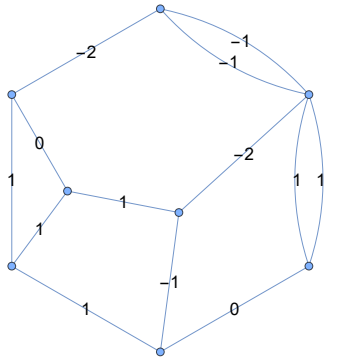
Knot[10, 42] → 

, Knot[10, 43] → 

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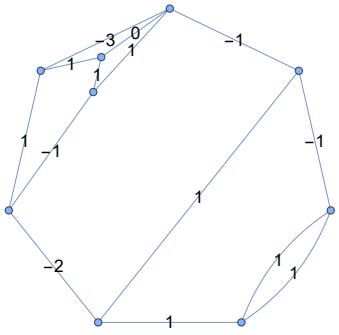
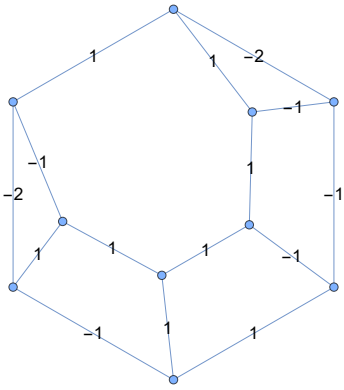
Knot[10, 44] → 

, Knot[10, 45] → 

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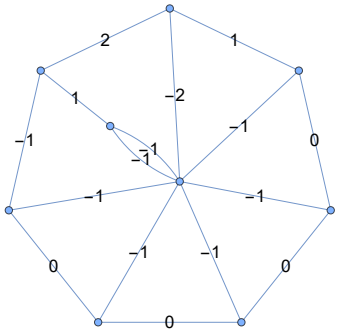
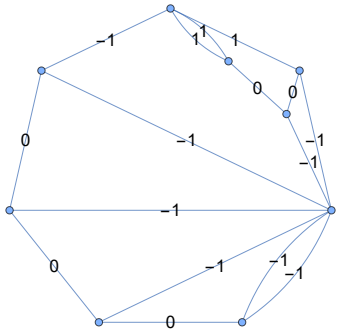
Knot[10, 46] → 

, Knot[10, 47] → 

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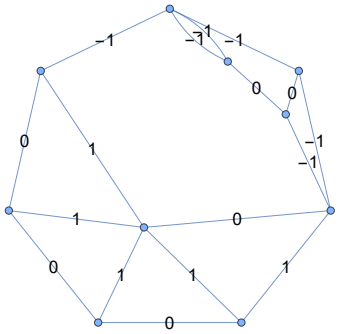
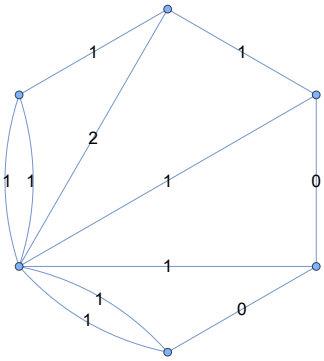
Knot[10, 48] → 

, Knot[10, 49] → 

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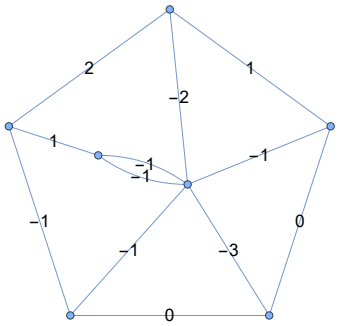
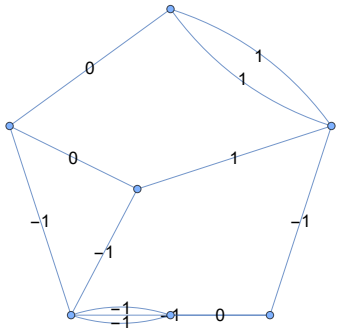
Knot[10, 50] → 

, Knot[10, 51] → 

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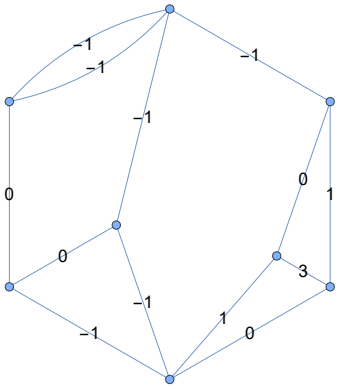
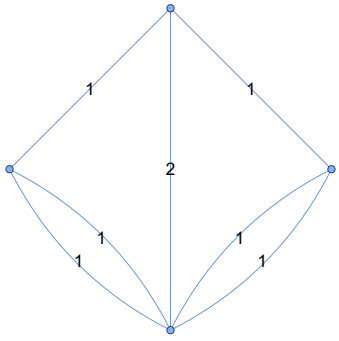
Knot[10, 52] → 

, Knot[10, 53] → 

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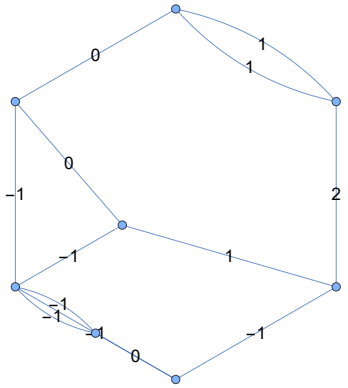
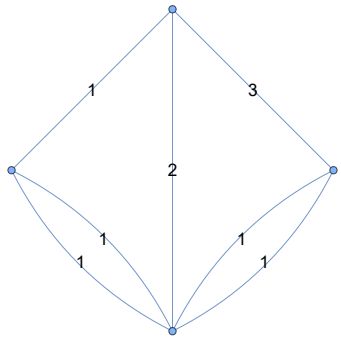
Knot[10, 54] → 

, Knot[10, 55] → 

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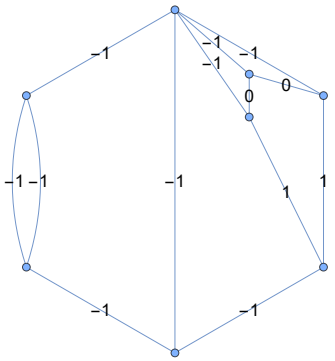
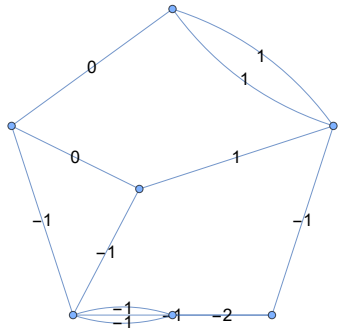
Knot[10, 56] → 

