Planar Configuration Spaces

of Disk Arrangements and Hinged Polygons

Clinton Bowen

Cal State Northridge

December 6, 2016

7ballLocked.pdf

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* item 2

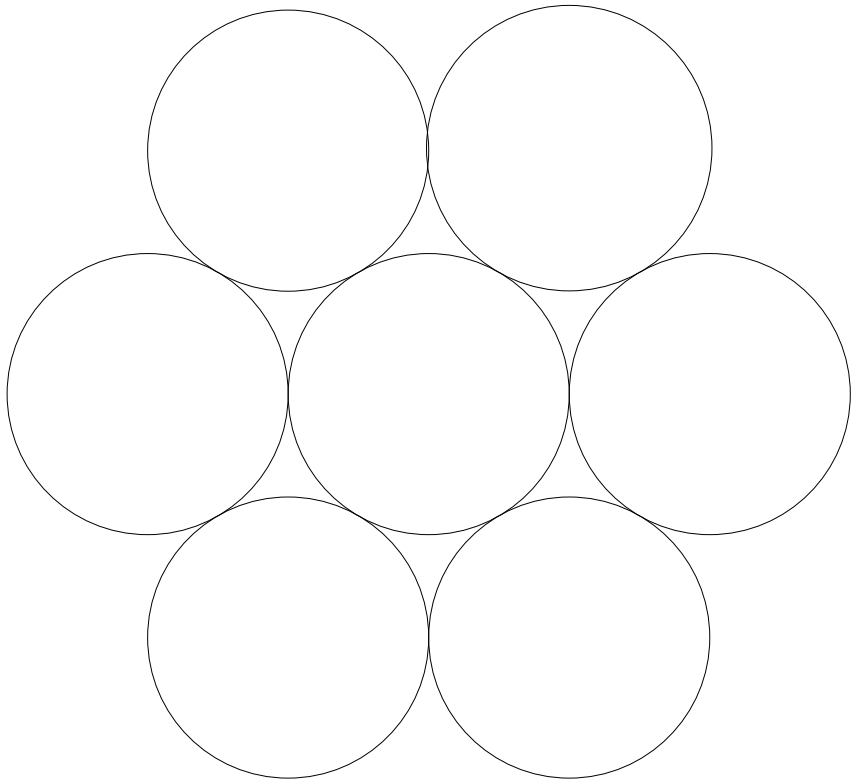

Figure: Caption Text

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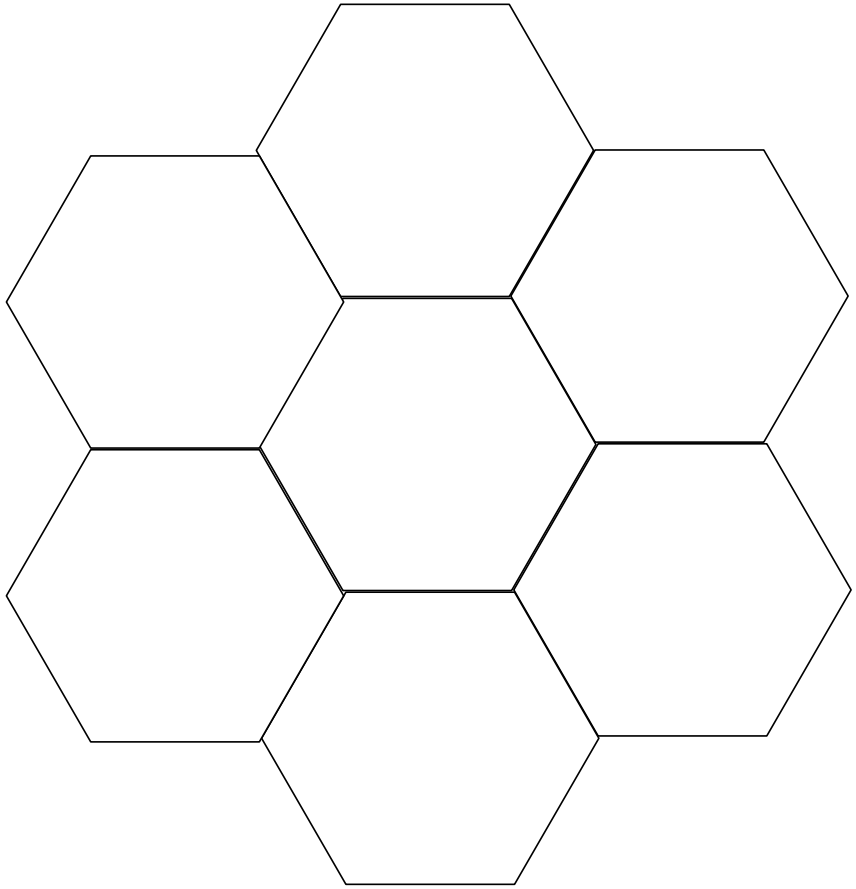

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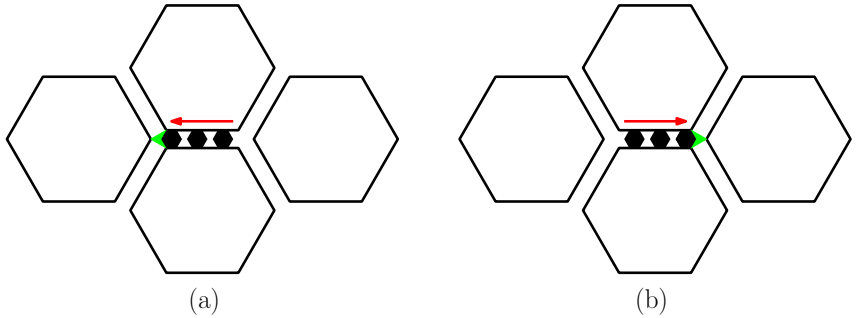

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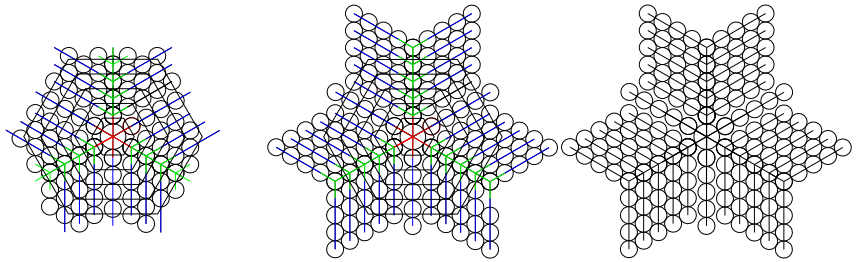

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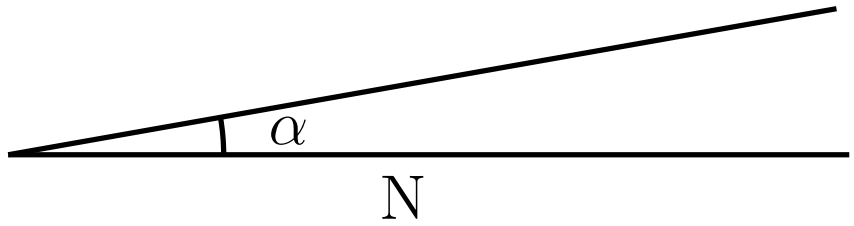

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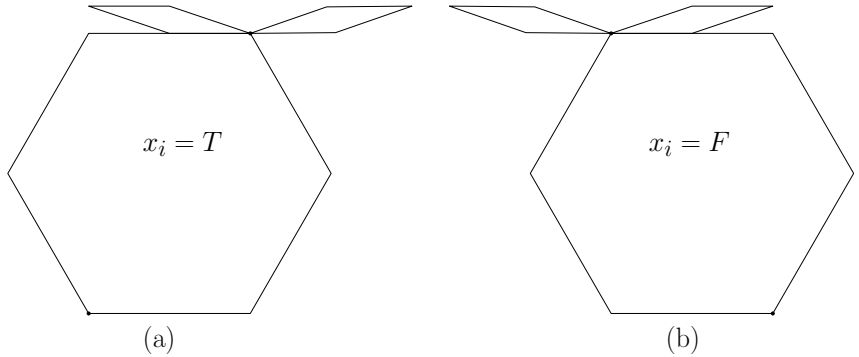

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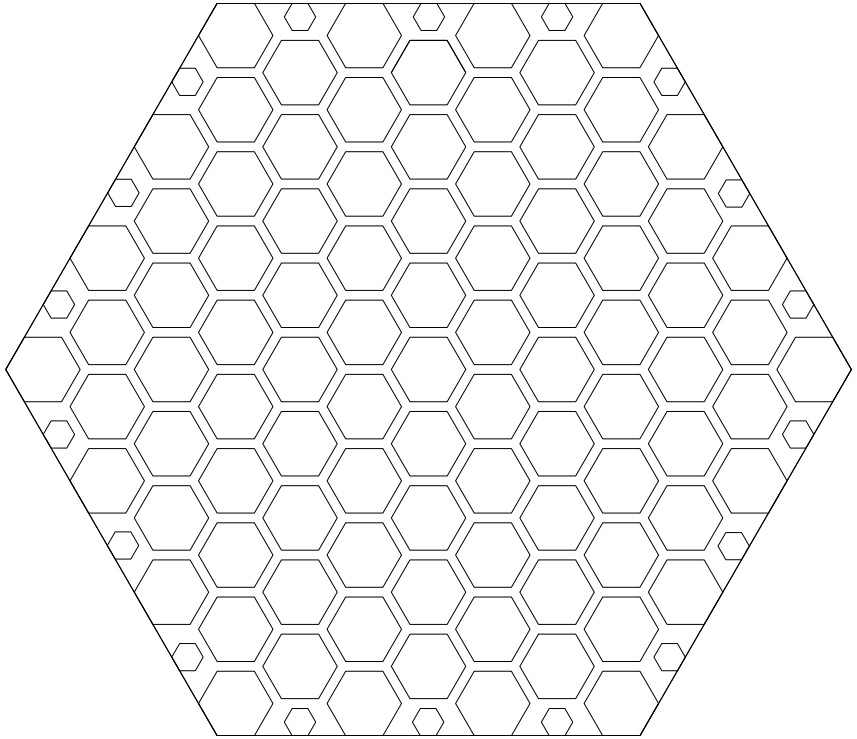

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BinaryTree1.pdf

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Figure: Caption Text

BinaryTree2.pdf

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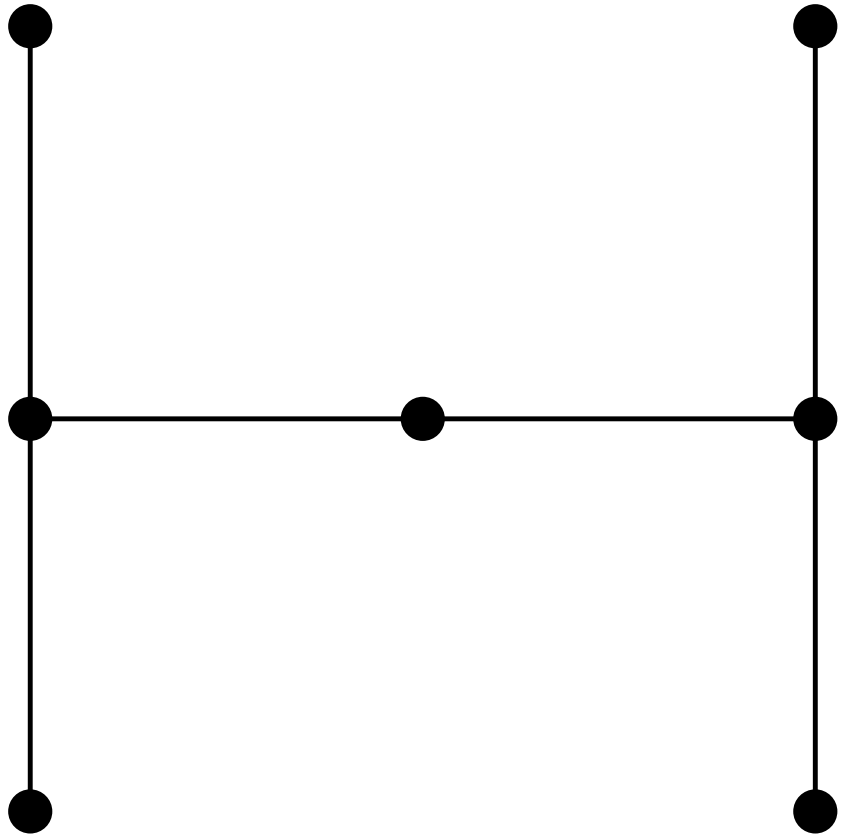

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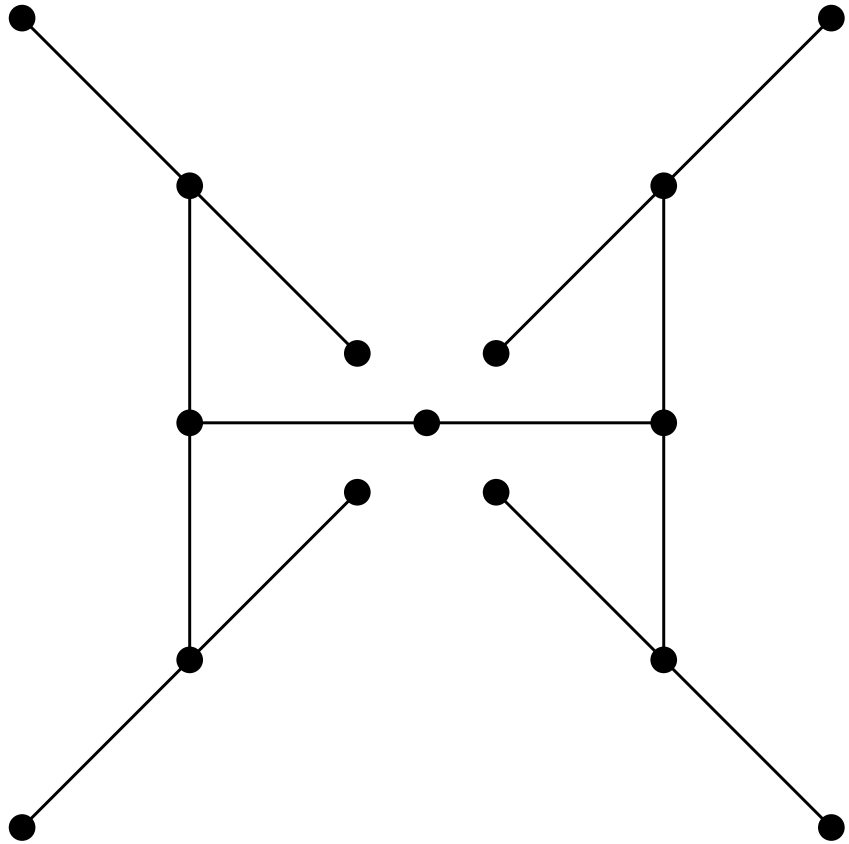

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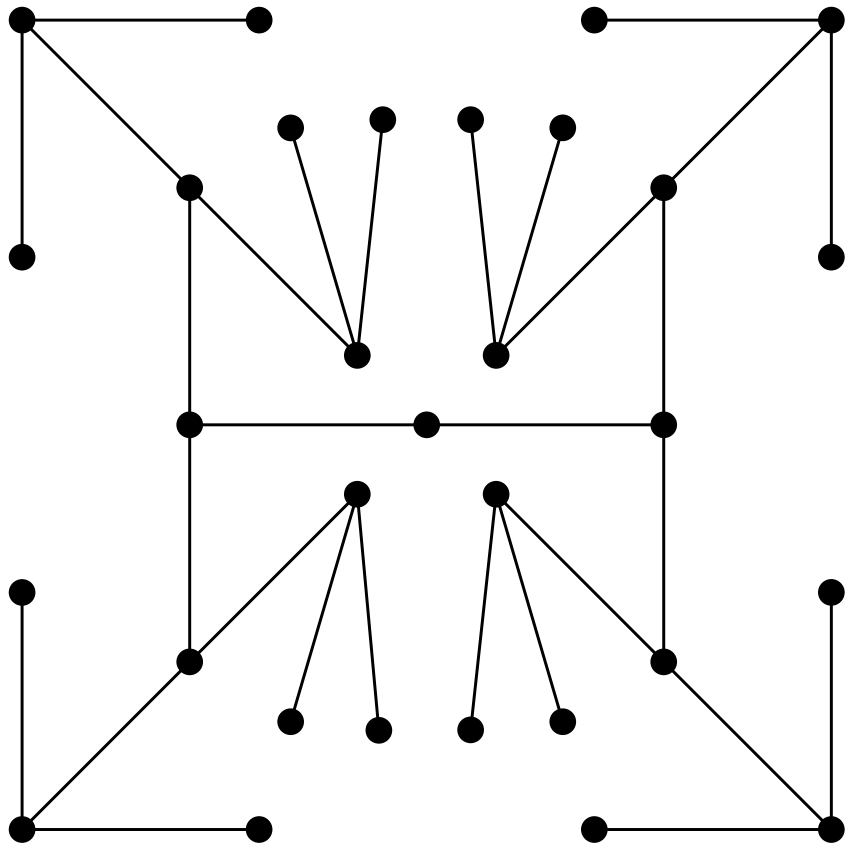

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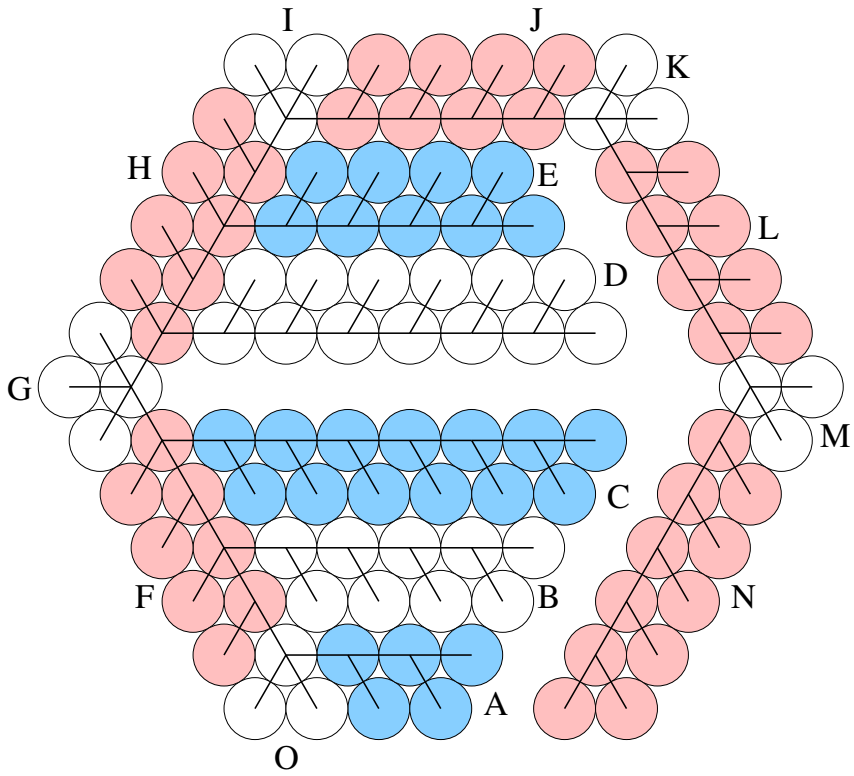

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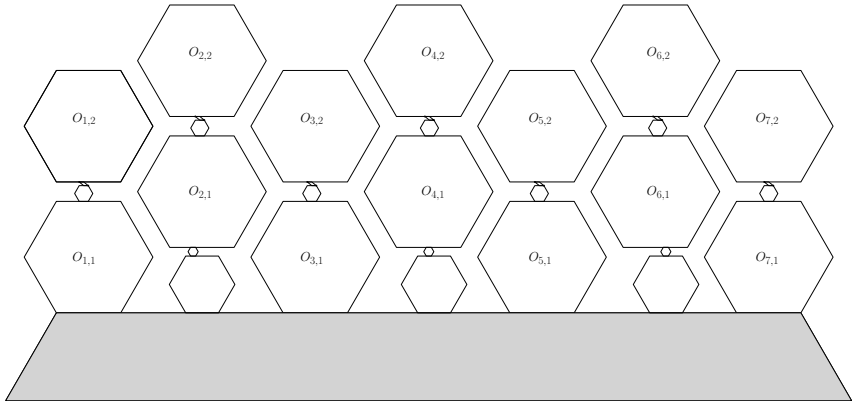

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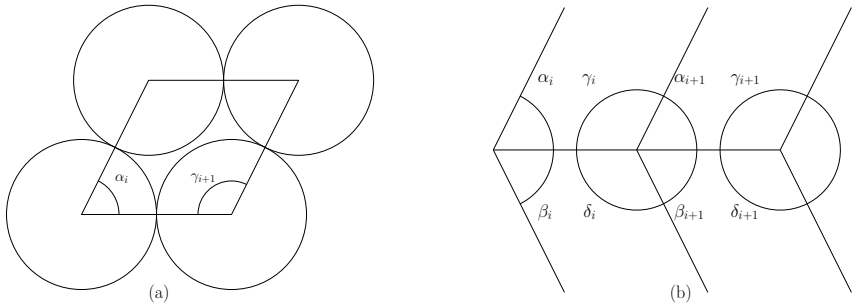