, Knot[10, 57] → 

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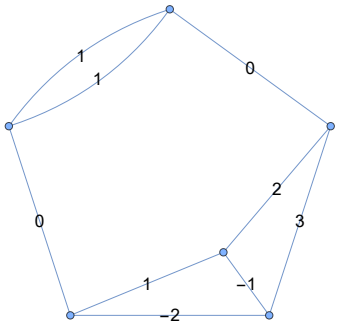
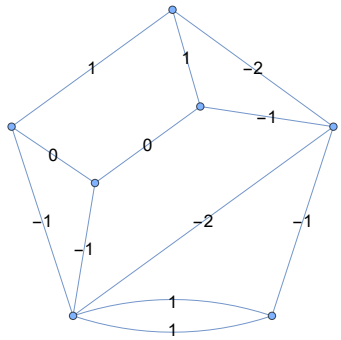
Knot[10, 58] → 

, Knot[10, 59] → 

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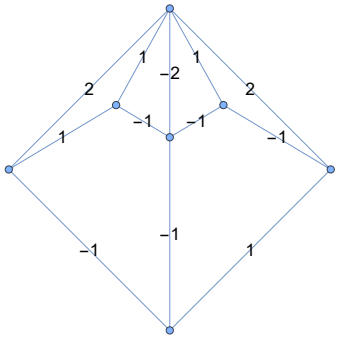
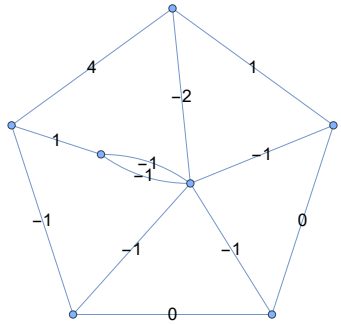
Knot[10, 60] → 

, Knot[10, 61] → 

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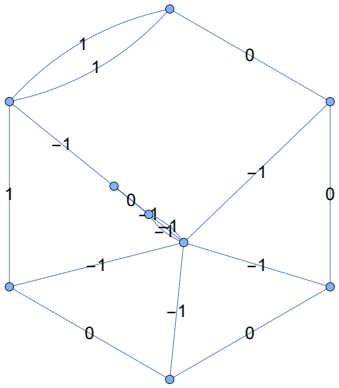

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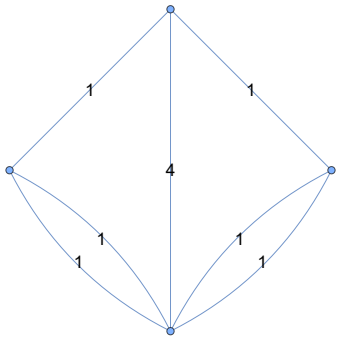

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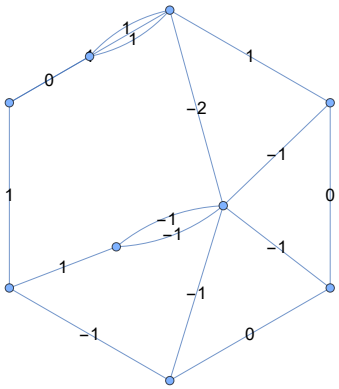

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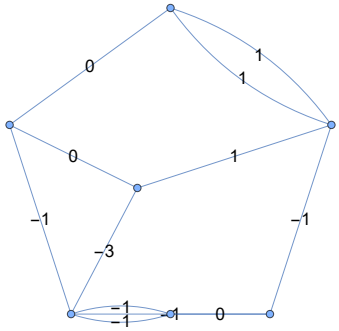

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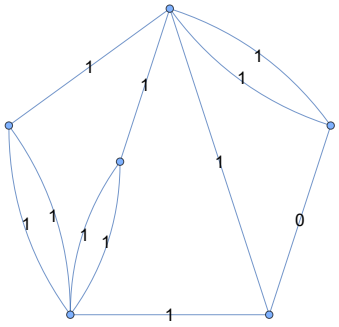

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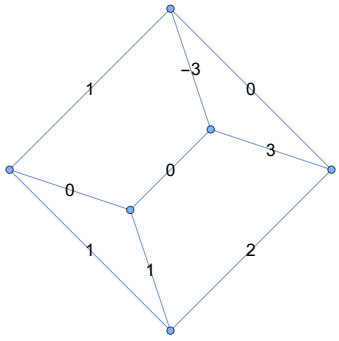

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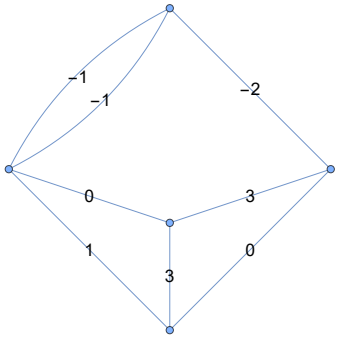

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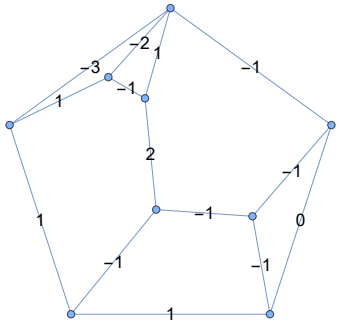

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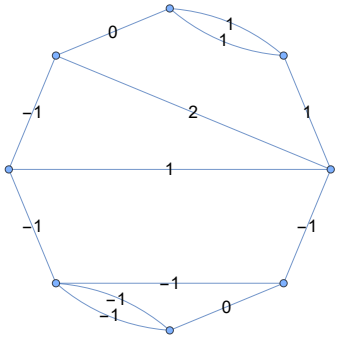
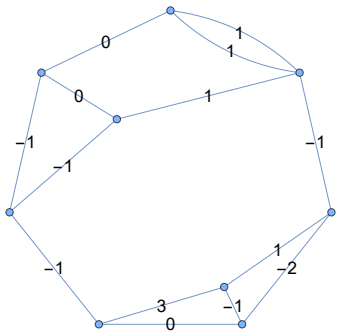
Knot[10, 70] → 

, Knot[10, 71] → 

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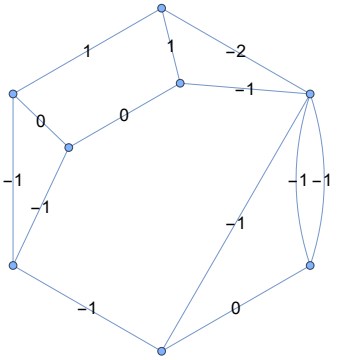
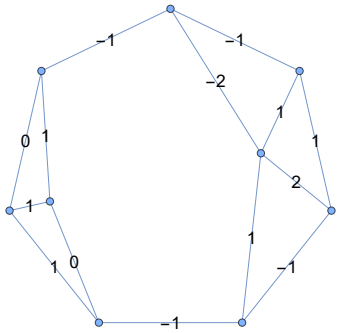
Knot[10, 72] → 