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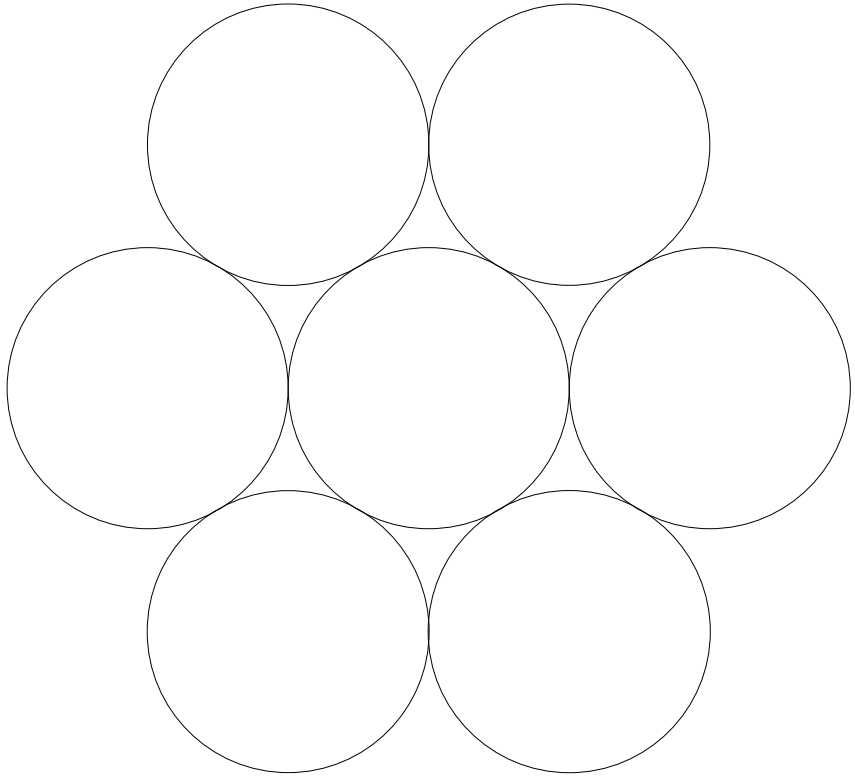

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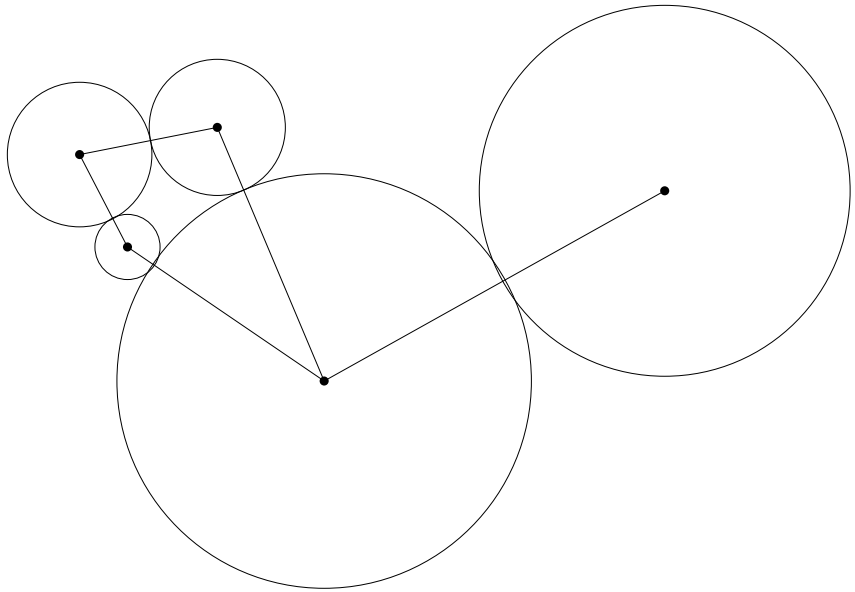

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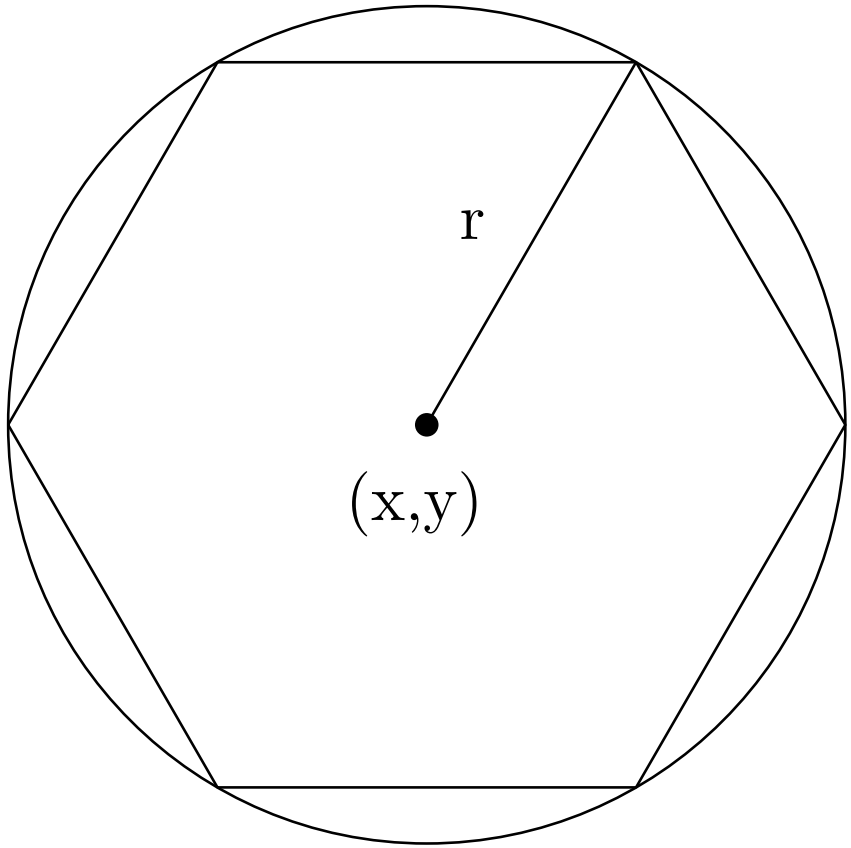

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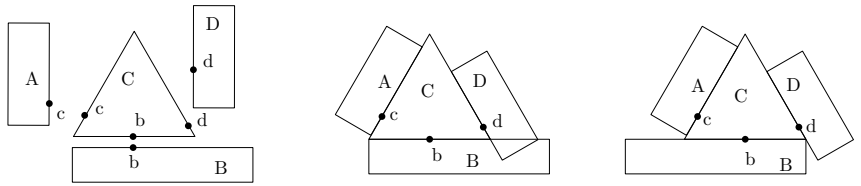

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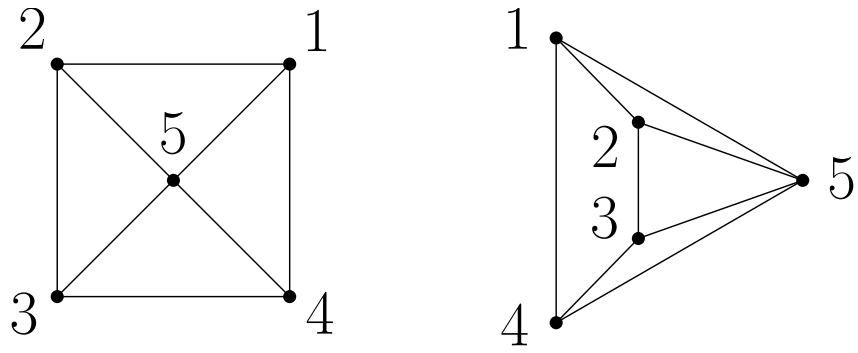

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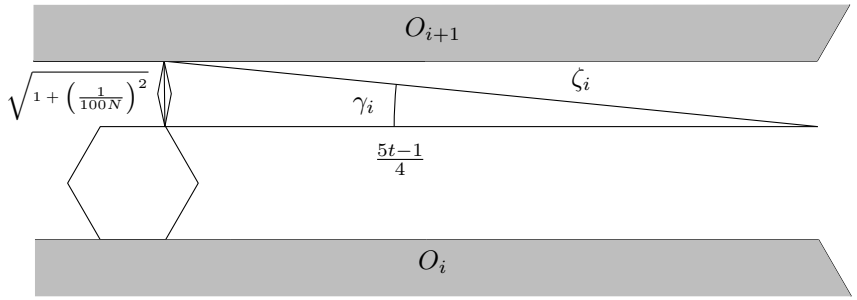

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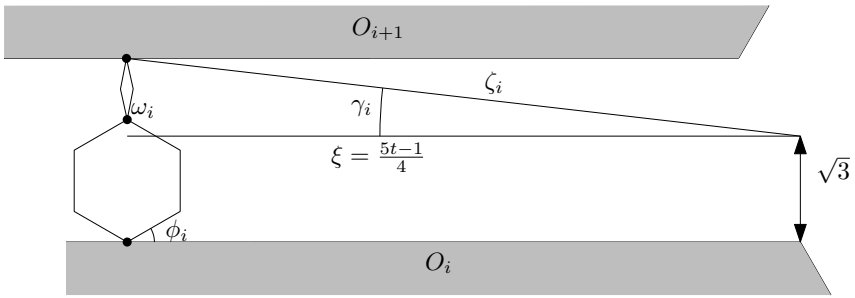

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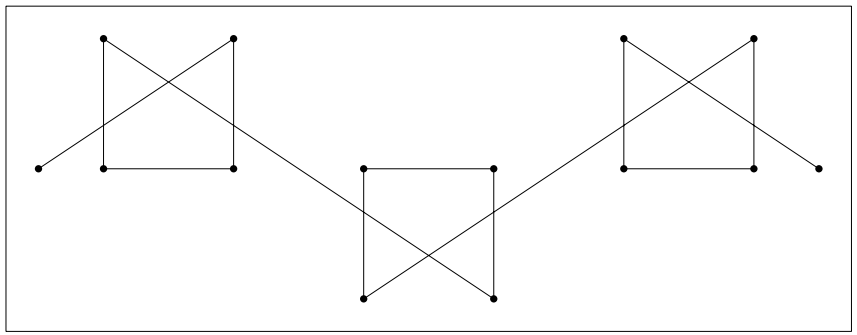

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crossingType2.pdf

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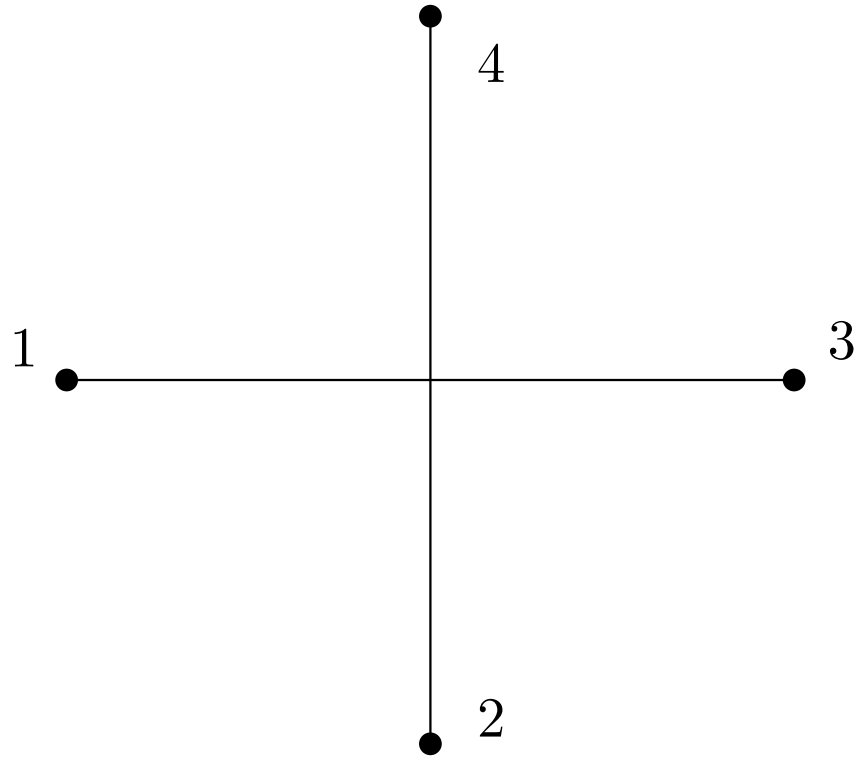

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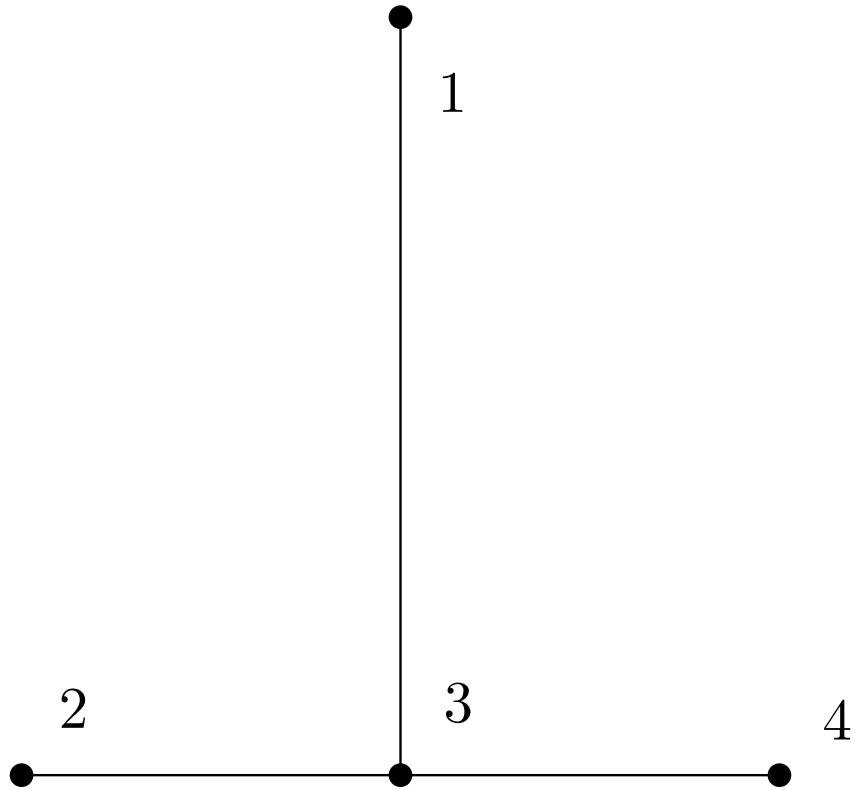

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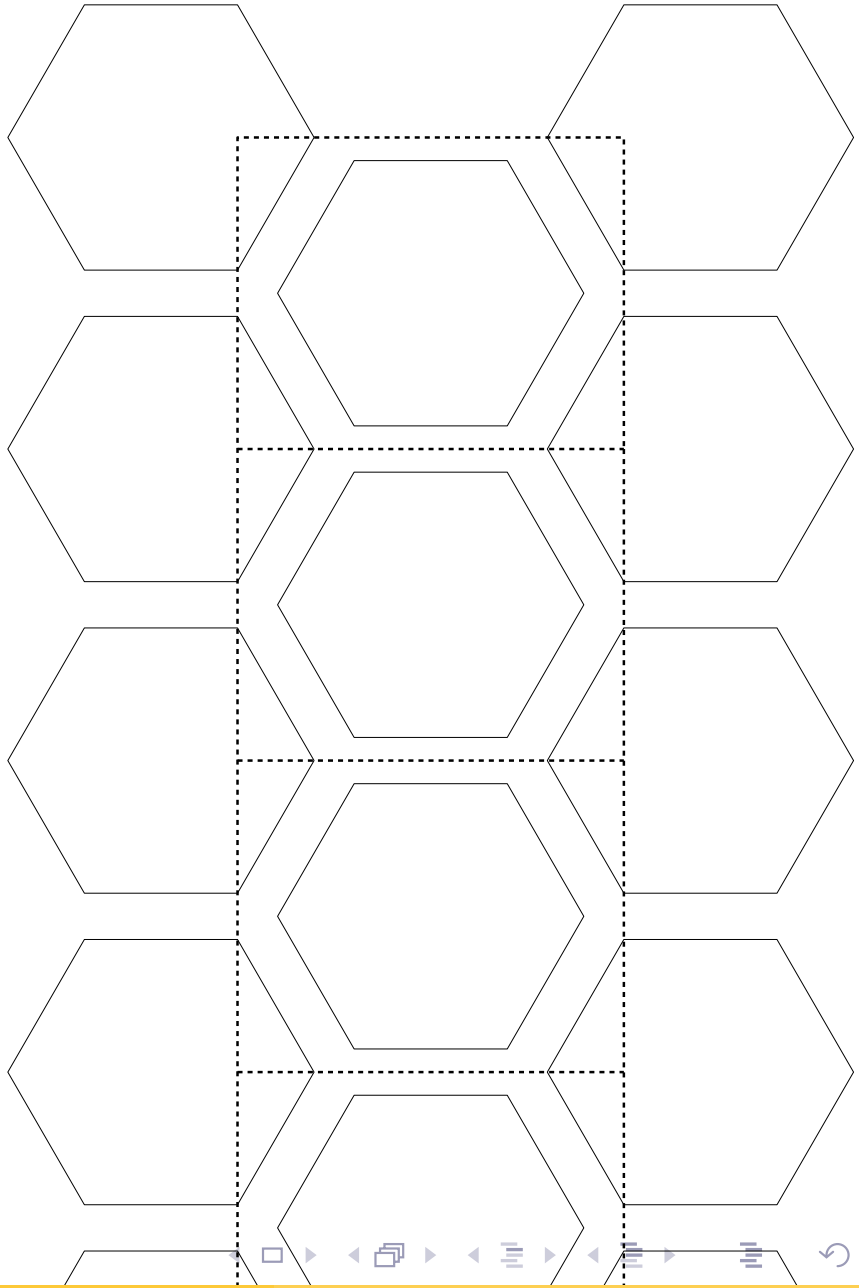

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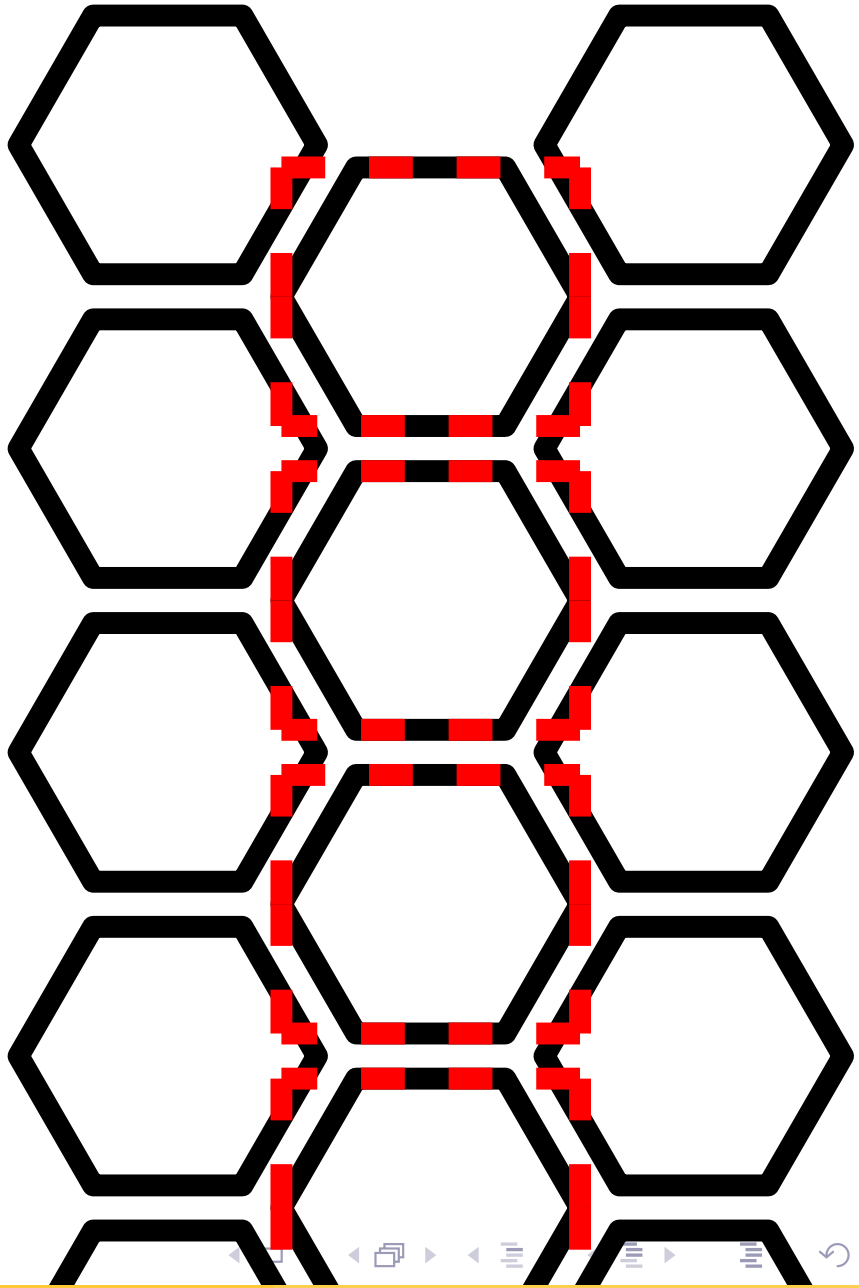

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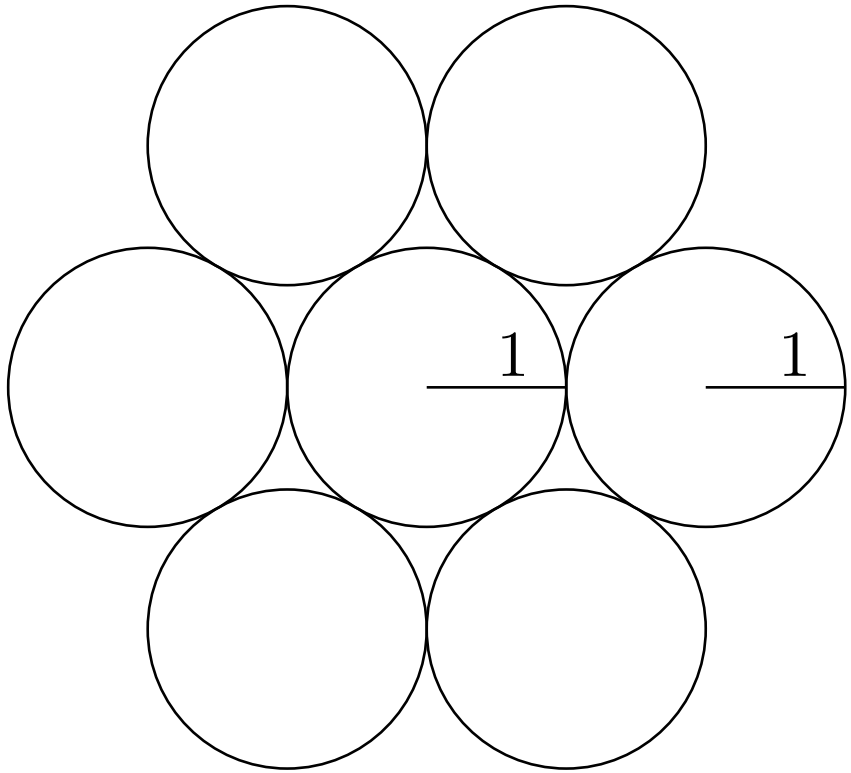

Figure: Caption Text

degree2arrangement.pdf

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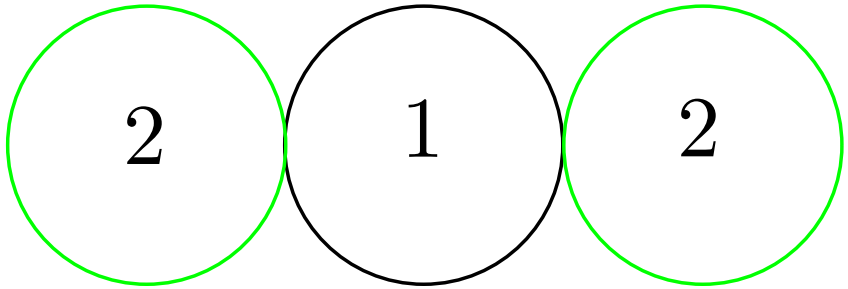

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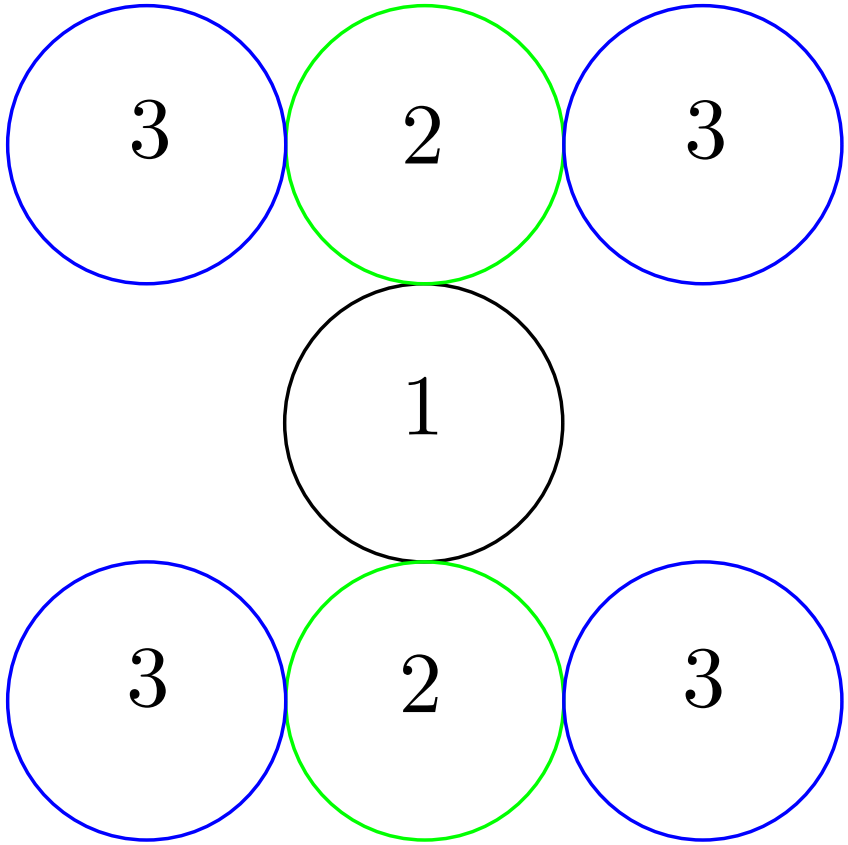

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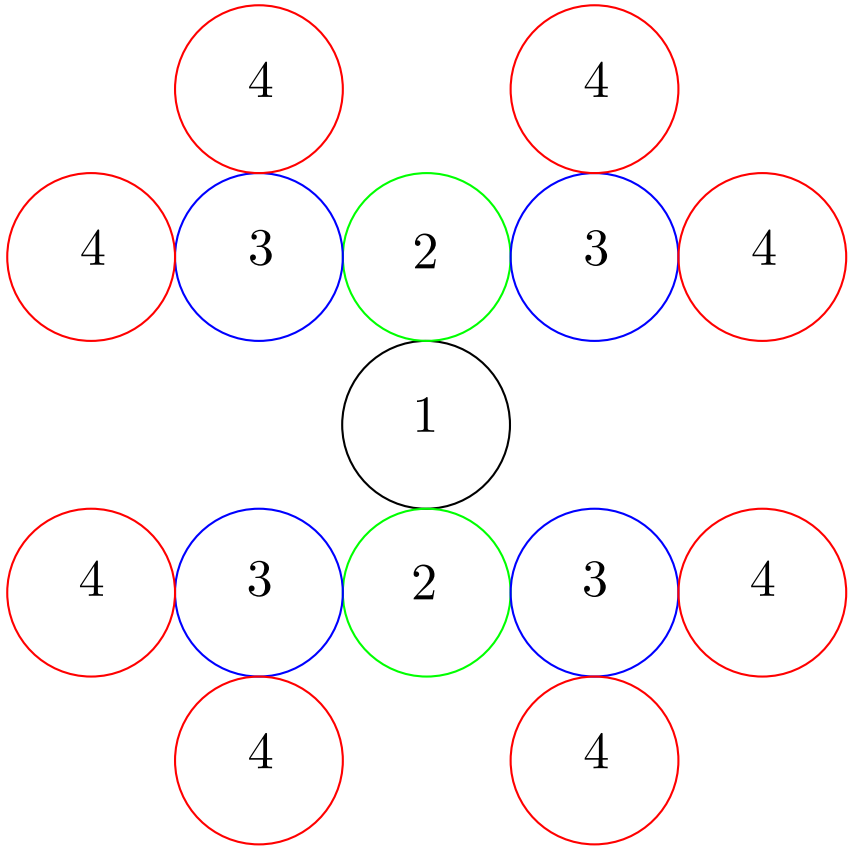

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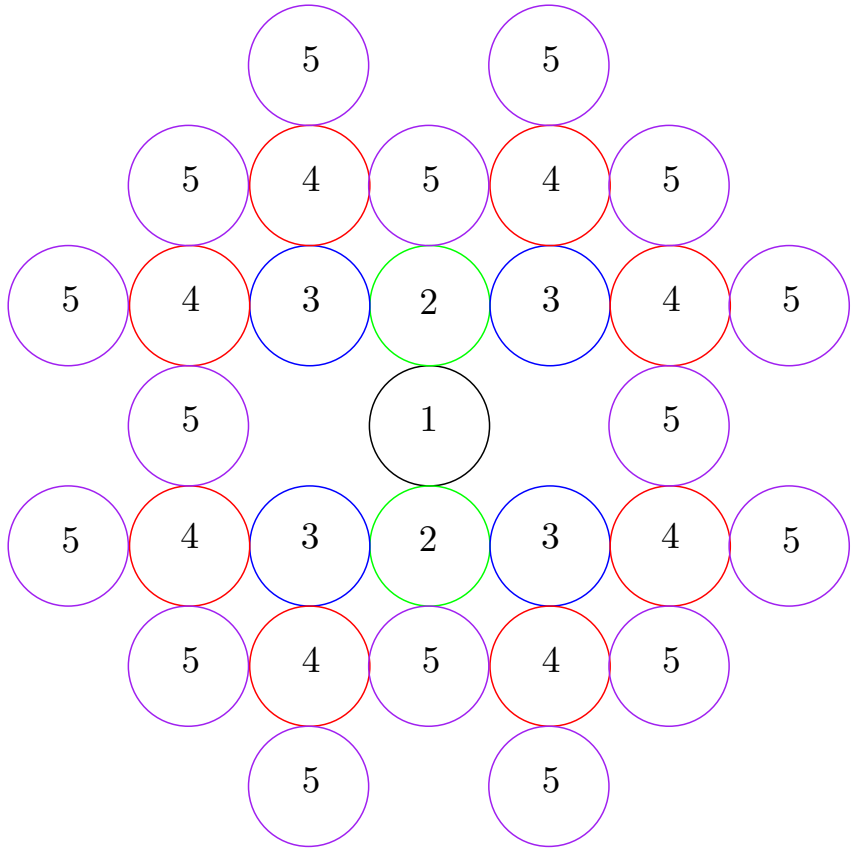

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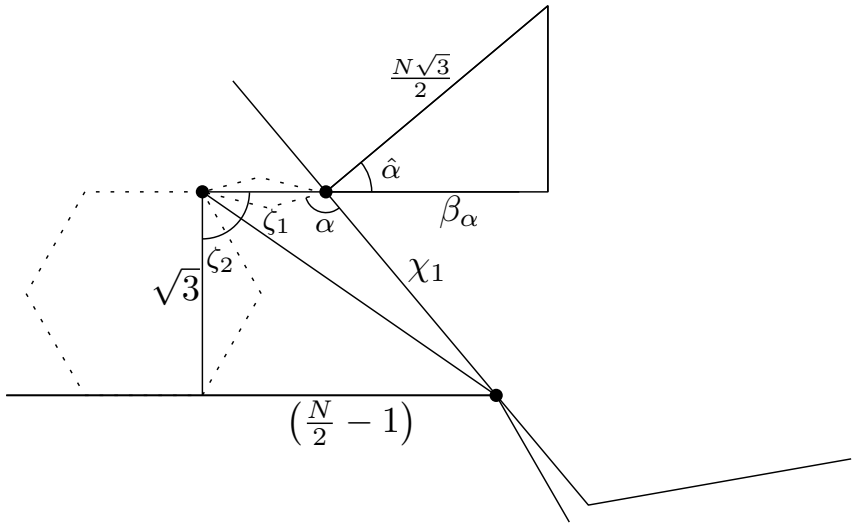

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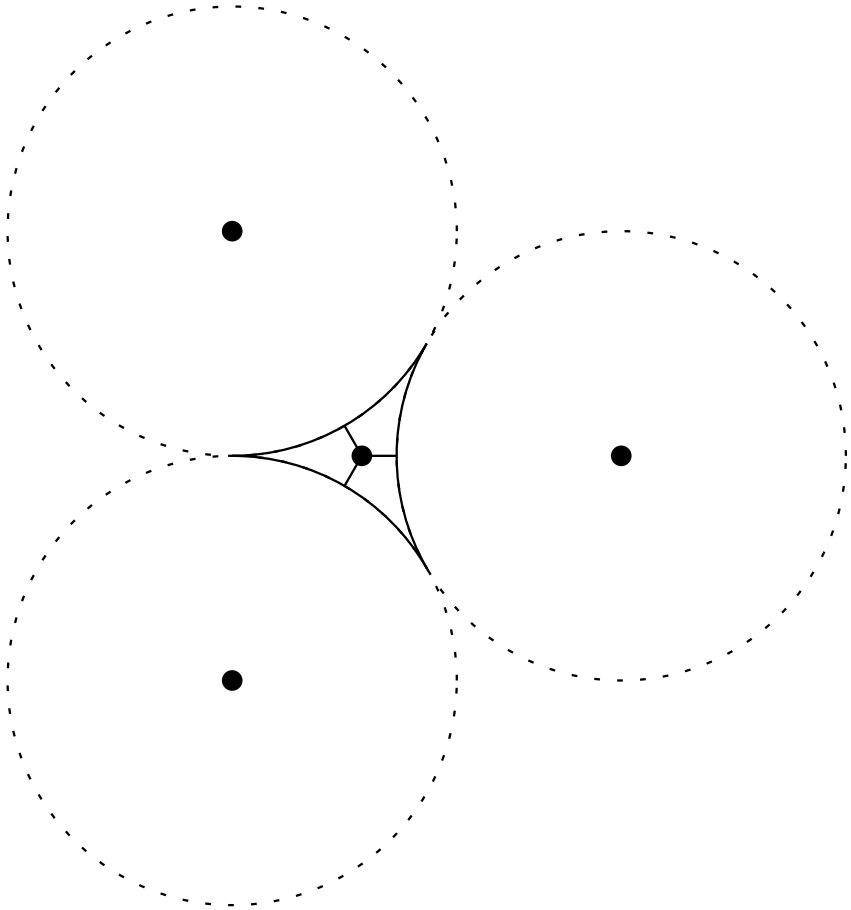

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DiskPackingReconfiguration.pdf

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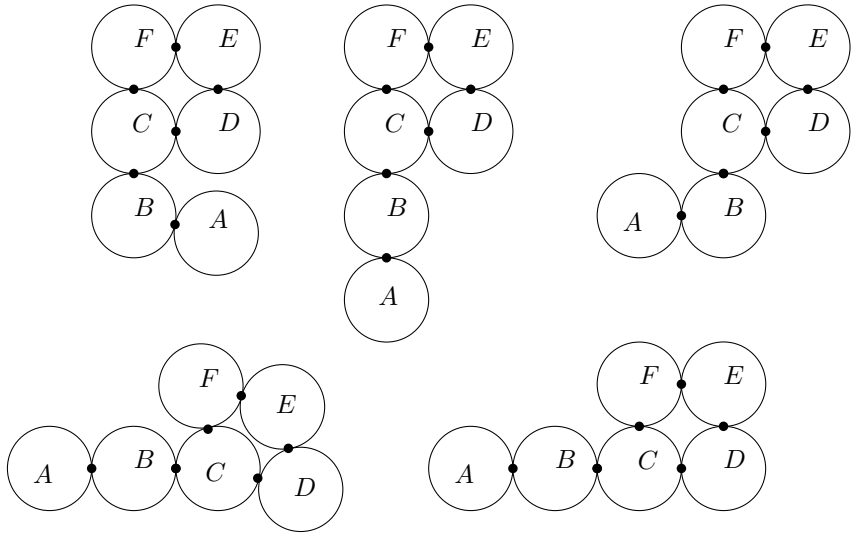

Figure: Caption Text

diskPackingTheoremExample.pdf

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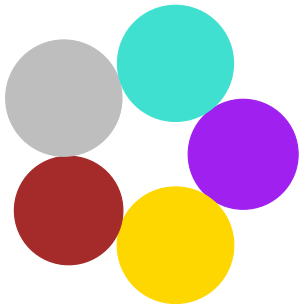

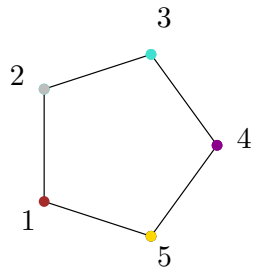

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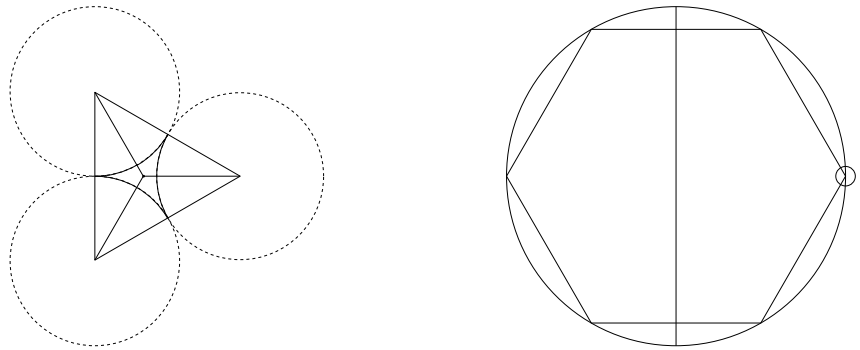

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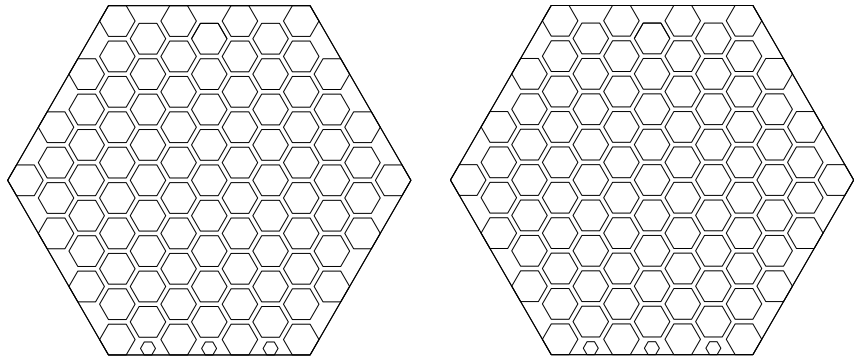

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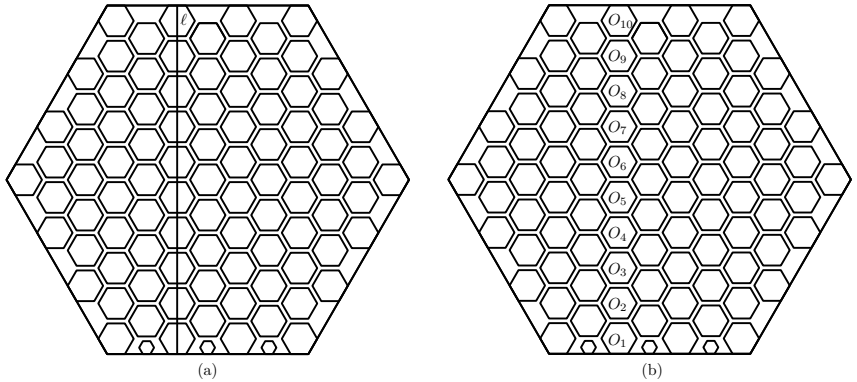

Figure: Caption Text

epsilonCenter.pdf

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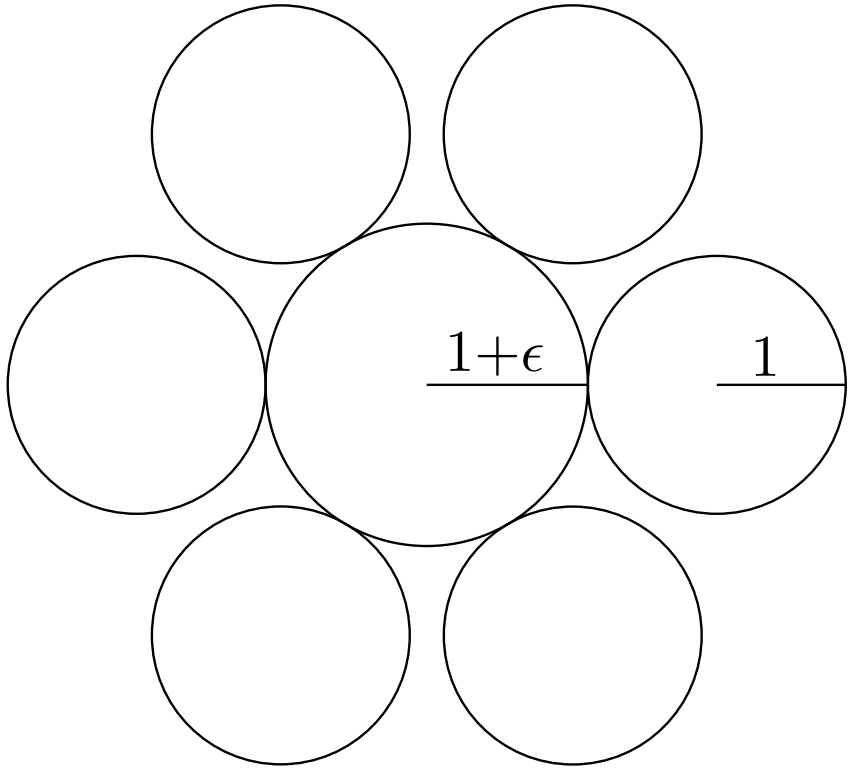