, Knot[10, 73] → 

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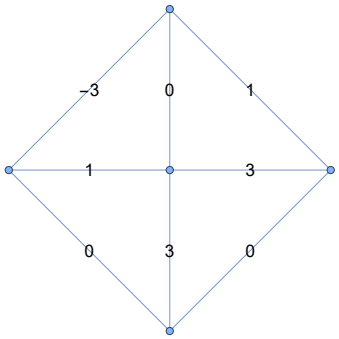
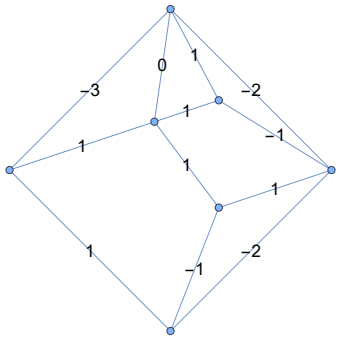
Knot[10, 74] → 

, Knot[10, 75] → 

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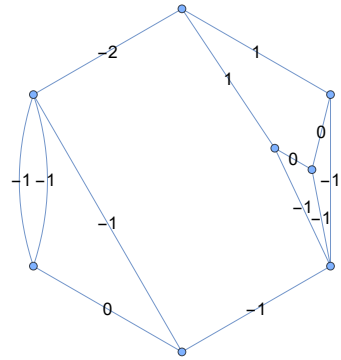
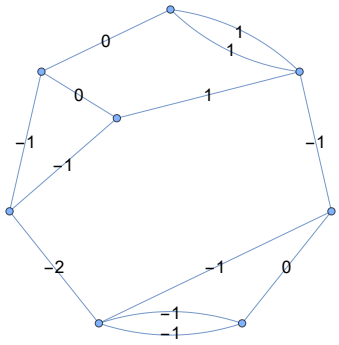
Knot[10, 76] → 

, Knot[10, 77] → 

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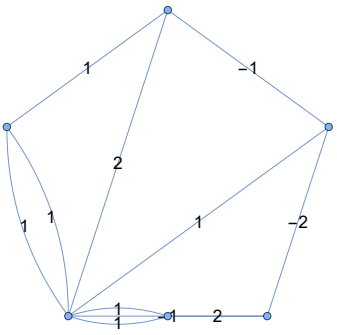
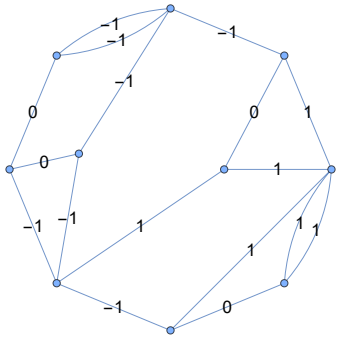
Knot[10, 78] → 
, Knot[10, 79] → 
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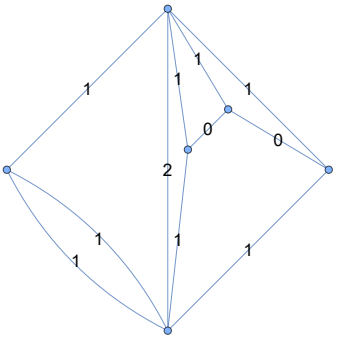
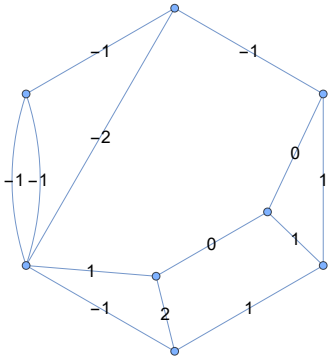
Knot[10, 80] → 
, Knot[10, 81] → 
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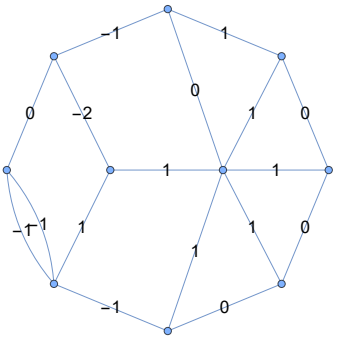
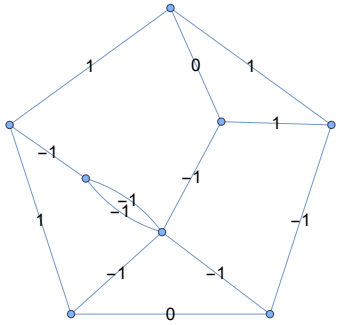
Knot[10, 82] → 
, Knot[10, 83] → 
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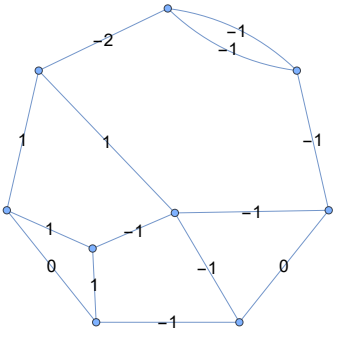
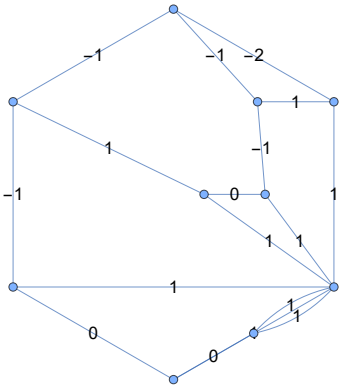
Knot[10, 84] → 
, Knot[10, 85] → 
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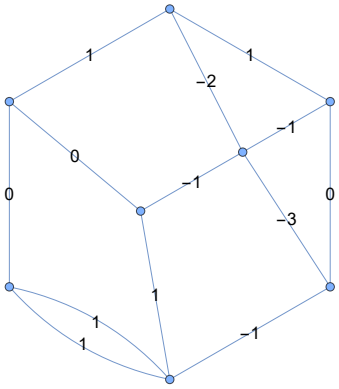
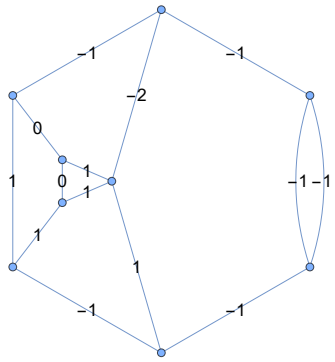
Knot[10, 86] → 

, Knot[10, 87] → 

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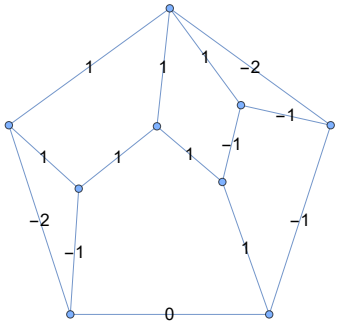
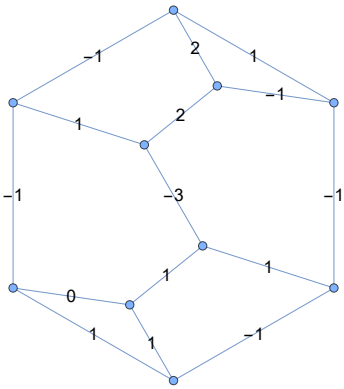
Knot[10, 88] → 