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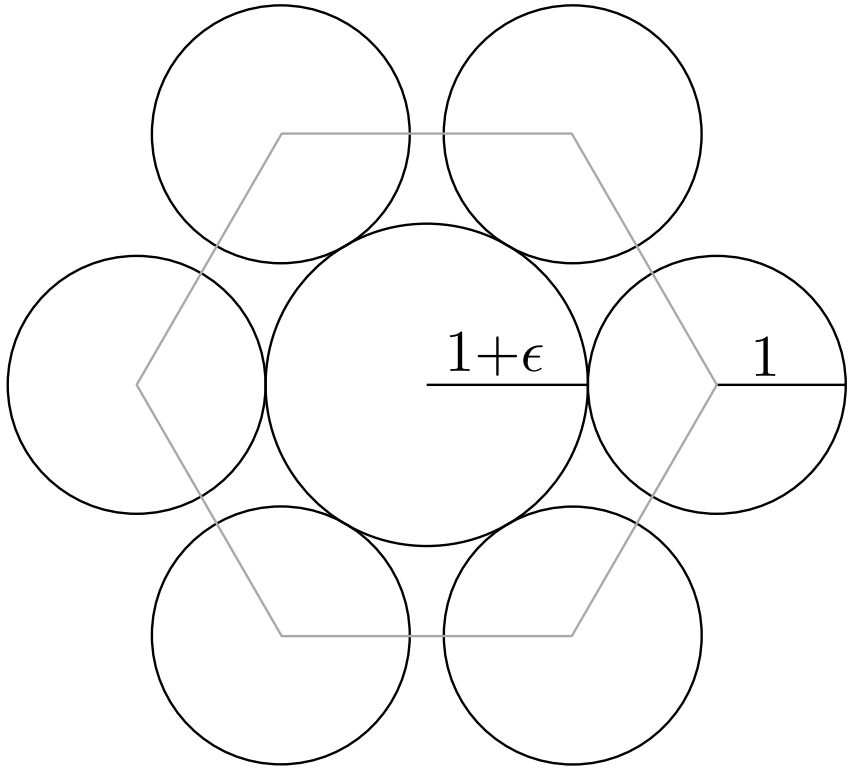

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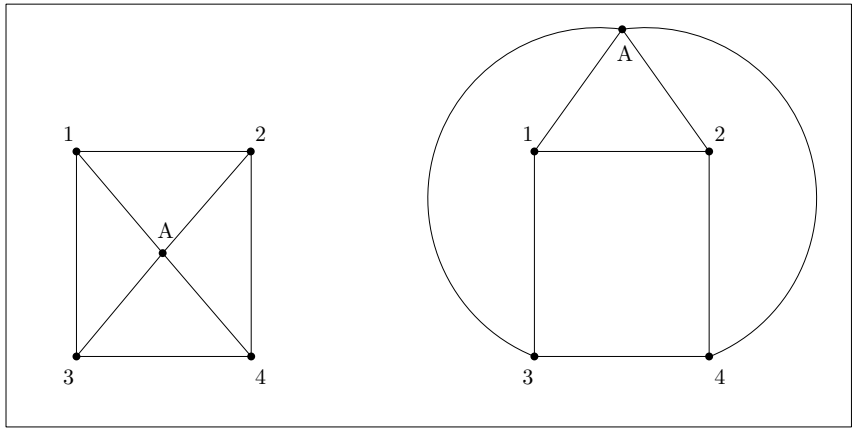

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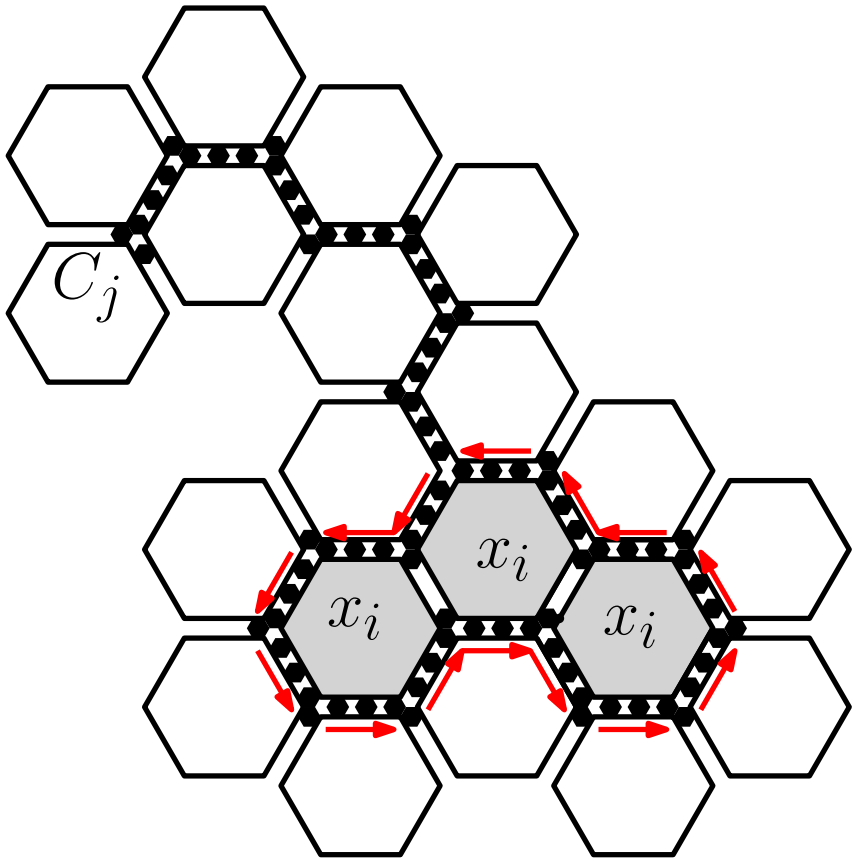

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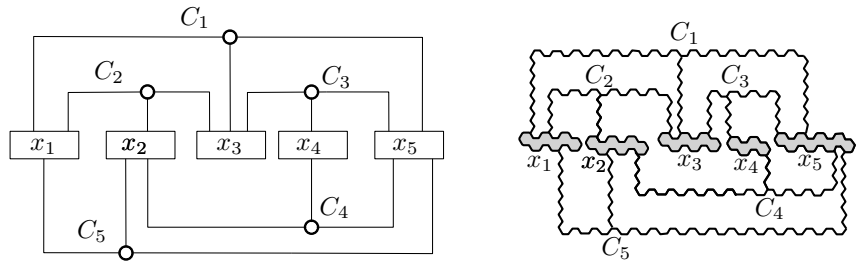

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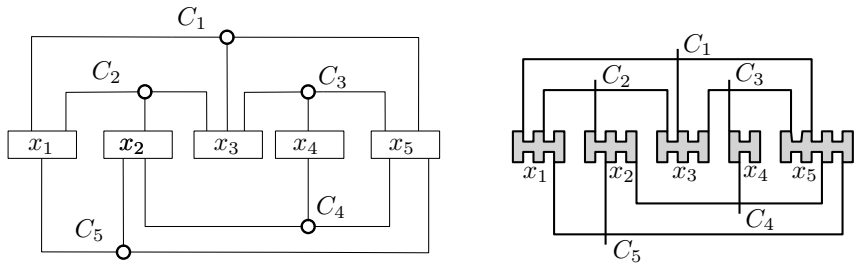

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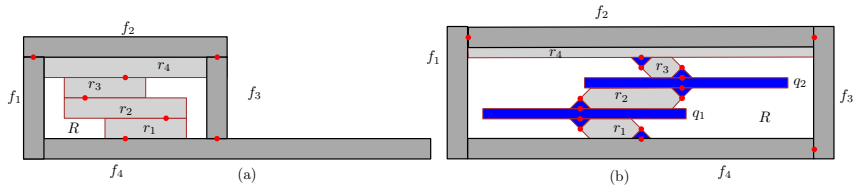

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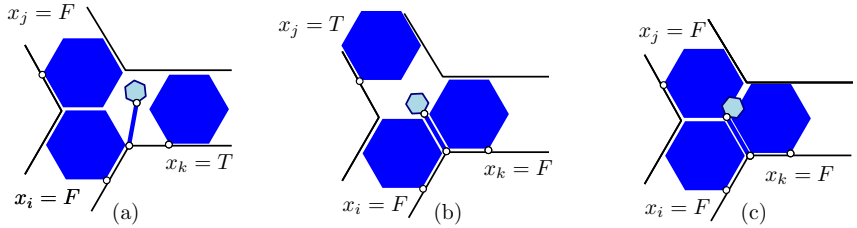

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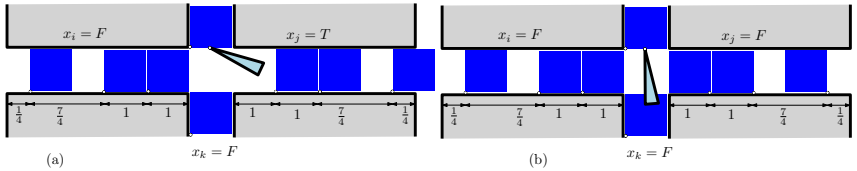

Figure: Caption Text

fig-frame-hex.pdf

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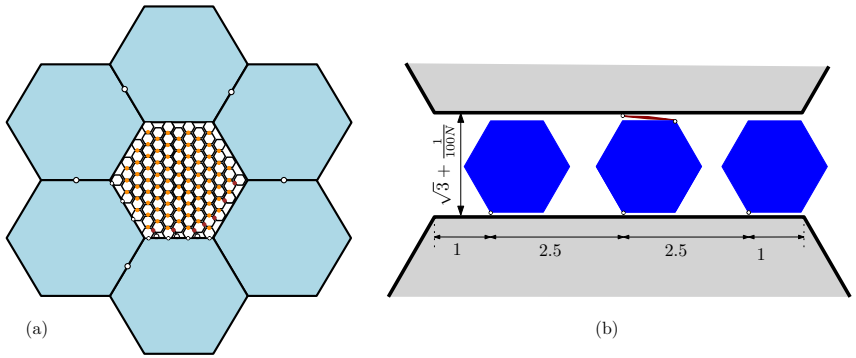

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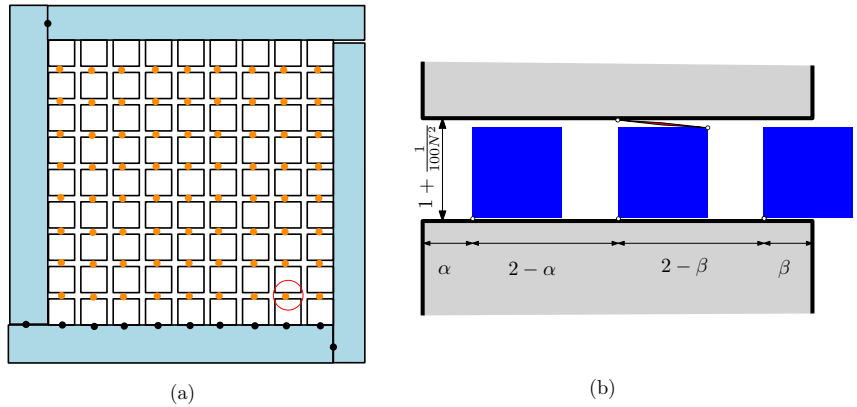

Figure: Caption Text

fig-hexagon.pdf

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* item 2

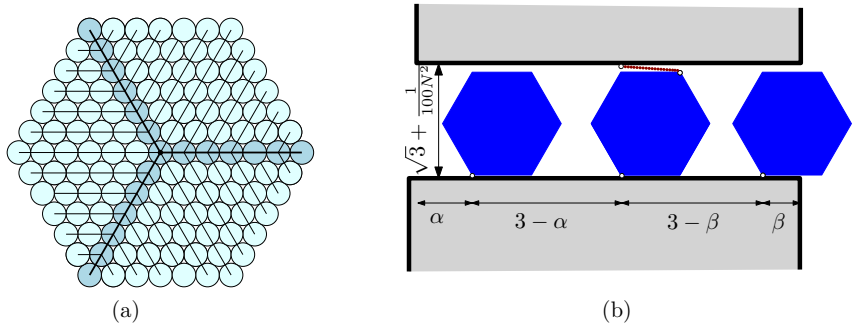

Figure: Caption Text

fig-logic.pdf

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* item 2

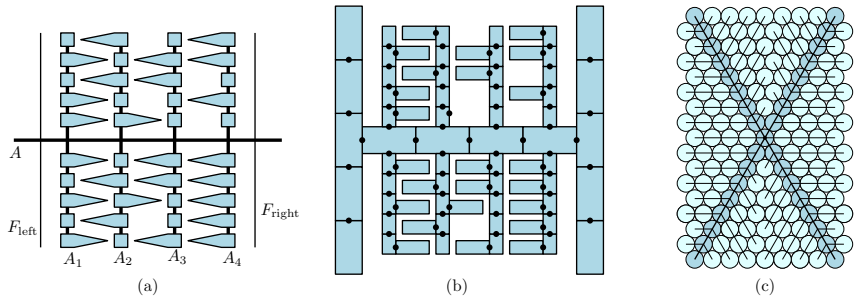

Figure: Caption Text

fig-transmitter-hex copy.pdf

* item 1
* item 2

copy.pdf

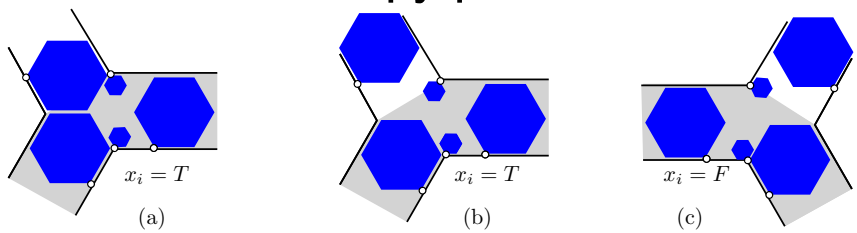

Figure: Caption Text

fig-transmitter-hex.pdf

* item 1
* item 2

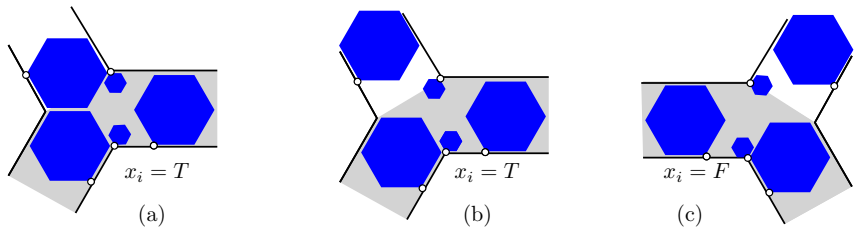

Figure: Caption Text

fig-transmitter.pdf

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* item 2

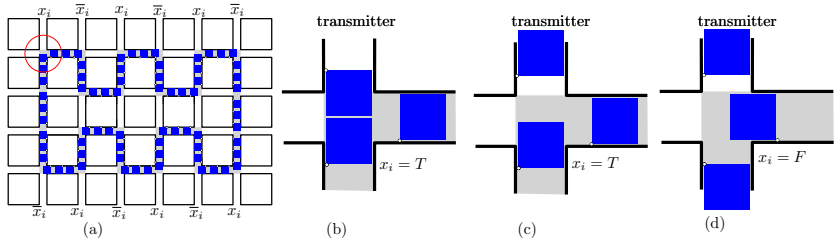

Figure: Caption Text

fig-triangles.pdf

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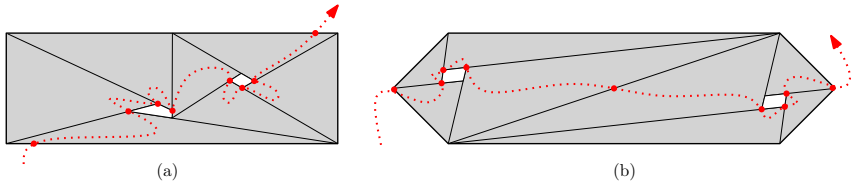