, Knot[10, 89] → 

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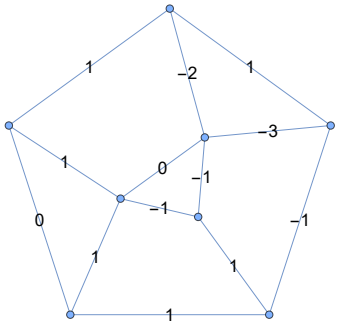
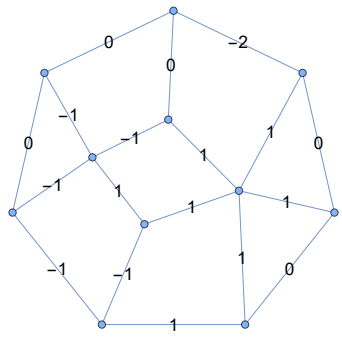
Knot[10, 90] → 

, Knot[10, 91] → 

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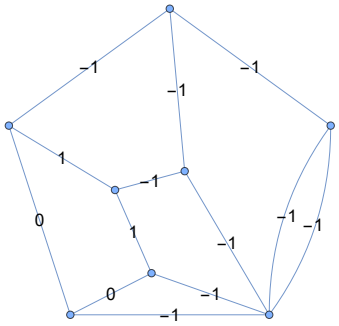
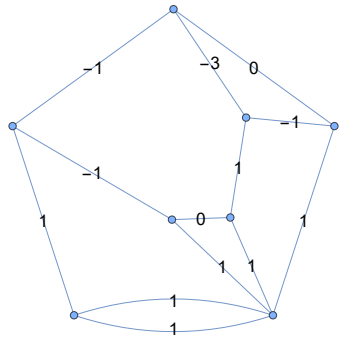
Knot[10, 92] → 

, Knot[10, 93] → 

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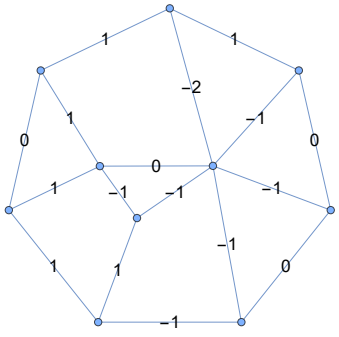
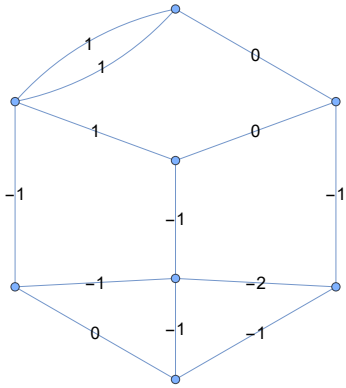
Knot[10, 94] → 
, Knot[10, 95] → 
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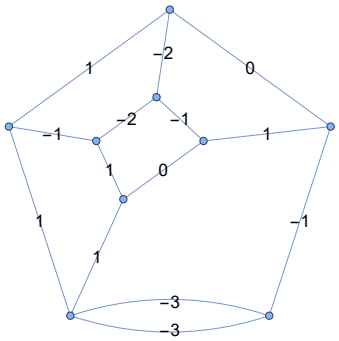
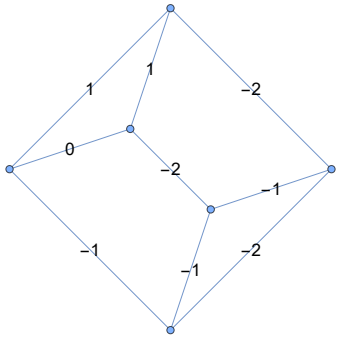
Knot[10, 96] → 
, Knot[10, 97] → 
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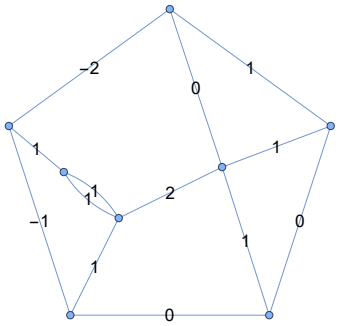
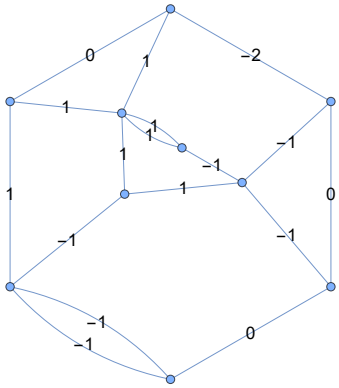
Knot[10, 98] → 
, Knot[10, 99] → 
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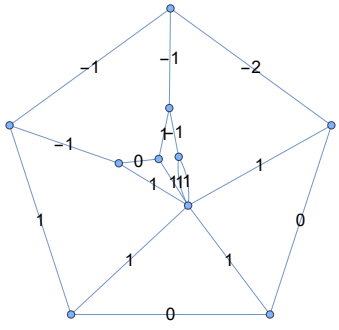
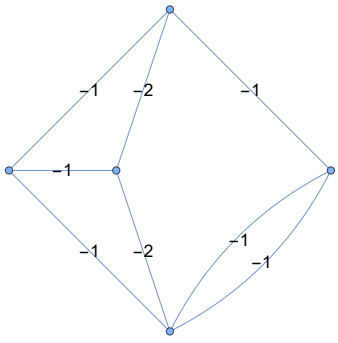
Knot[10, 100] → 
, Knot[10, 101] → 
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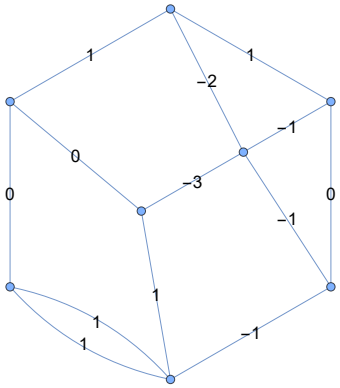
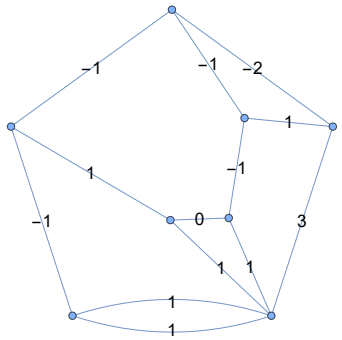
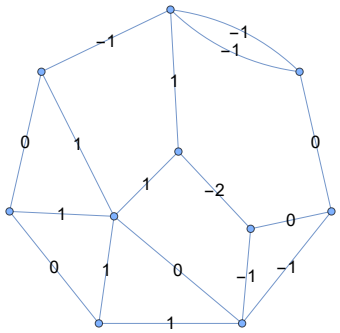
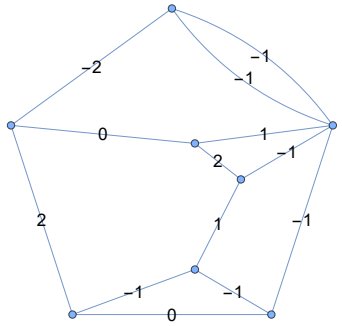
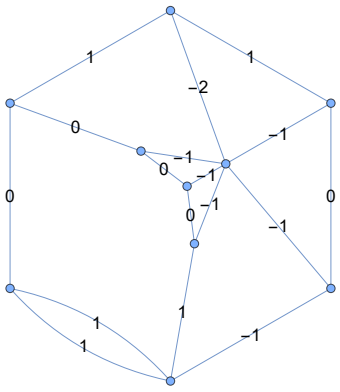
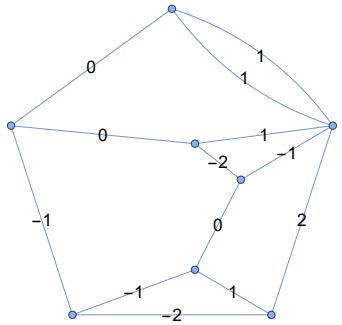
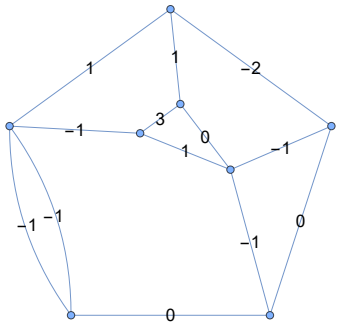
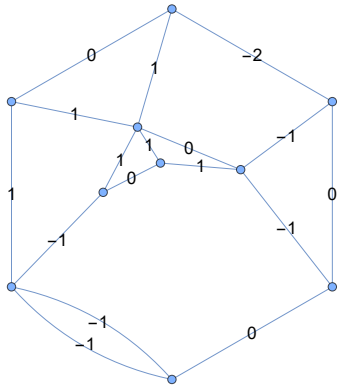
Knot[10, 102] →  , Knot[10, 103] →  ,

Knot[10, 104] →  , Knot[10, 105] →  ,

Knot[10, 106] →  , Knot[10, 107] →  ,

Knot[10, 108] → 
, Knot[10, 109] → 
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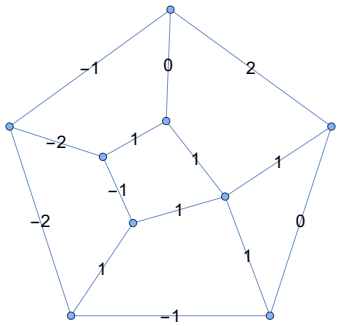
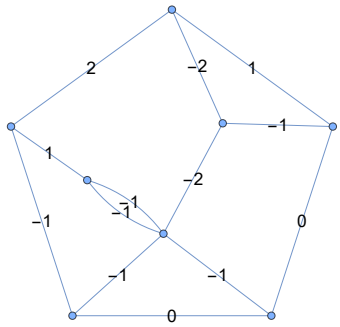
Knot[10, 110] → 
, Knot[10, 111] → 
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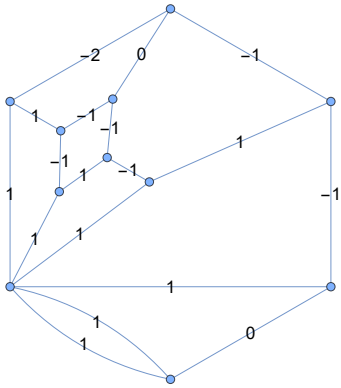
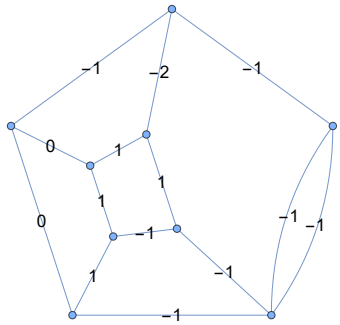
Knot[10, 112] → 
, Knot[10, 113] → 
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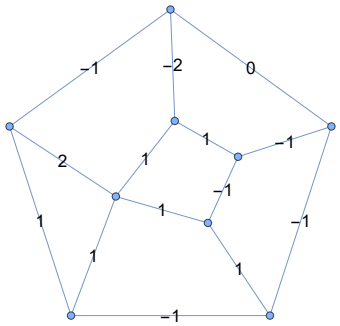
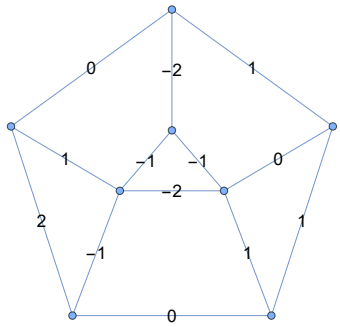
Knot[10, 114] → 
, Knot[10, 115] → 
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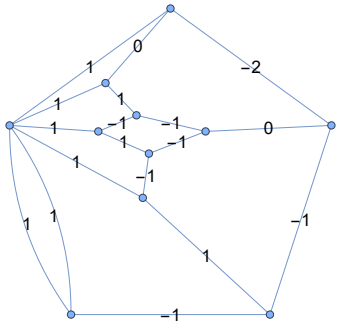
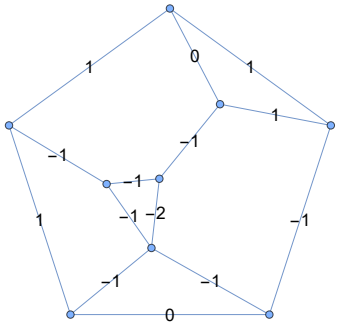
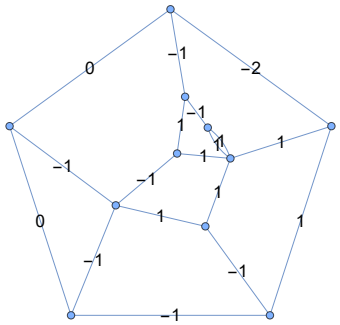
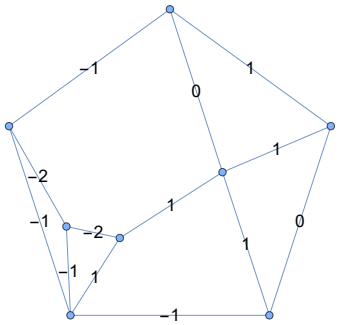
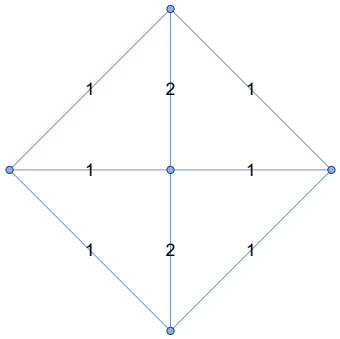
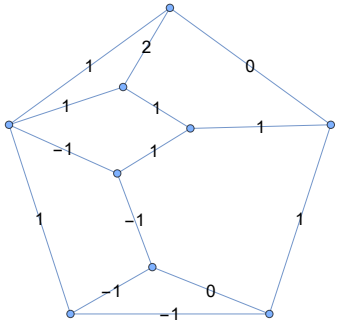
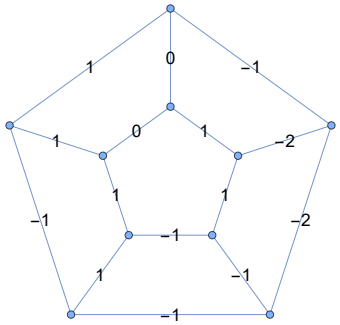
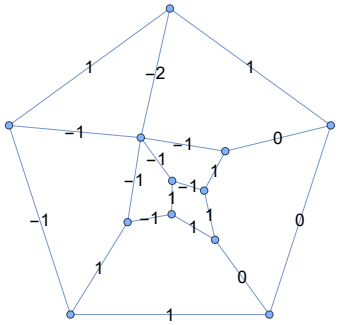
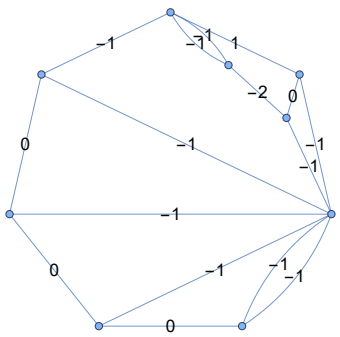
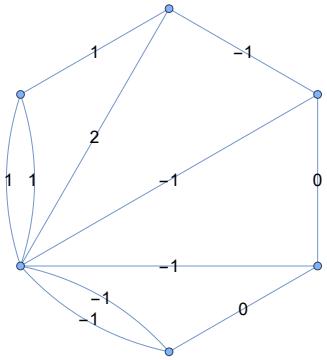
`Knot[10, 116]` →  , `Knot[10, 117]` →  ,