Figure: Caption Text

fig-ushape.pdf

* item 1
* item 2

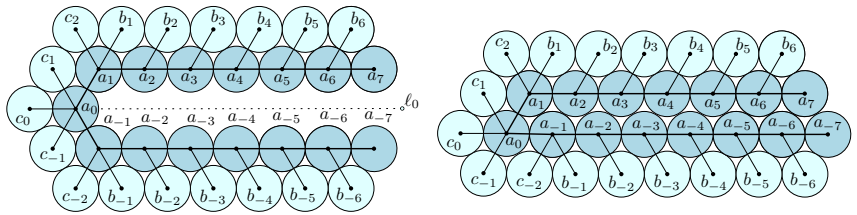


Figure: Caption Text

fig-variable-hex+.pdf

* item 1
* item 2

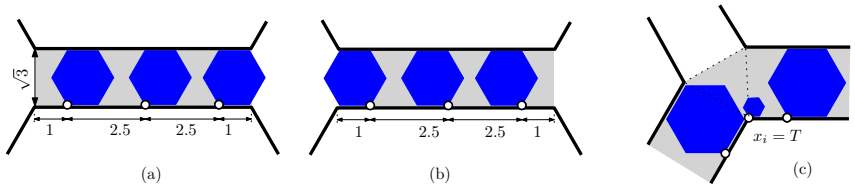


Figure: Caption Text

fig-variable.pdf

* item 1
* item 2

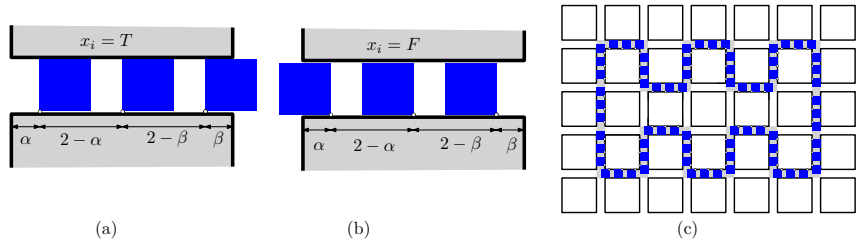


Figure: Caption Text

fig1+.pdf

* item 1
* item 2

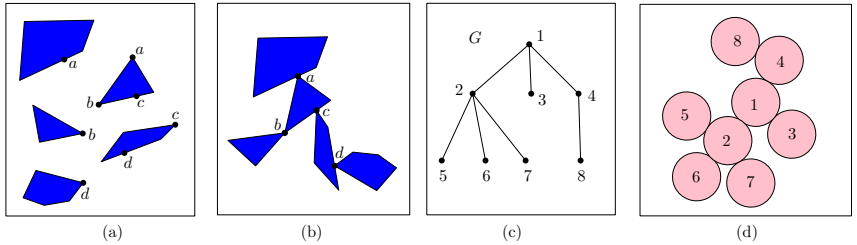


Figure: Caption Text

fig1.pdf

* item 1
* item 2

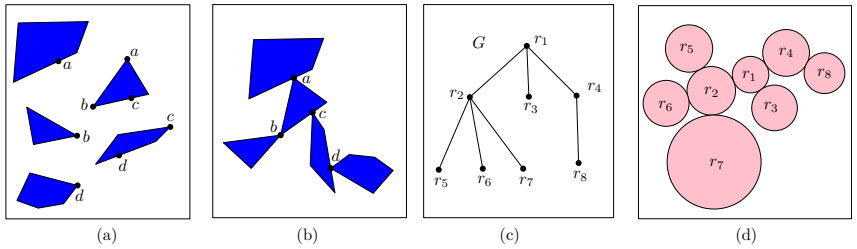


Figure: Caption Text

FlagWithRhombus.pdf

* item 1
* item 2

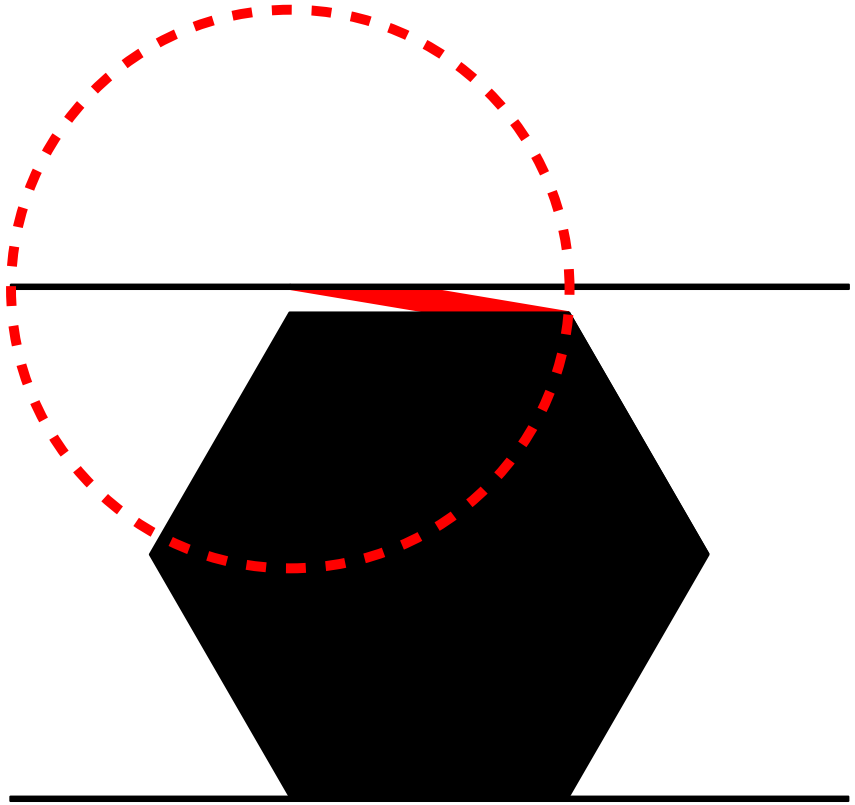


Figure: Caption Text

FlexibleHexagons.pdf

* item 1
* item 2

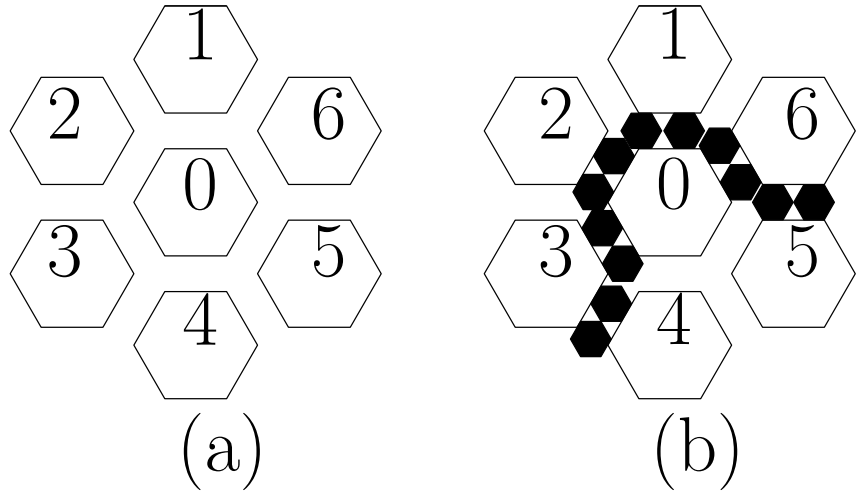
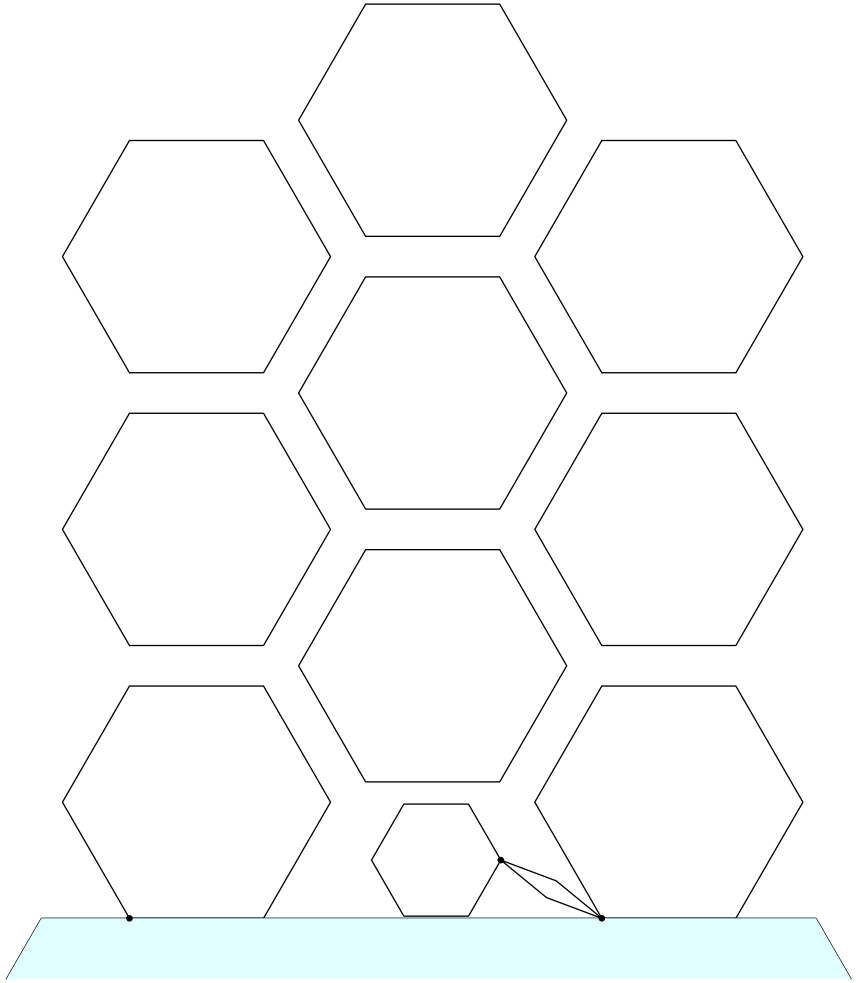


Figure: Caption Text

FrameObstacleHexagonCloseUp.pdf



freeJointPinnedJoint.pdf

* item 1
* item 2

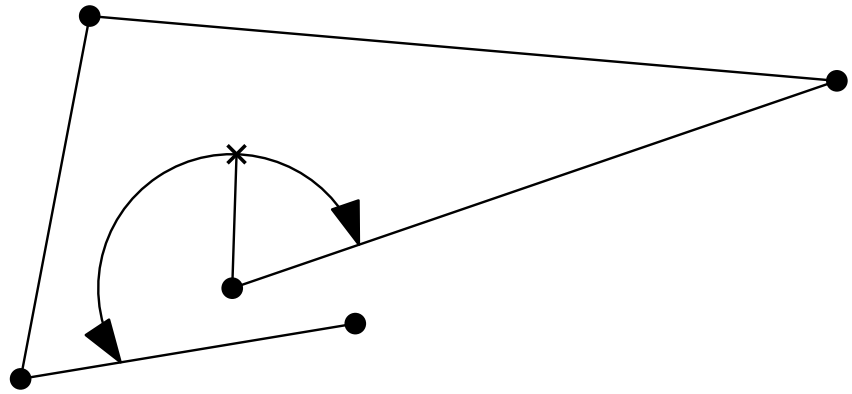


Figure: Caption Text

GeometricDissectionBusschop.pdf

* item 1
* item 2

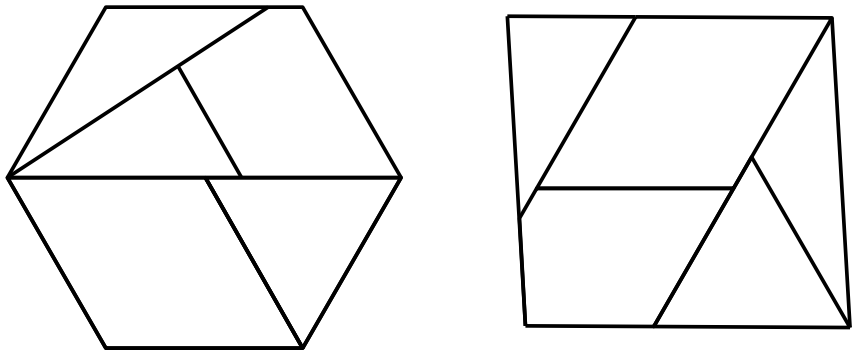
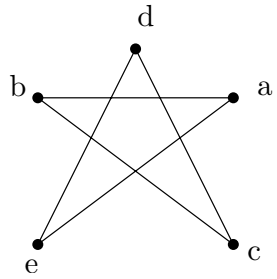


Figure: Caption Text

graphIsomorphismExample.pdf

* item 1
* item 2



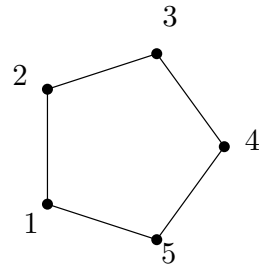


Figure: Caption Text

HaberdasherProblem.pdf

* item 1
* item 2

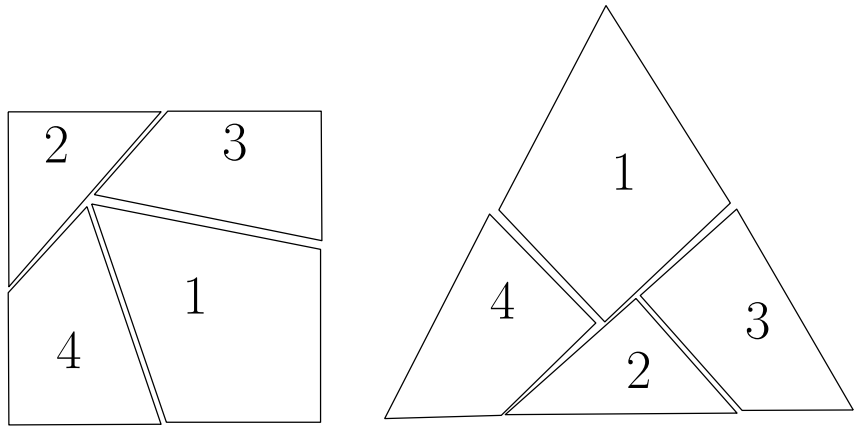


Figure: Caption Text

HalfSizeHexagon.pdf

* item 1
* item 2

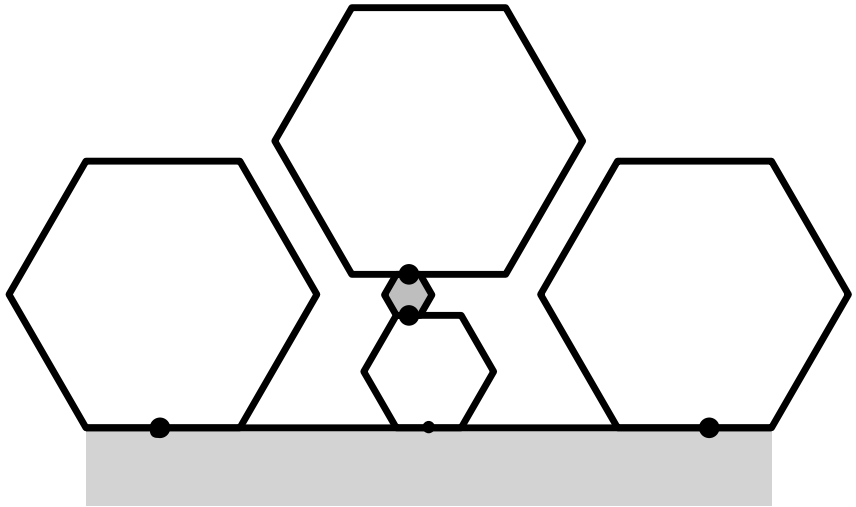


Figure: Caption Text

HausdorffDistanceExample1.pdf

* item 1
* item 2

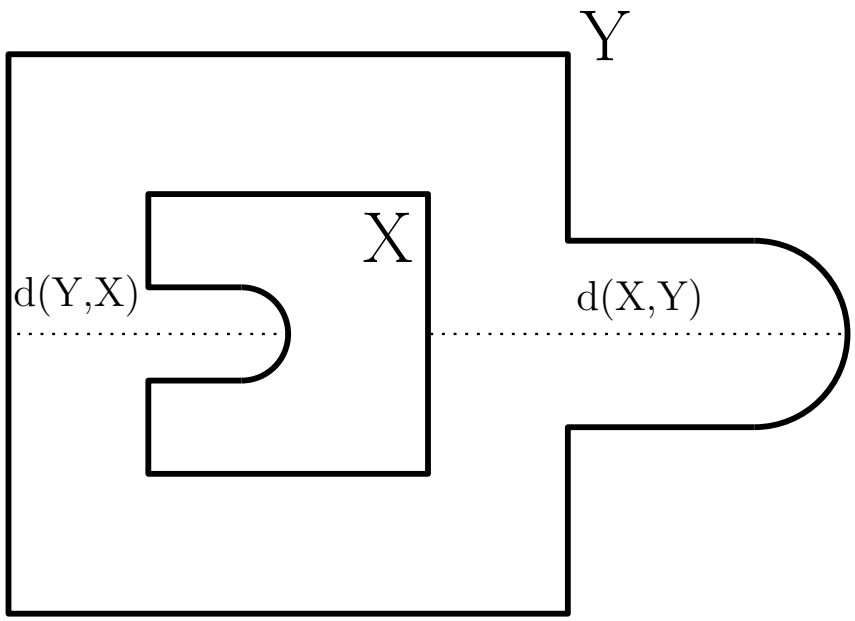


Figure: Caption Text

HausdorffDistanceExample1Small.pdf

* item 1
* item 2

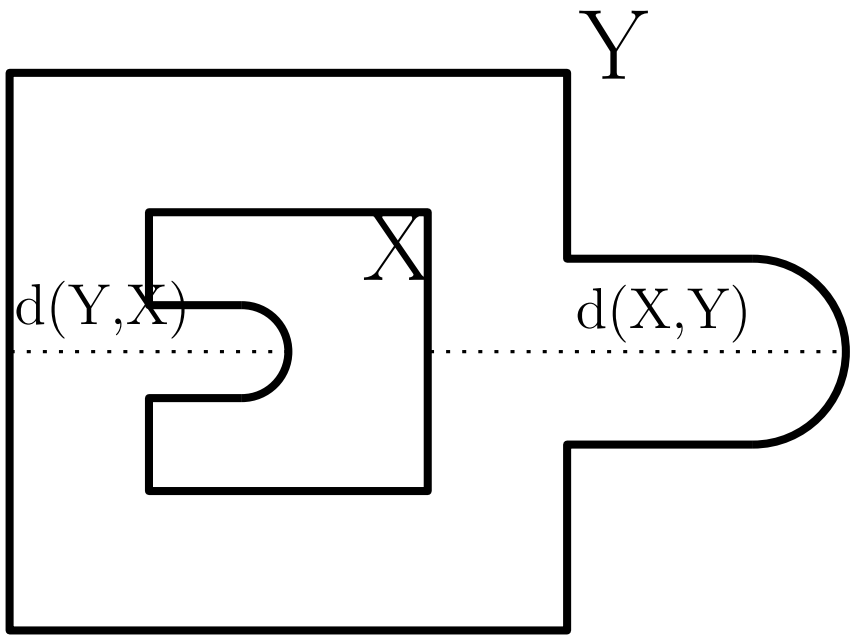


Figure: Caption Text

hexagonalConstructionOfJSmall.pdf

* item 1
* item 2

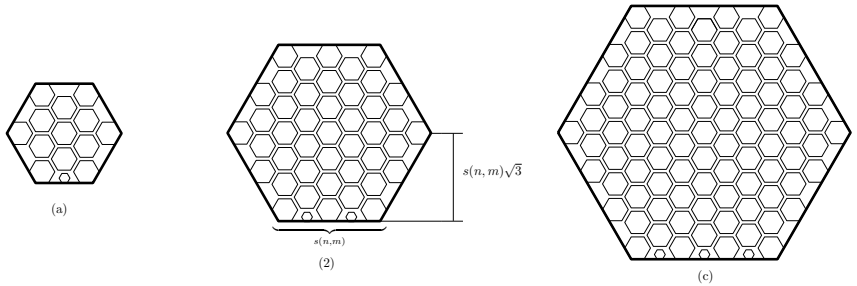


Figure: Caption Text

hexagonalConstructionOfJSmallWithoutHalfHexagons.pdf

* item 1
* item 2

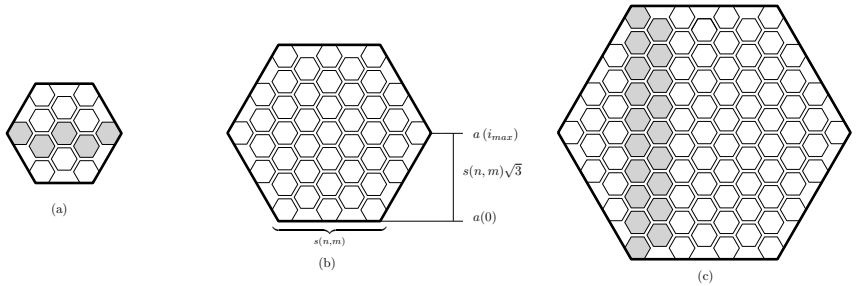


Figure: Caption Text

HexagonalGridRho.pdf

* item 1
* item 2

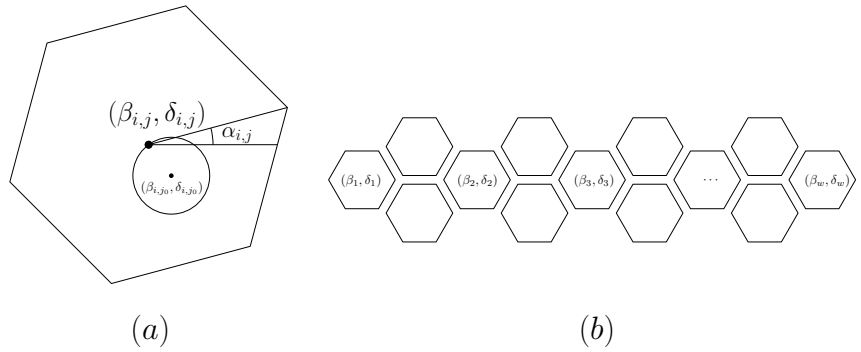


Figure: Caption Text

hexagonInChannel.pdf

* item 1
* item 2

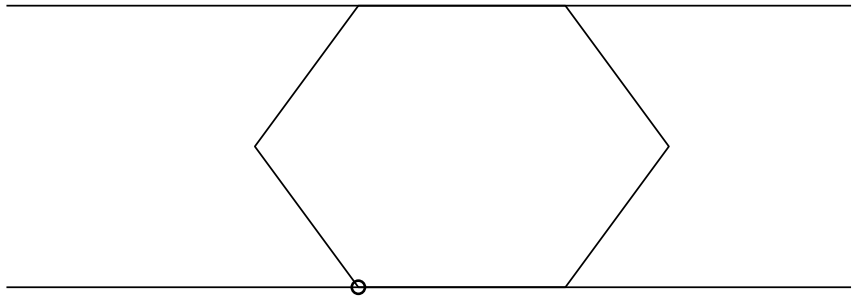


Figure: Caption Text

hexagonInChannelWithPinnedJointLeft.pdf

* item 1
* item 2

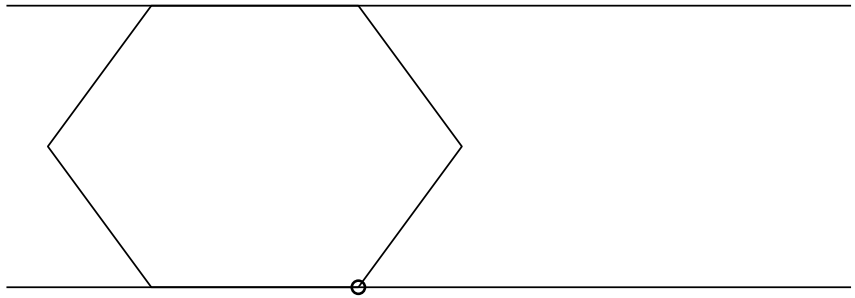


Figure: Caption Text

hexagonInChannelWithPinnedJointRight.pdf

* item 1
* item 2

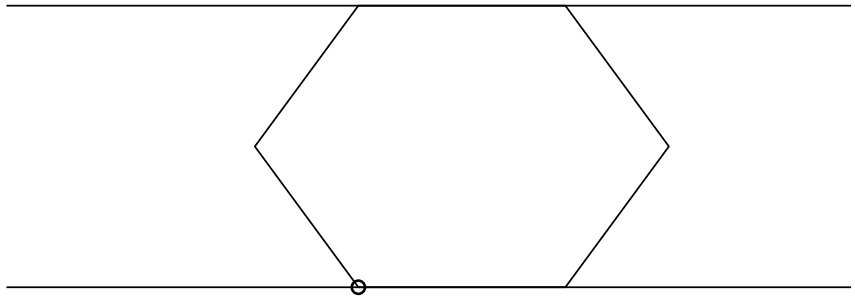


Figure: Caption Text

hexagonNonCanonical.pdf

* item 1
* item 2

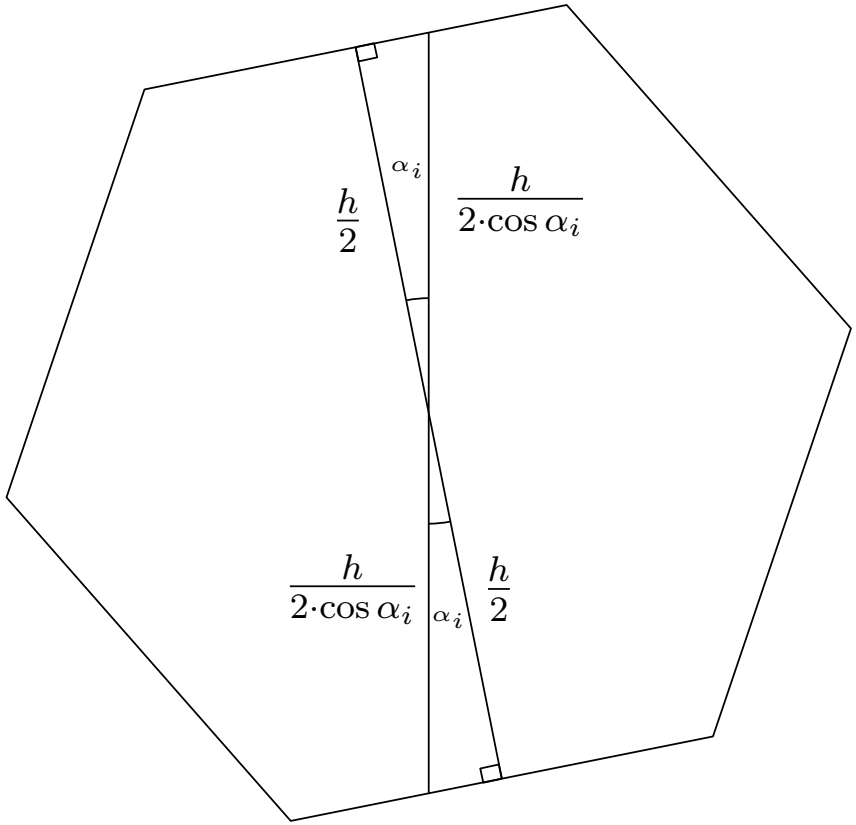


Figure: Caption Text

hexagonNonCanonical2.pdf

* item 1
* item 2

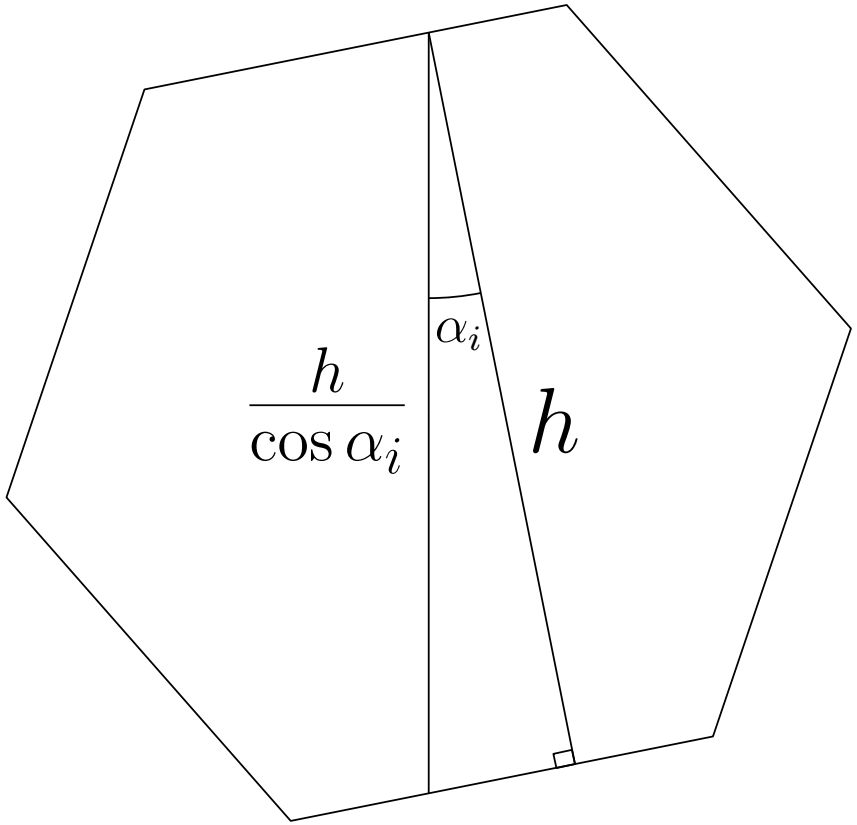


Figure: Caption Text

hexagonNonCanonical3.pdf

* item 1
* item 2

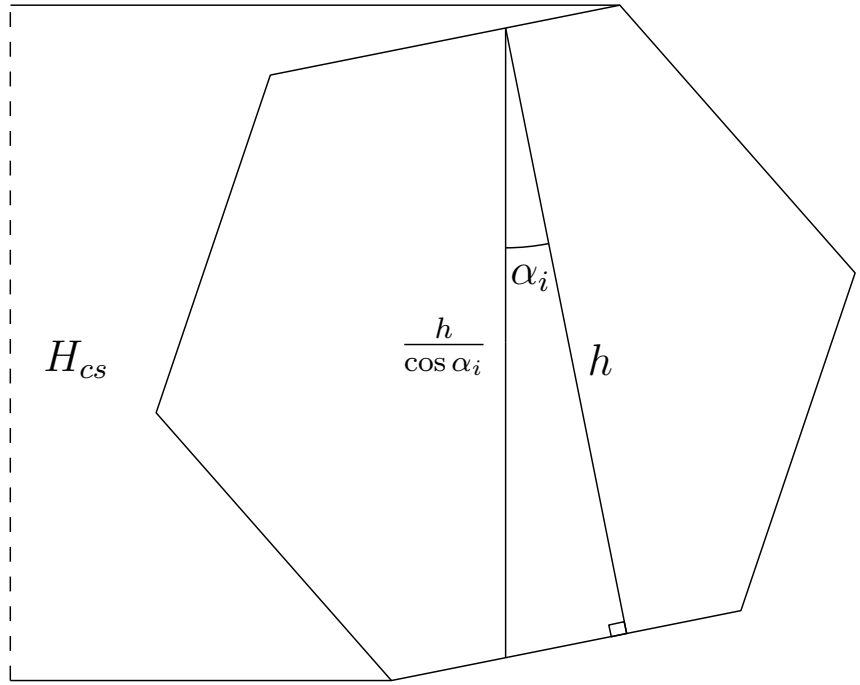


Figure: Caption Text

hexagonNonCanonical4.pdf

* item 1
* item 2

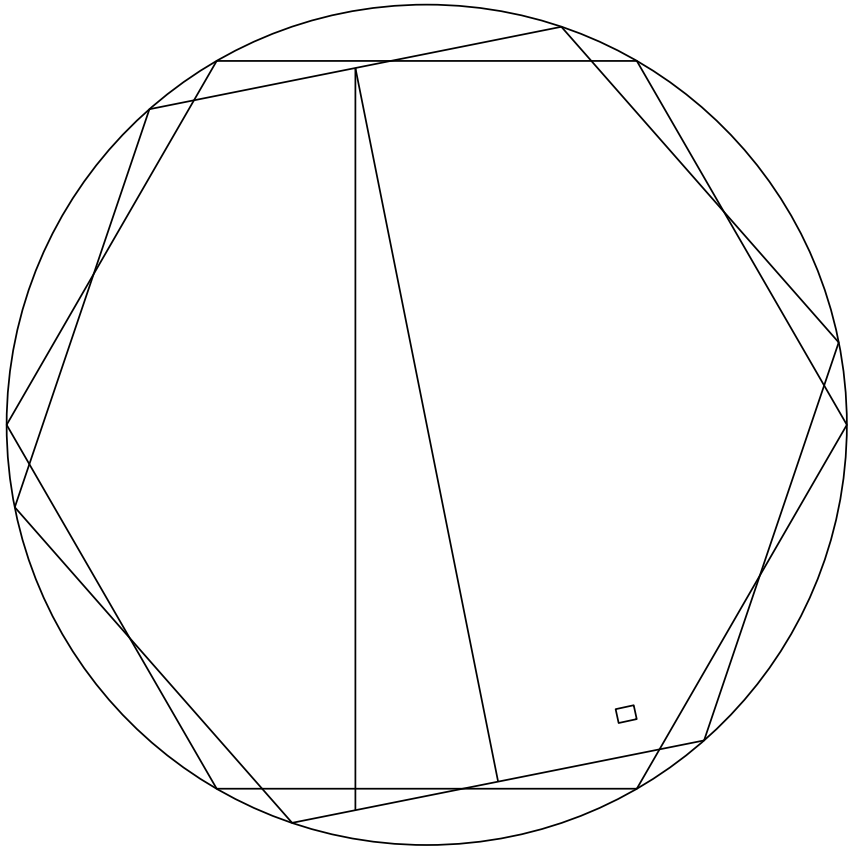


Figure: Caption Text

hexagonOutline5Layer.pdf

* item 1
* item 2

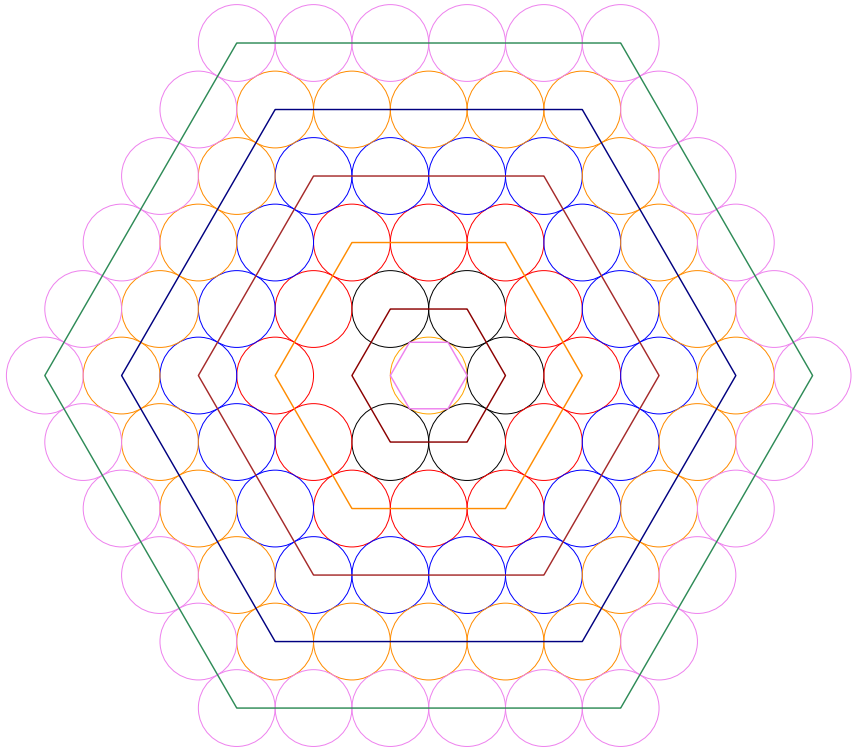


Figure: Caption Text

hexagonOutline5LayerSmall.pdf

* item 1
* item 2

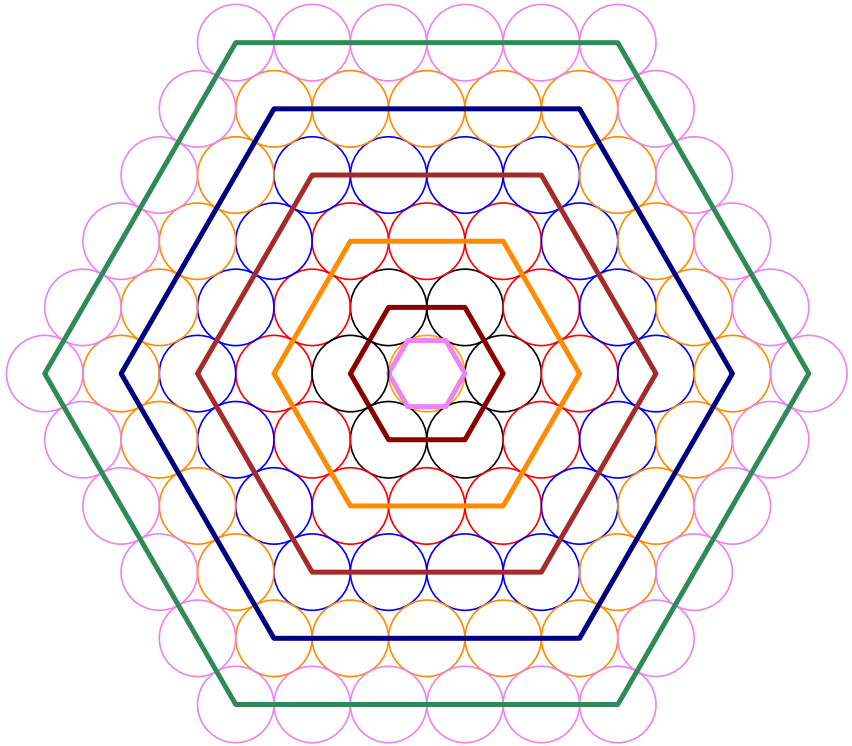


Figure: Caption Text

hexagonOutlineLayerSmall.pdf

* item 1
* item 2

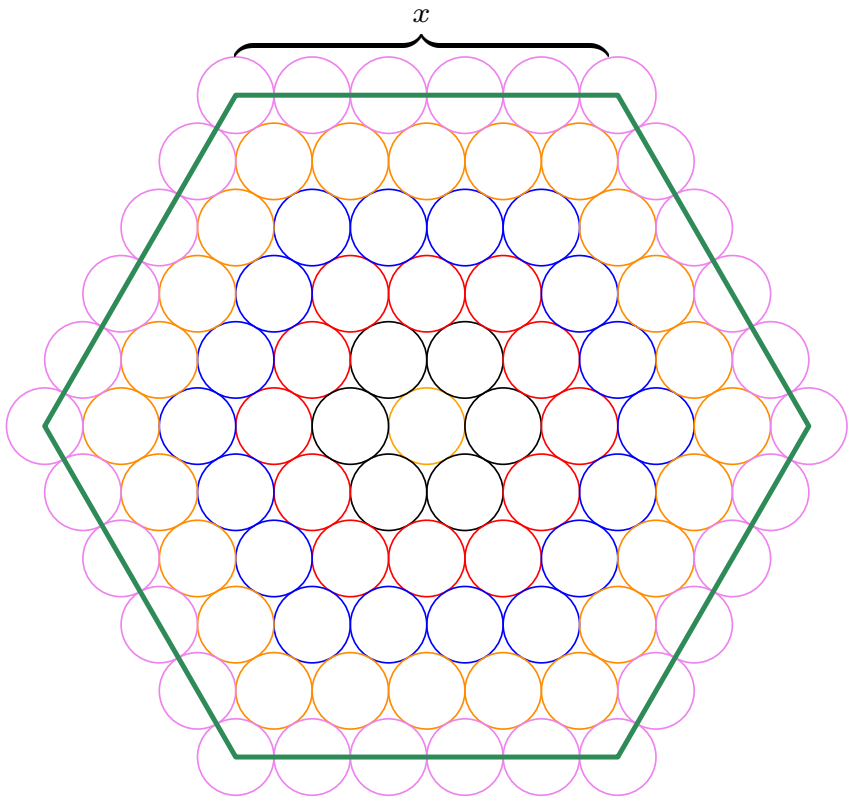


Figure: Caption Text

hexagonPetiolesLeafs9Layers.pdf

* item 1
* item 2

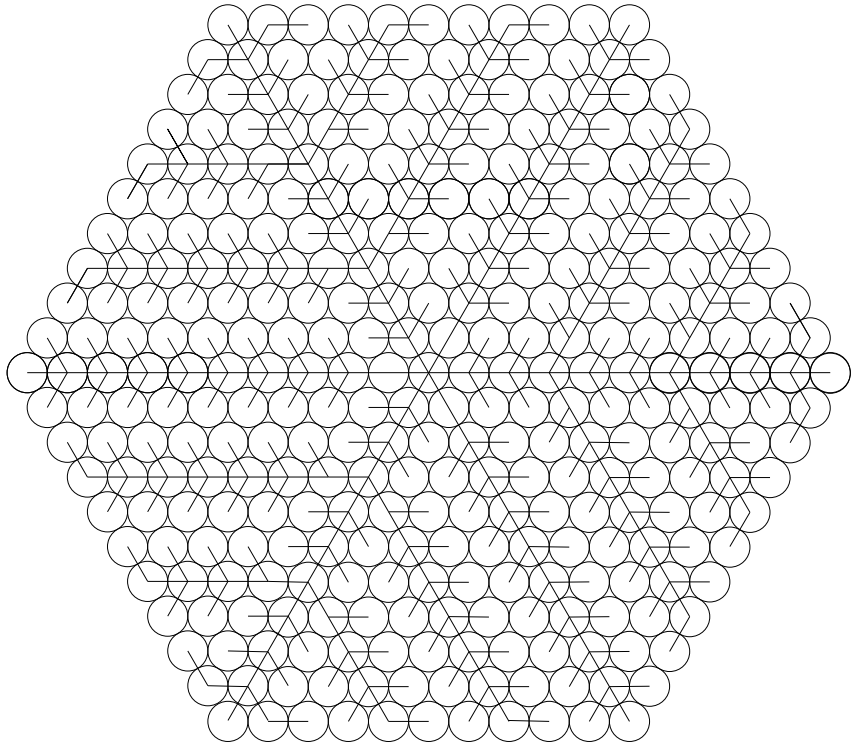


Figure: Caption Text

hexagonPetiolesLeafs9LayersRotatedOutward.pdf

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* item 2

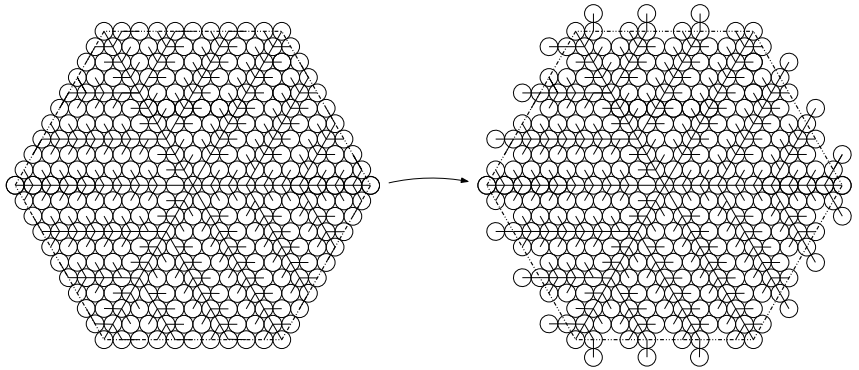