`Knot[10, 118]` →  , `Knot[10, 119]` →  ,

`Knot[10, 120]` →  , `Knot[10, 121]` →  ,

`Knot[10, 122]` →  , `Knot[10, 123]` →  ,

Knot[10, 124] → 

, Knot[10, 125] → 

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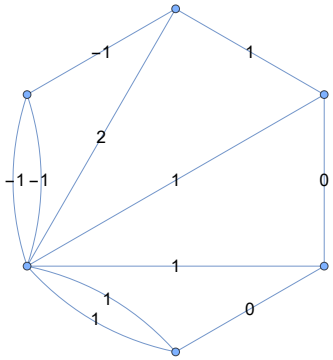
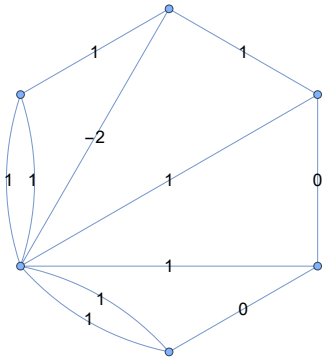
Knot[10, 126] → 

, Knot[10, 127] → 

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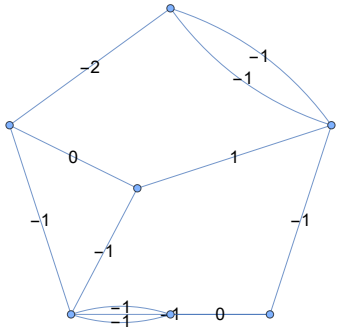
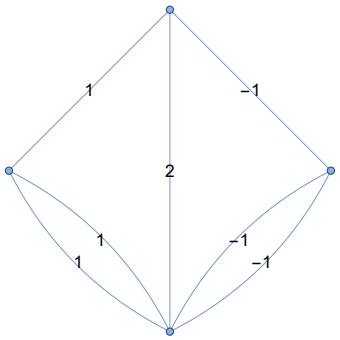
Knot[10, 128] → 

, Knot[10, 129] → 
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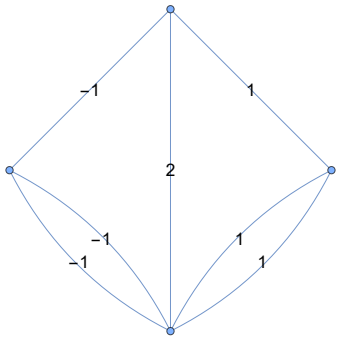
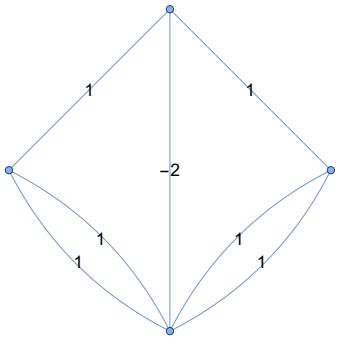
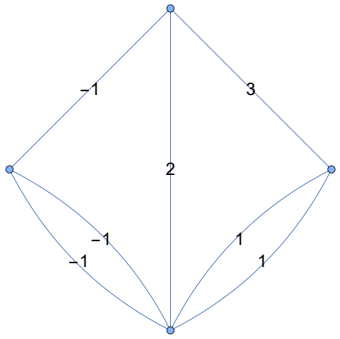
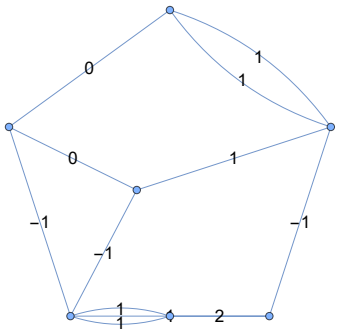
Knot[10, 130] → 



Knot[10, 132] → 

, Knot[10, 133] → 

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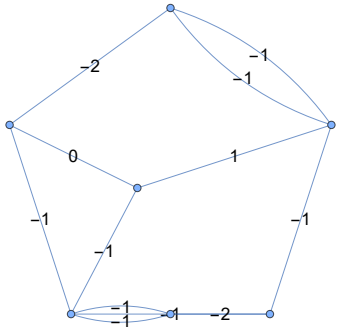
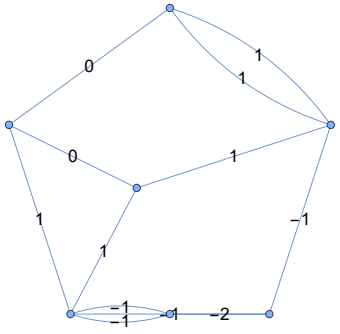
Knot[10, 134] → 

, Knot[10, 135] → 

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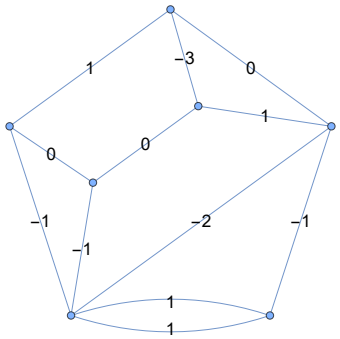
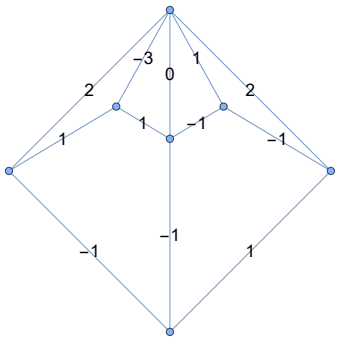
Knot[10, 136] → 

, Knot[10, 137] → 

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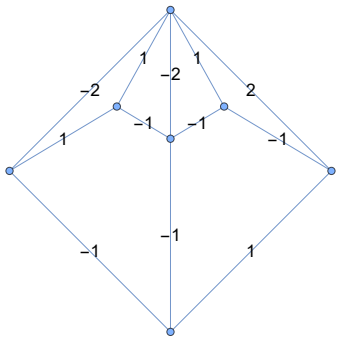
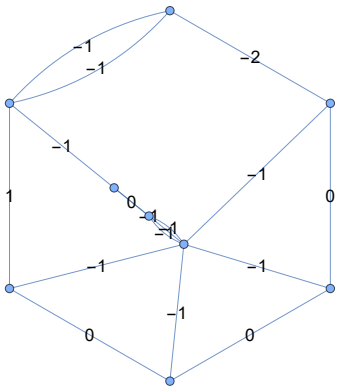
Knot[10, 138] → 

, Knot[10, 139] → 

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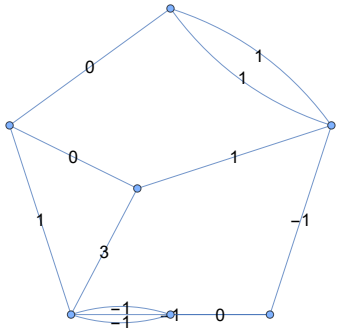
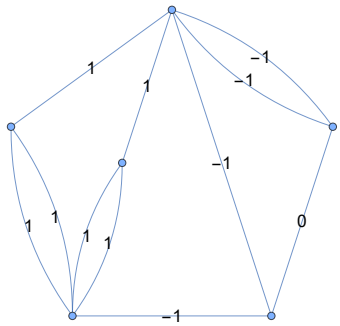
Knot[10, 140] → 

, Knot[10, 141] → 

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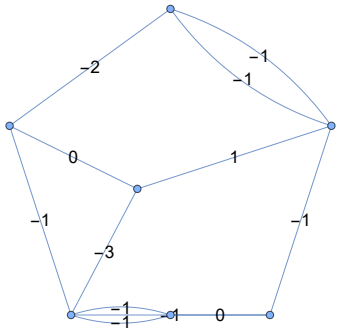
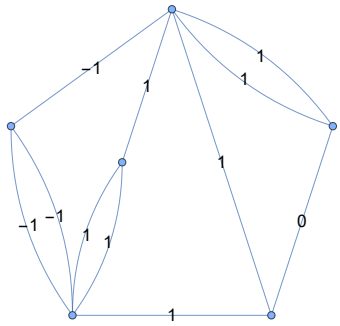
Knot[10, 142] → 

, Knot[10, 143] → 

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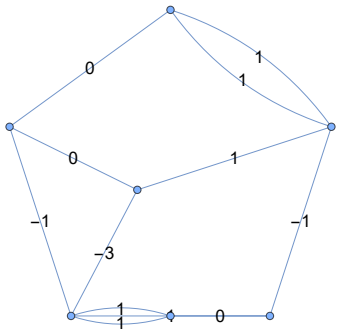
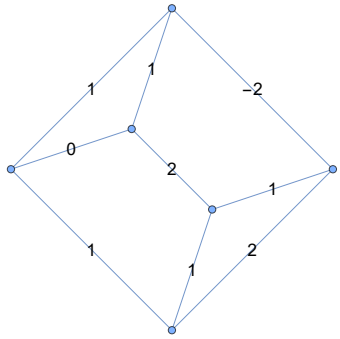
Knot[10, 144] → 

, Knot[10, 145] → 

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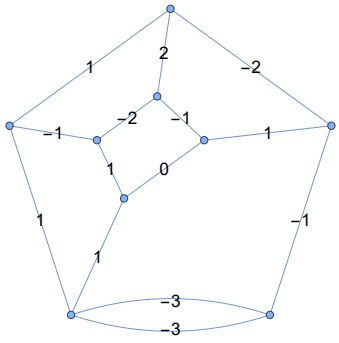
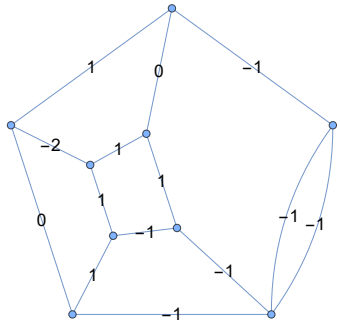
Knot[10, 146] → 