Figure: Caption Text

HingedDissection.pdf

* item 1
* item 2

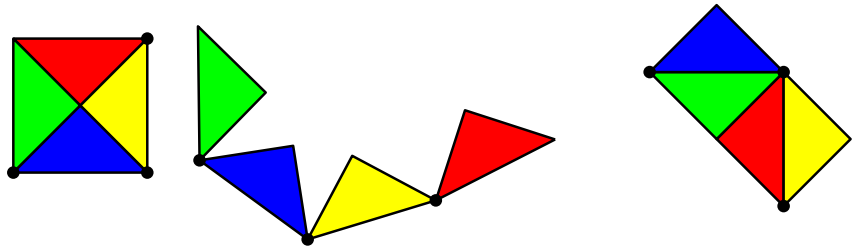


Figure: Caption Text

HingedHaberdasher.pdf

* item 1
* item 2

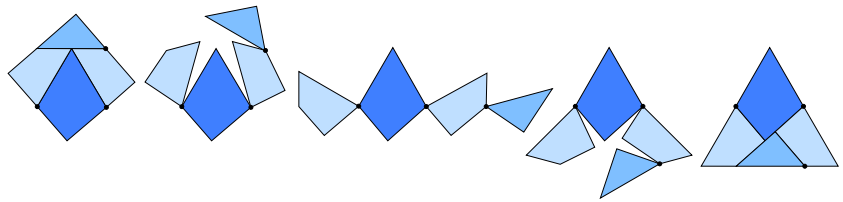


Figure: Caption Text

HingedLogicEngineBig.pdf

* item 1
* item 2

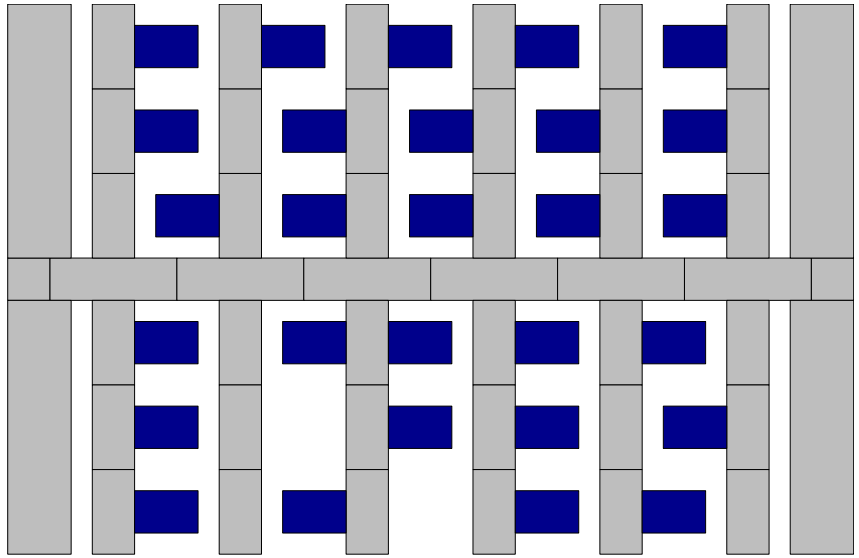


Figure: Caption Text

HingedLogicEngineSmall.pdf

* item 1
* item 2

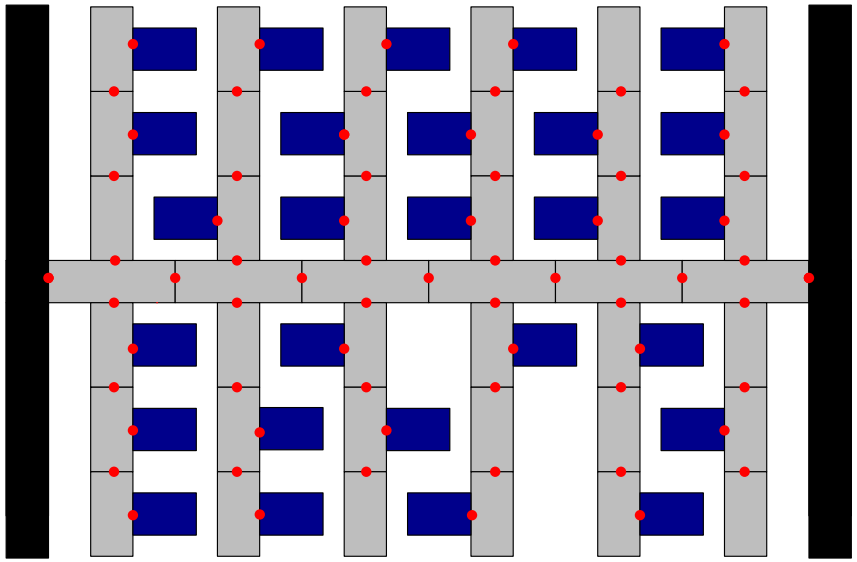


Figure: Caption Text

HingedLogicEngineSmallEnumerated.pdf

* item 1
* item 2

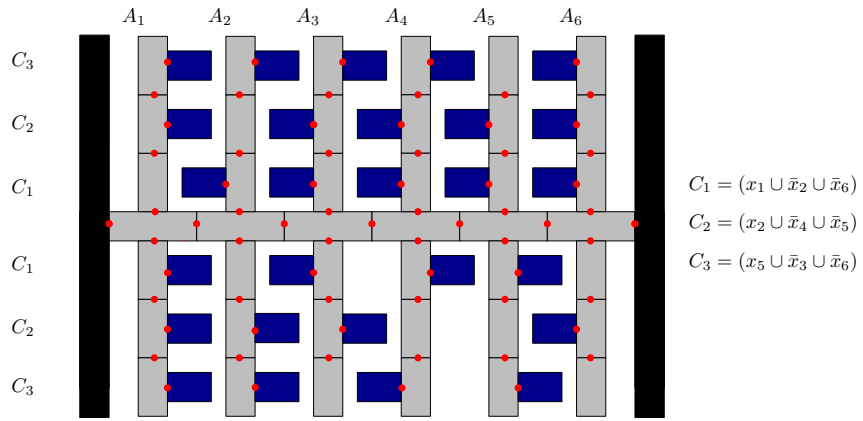


Figure: Caption Text

HingedTriangleSquare.pdf

* item 1
* item 2

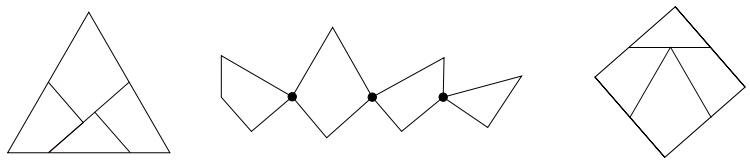


Figure: Caption Text

hingeOnThreeDistinctPolygons.pdf

* item 1
* item 2

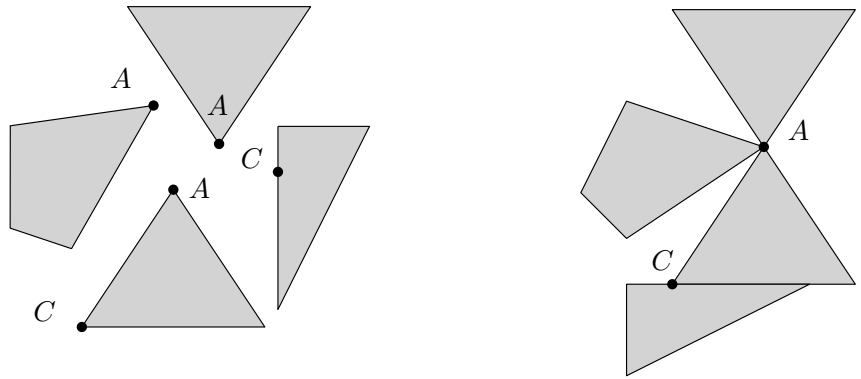


Figure: Caption Text

honeycomb.pdf

* item 1
* item 2

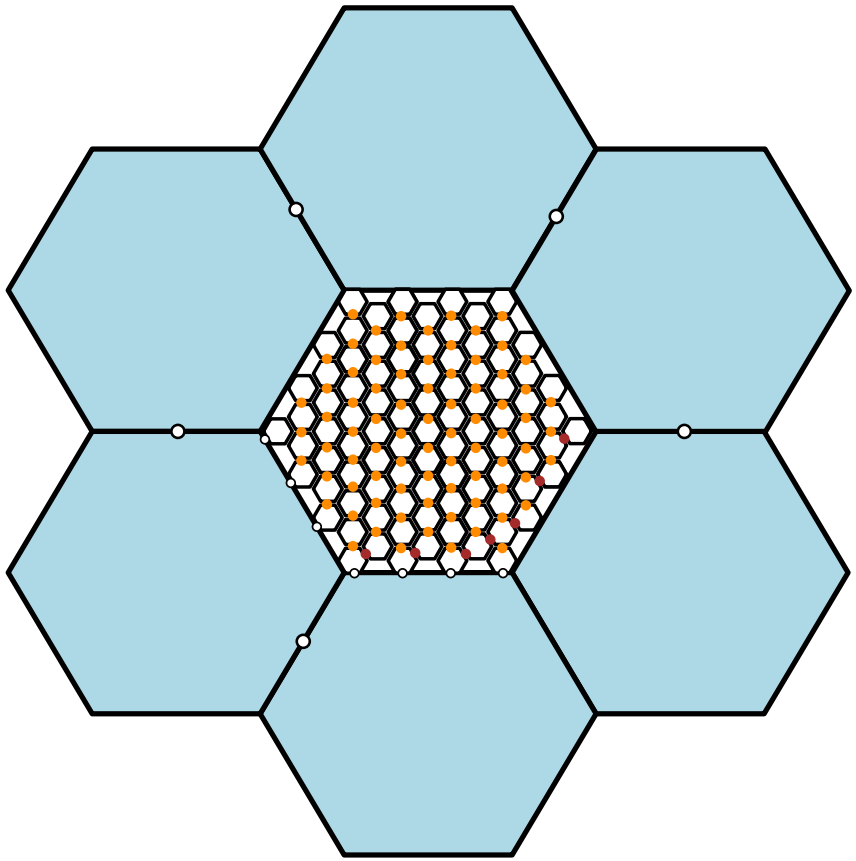


Figure: Caption Text

HoneyCombAssociatedGraphSideBySide.pdf

* item 1
* item 2

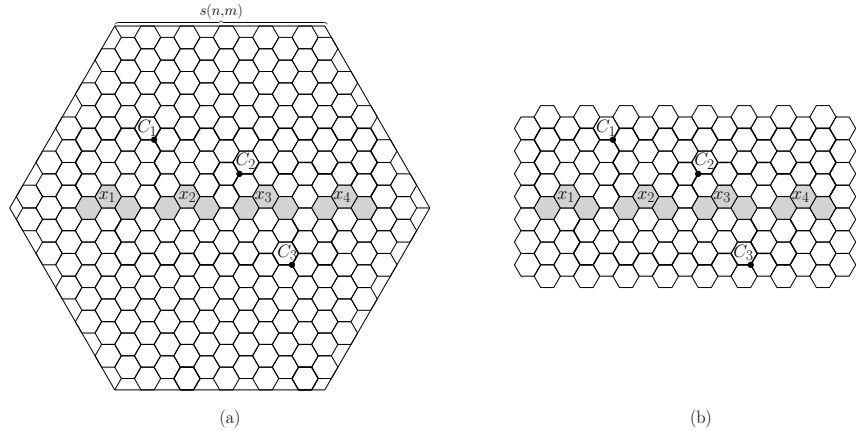


Figure: Caption Text

HoneyCombAssociatedGraphSmall.pdf

* item 1
* item 2

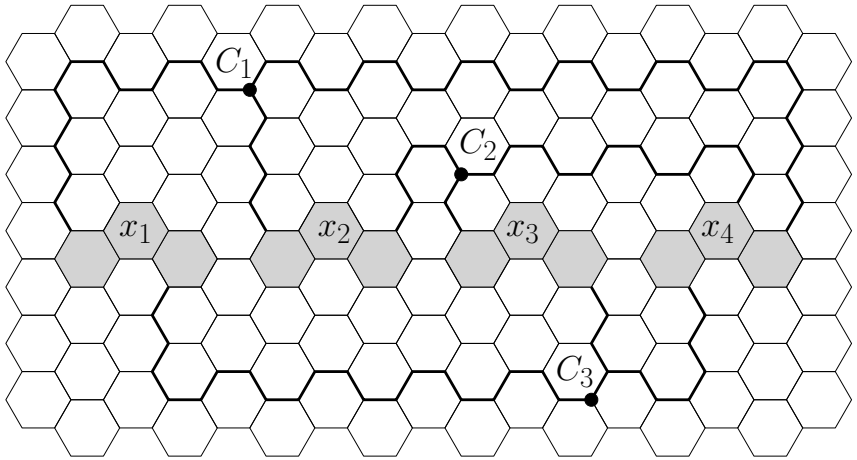


Figure: Caption Text

HoneycombFlixible.pdf

* item 1
* item 2

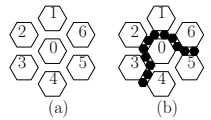


Figure: Caption Text

honeycombSatSmall.pdf

* item 1
* item 2

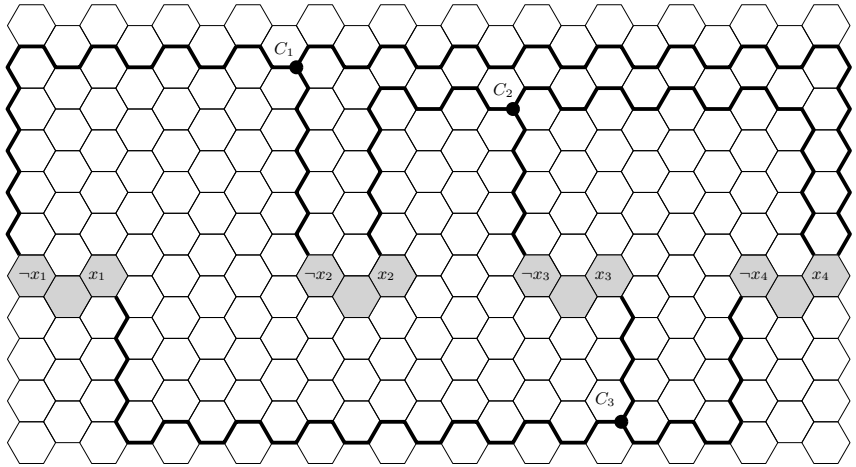


Figure: Caption Text

HorizontalArgument.pdf

* item 1
* item 2

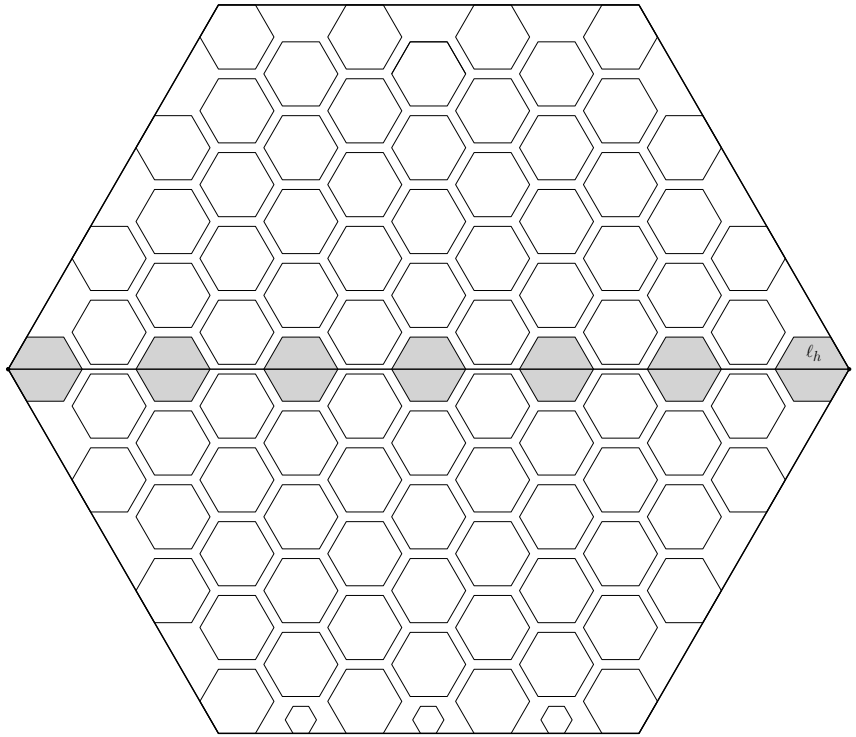


Figure: Caption Text

HorizontalArgument2.pdf

* item 1
* item 2

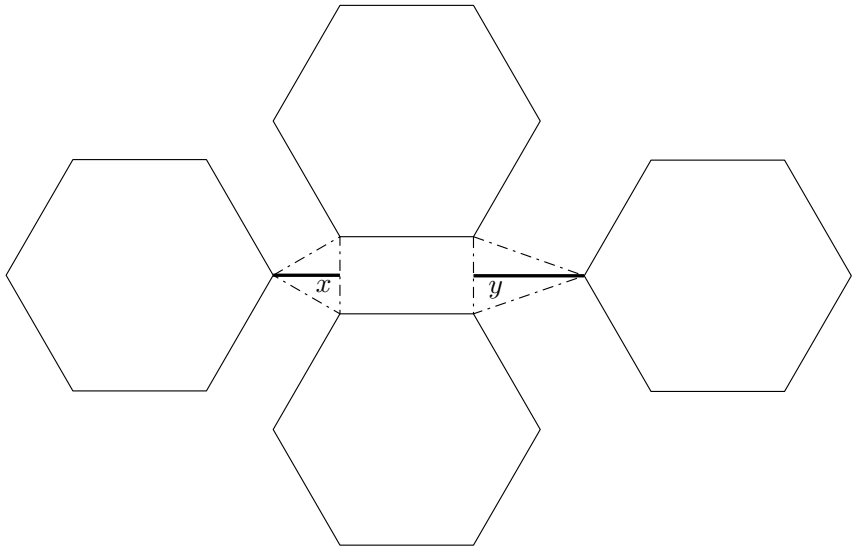


Figure: Caption Text

HorizontalArgumentRho.pdf

* item 1
* item 2

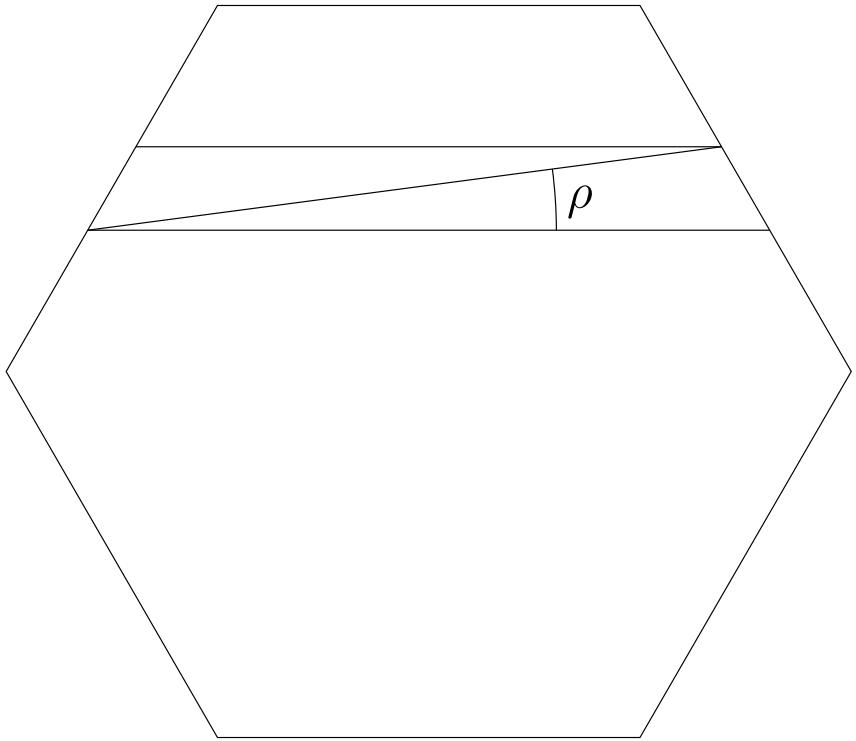


Figure: Caption Text

HorizontalCorridorArgument.pdf

* item 1
* item 2

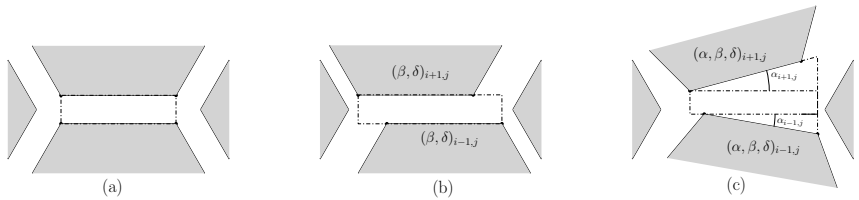


Figure: Caption Text

horizontalHeightCorridor.pdf

* item 1
* item 2

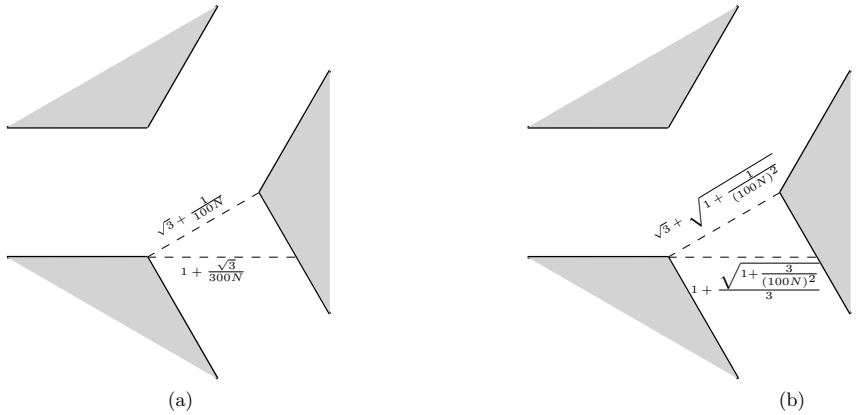


Figure: Caption Text

HorizontalJunctionArgument.pdf

* item 1
* item 2

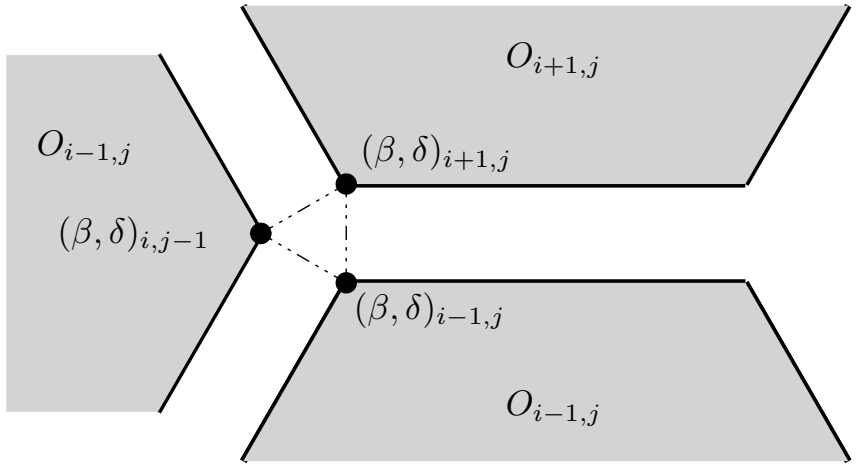


Figure: Caption Text

HumanTurkeyLinkage.pdf

* item 1
* item 2

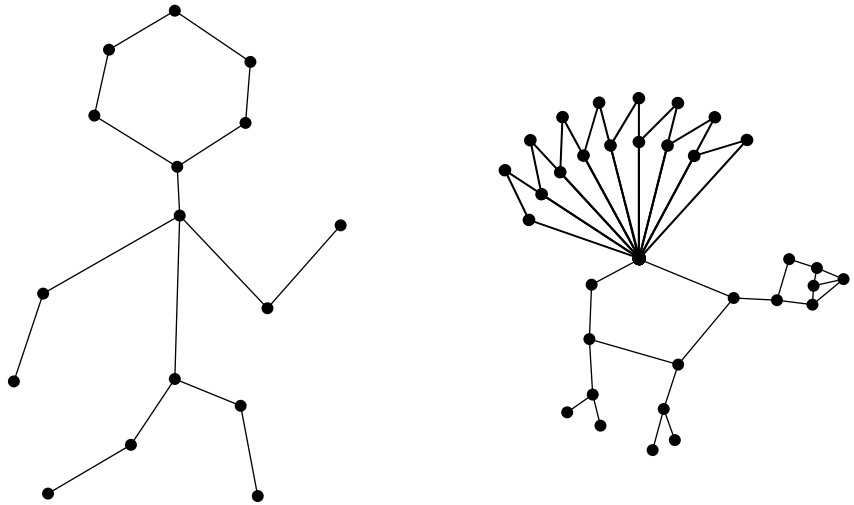


Figure: Caption Text

InsertFigure.pdf

* item 1
* item 2

Figure: Caption Text

kuratowskiExamples.pdf

* item 1
* item 2

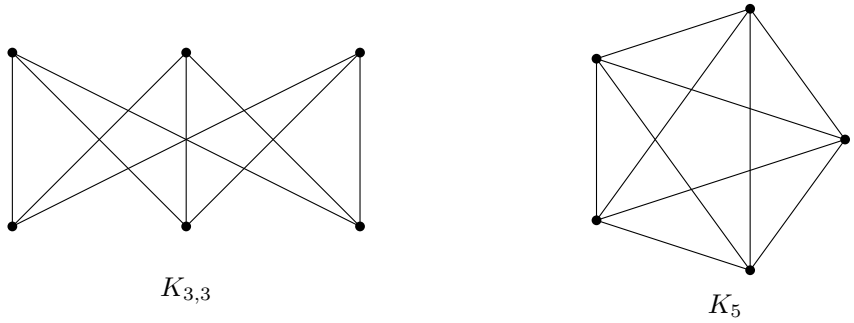
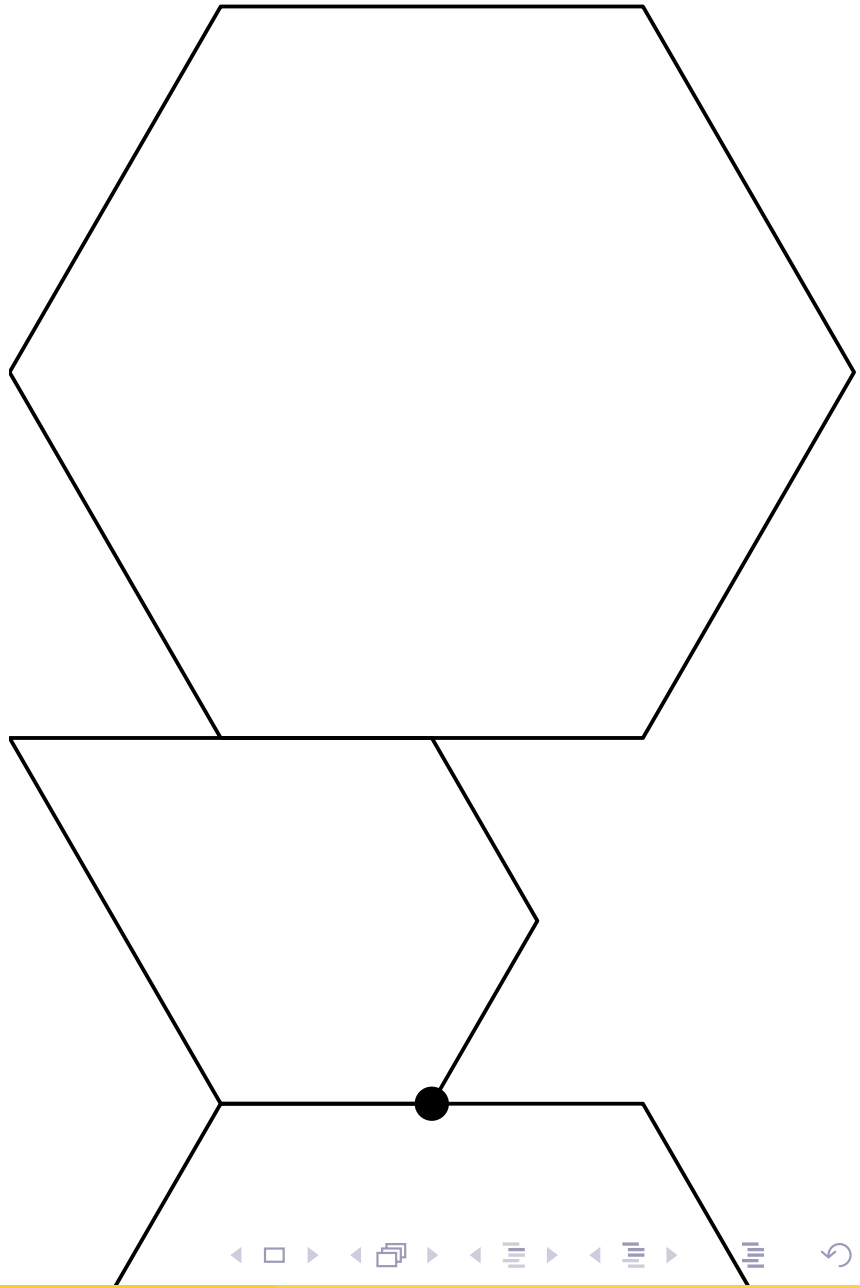