, Knot[10, 147] → 

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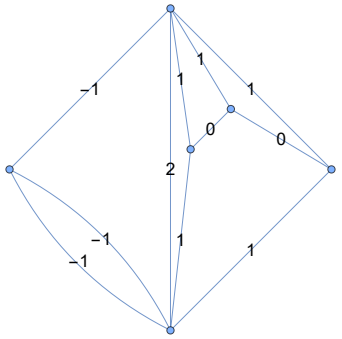
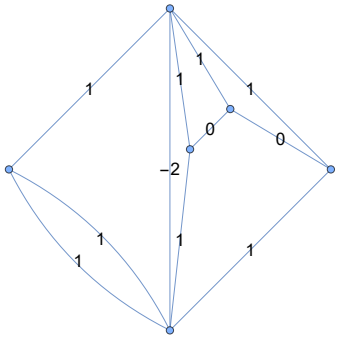
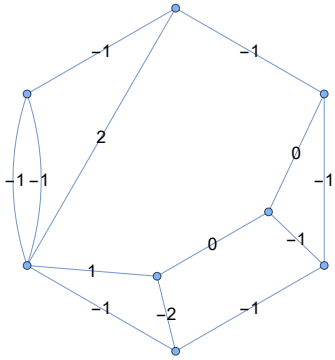
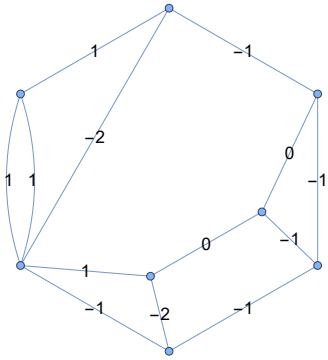
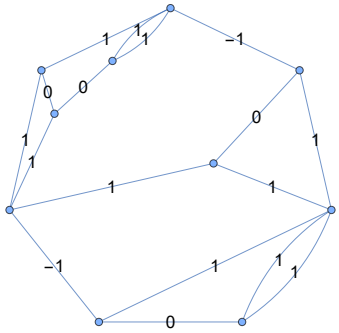
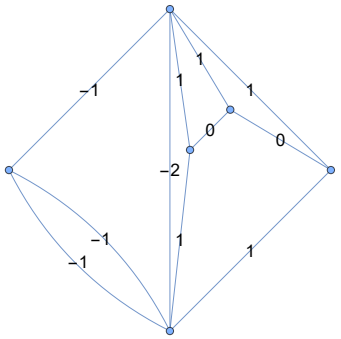
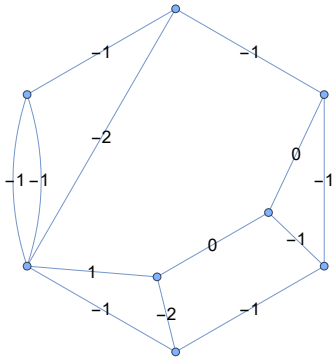
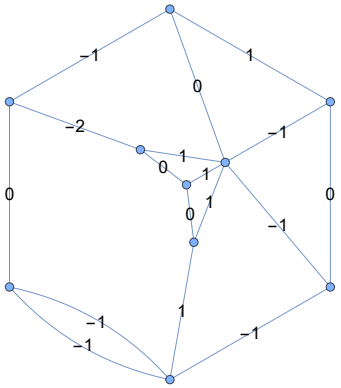
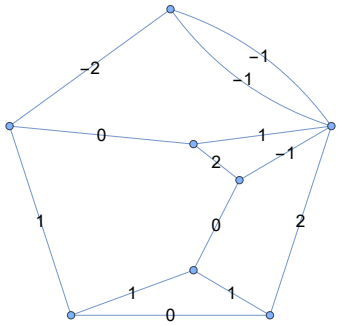
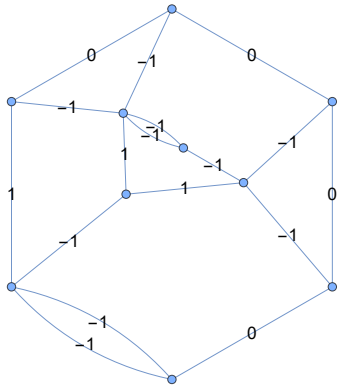
Knot[10, 148] →  , Knot[10, 149] →  ,

Knot[10, 150] →  , Knot[10, 151] →  ,

Knot[10, 152] →  , Knot[10, 153] →  ,

Knot[10, 154] →  , Knot[10, 155] →  ,

Knot[10, 156] → 

, Knot[10, 157] → 

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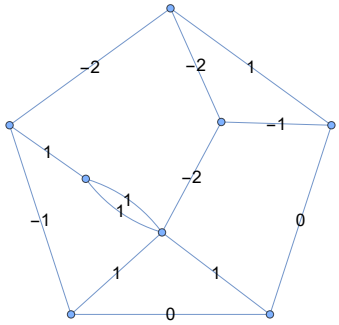
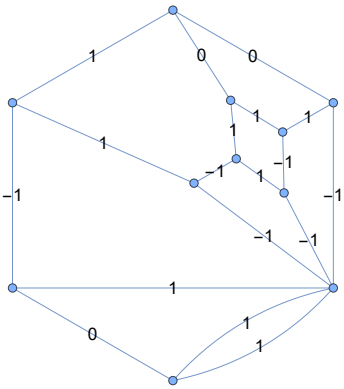
Knot[10, 158] → 

, Knot[10, 159] → 

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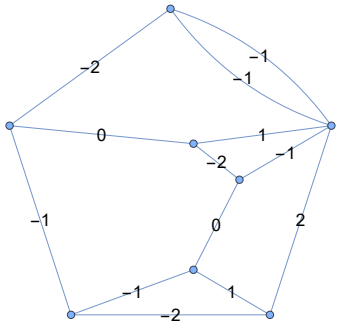
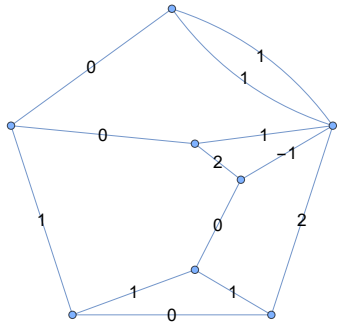
Knot[10, 160] → 

, Knot[10, 161] → 

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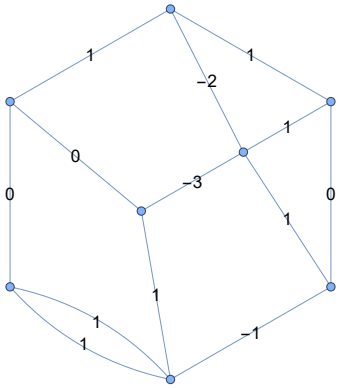
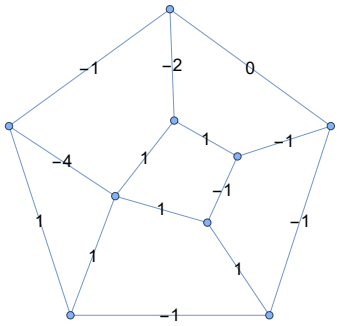
Knot[10, 162] → 

, Knot[10, 163] → 

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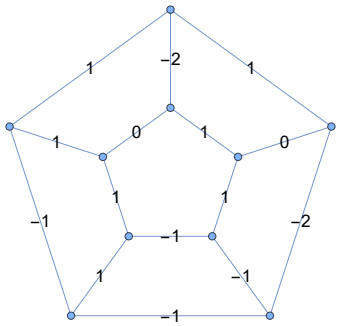
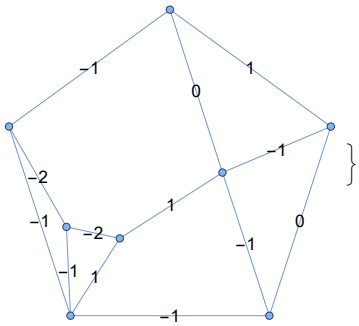
Knot[10, 164] → 

, Knot[10, 165] → 

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