Figure: Caption Text

LeftSwitchBetweenTwoPolygons.pdf



* item 1
* item 2

lemmaHingedPolygon2.pdf

* item 1
* item 2

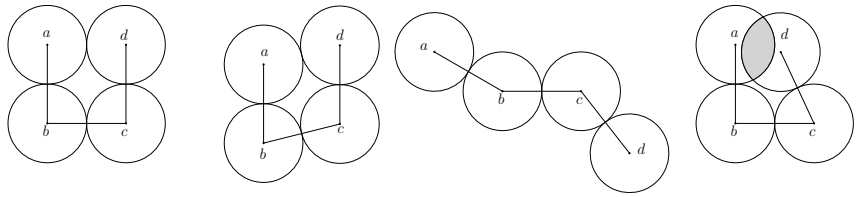


Figure: Caption Text

LineSegmentDelta.pdf

* item 1
* item 2

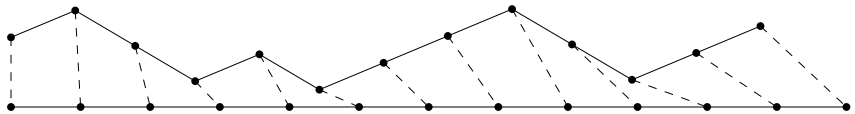


Figure: Caption Text

linkageillustration.pdf

* item 1
* item 2

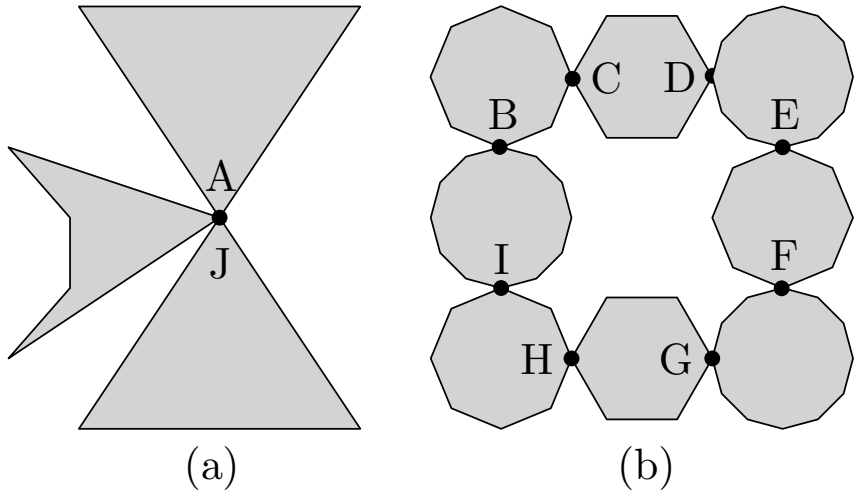


Figure: Caption Text

LinkageWithTwoLengthAssignments.pdf

* item 1
* item 2

$G = (V, E)$
$V = \{1, 2, 3, 4\}$
$E = \{12, 23, 34, 41, 13\}$
$\ell_1(12) = \ell_1(23) = \ell_1(34) = \ell_1(41) = \ell_1(13) = 1$
$\ell_2(12) = \ell_2(23) = 1, \ell_2(13) = \ell_2(34) = \sqrt{2}, \ell_2(41) = 2$

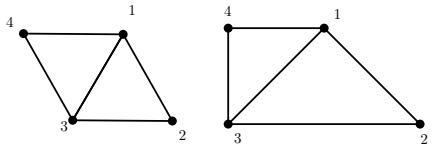


Figure: Caption Text

LockedConnellyLinkage.pdf

* item 1
* item 2

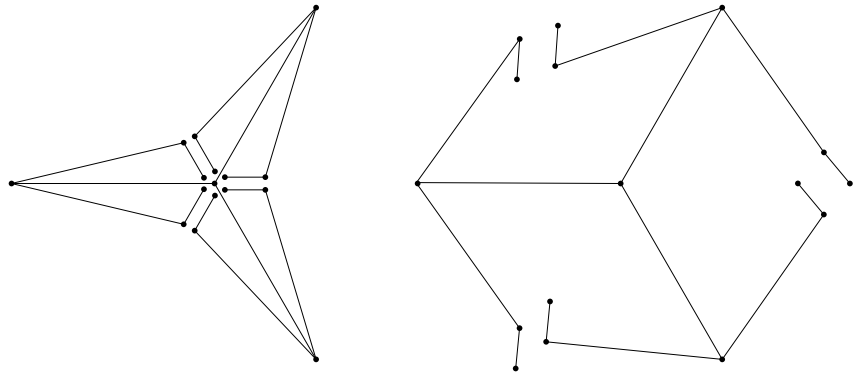


Figure: Caption Text

lockingShape.pdf

* item 1
* item 2

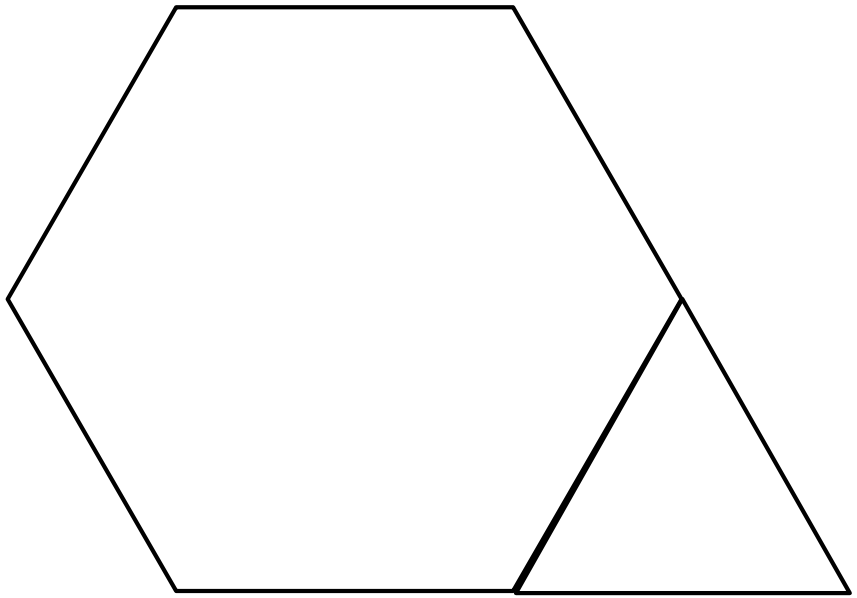


Figure: Caption Text

logicengine.pdf

* item 1
* item 2

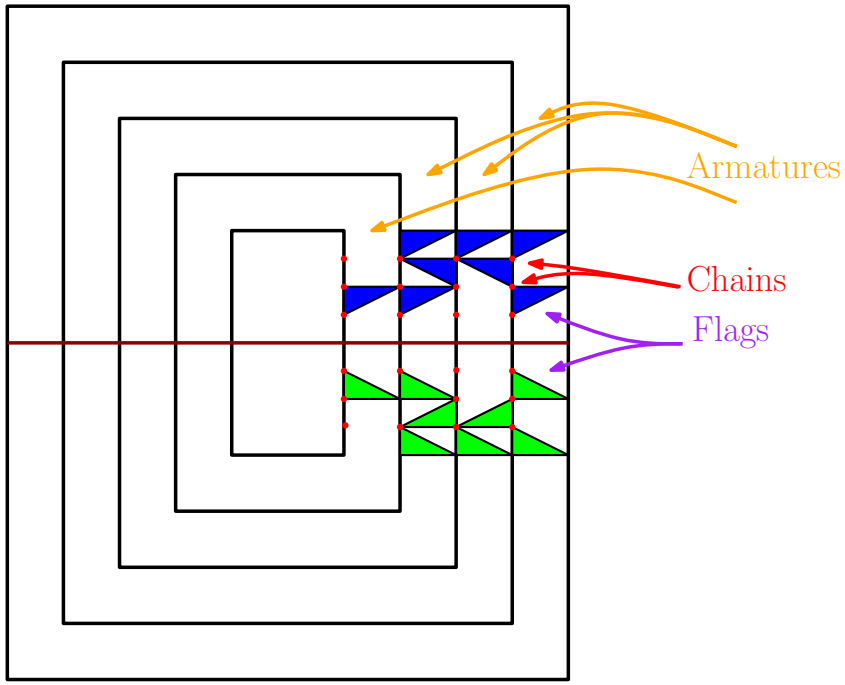


Figure: Caption Text

logicEngineCollisions.pdf

* item 1
* item 2

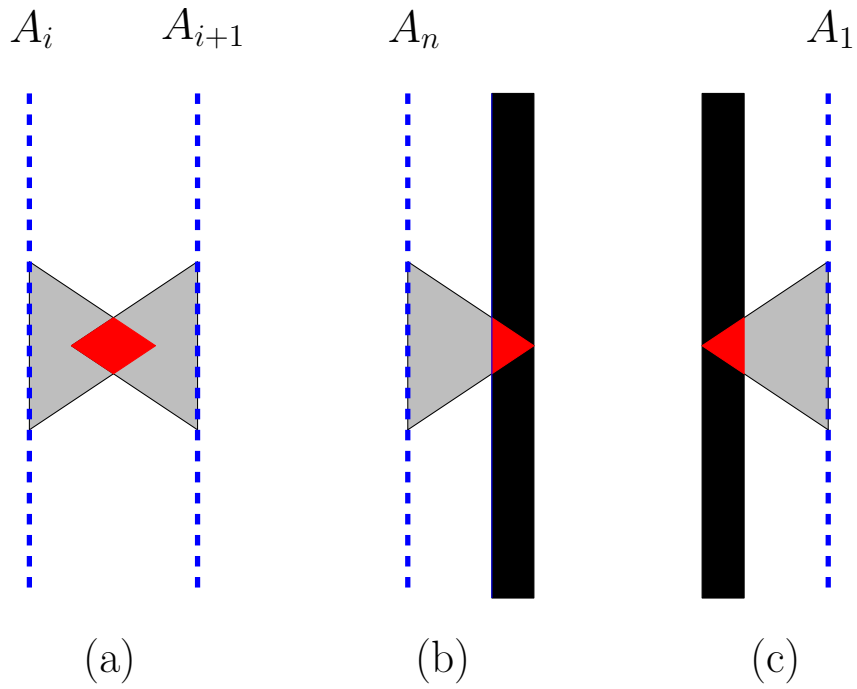


Figure: Caption Text

logicEngineCollisionsSmall.pdf

* item 1
* item 2

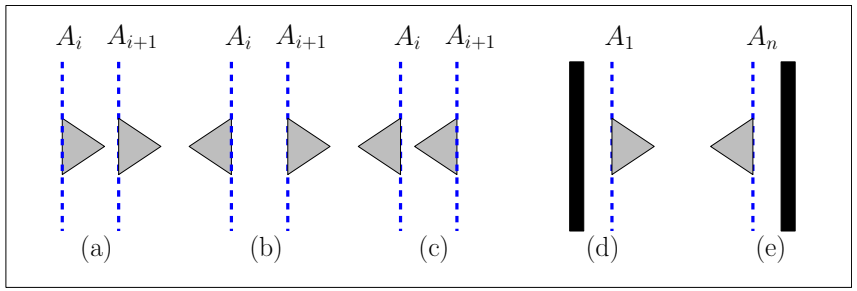


Figure: Caption Text

logicengineFlags.pdf

* item 1
* item 2

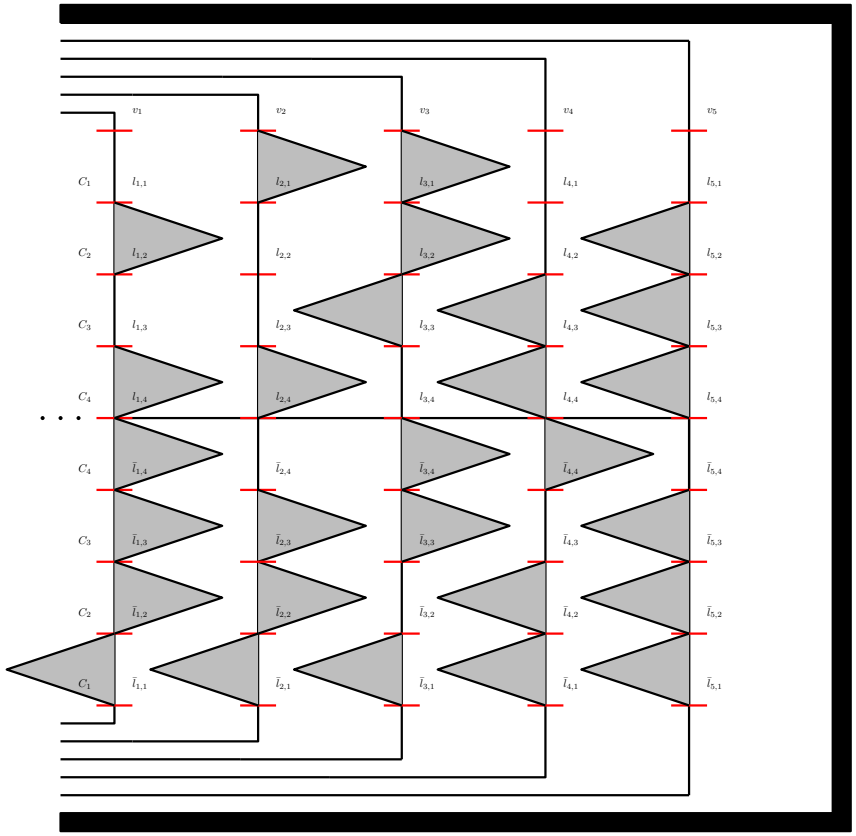


Figure: Caption Text

LogicEngineFrame.pdf

* item 1
* item 2

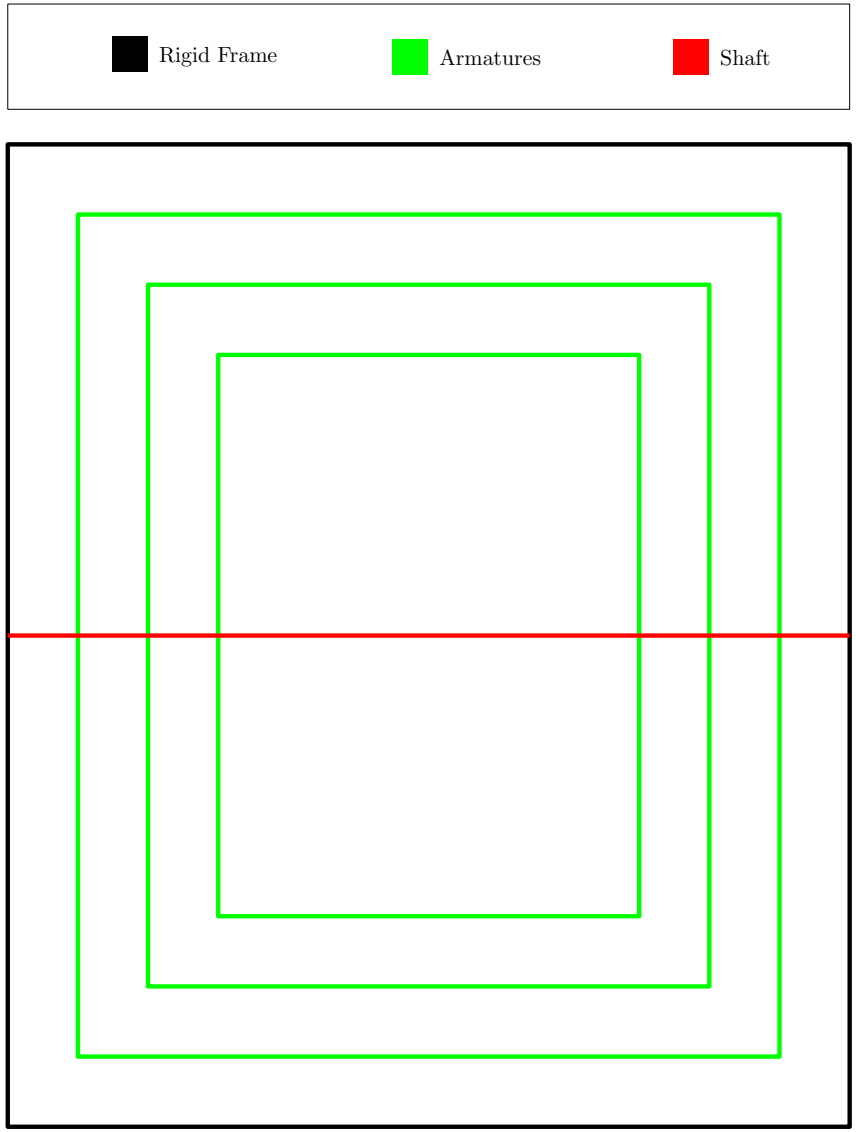


Figure: Caption Text

LogicEngineFrameFigure1.pdf

* item 1
* item 2

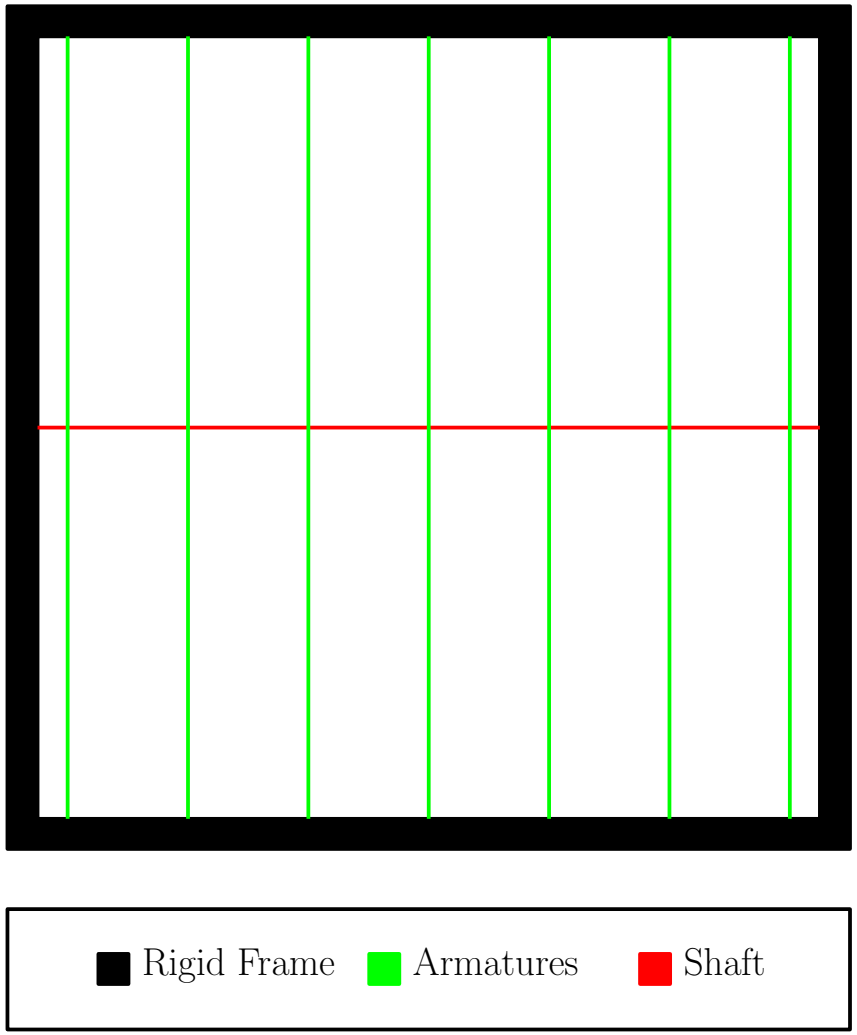


Figure: Caption Text

LogicEngineFrameFigure1halfScaled.pdf

* item 1
* item 2

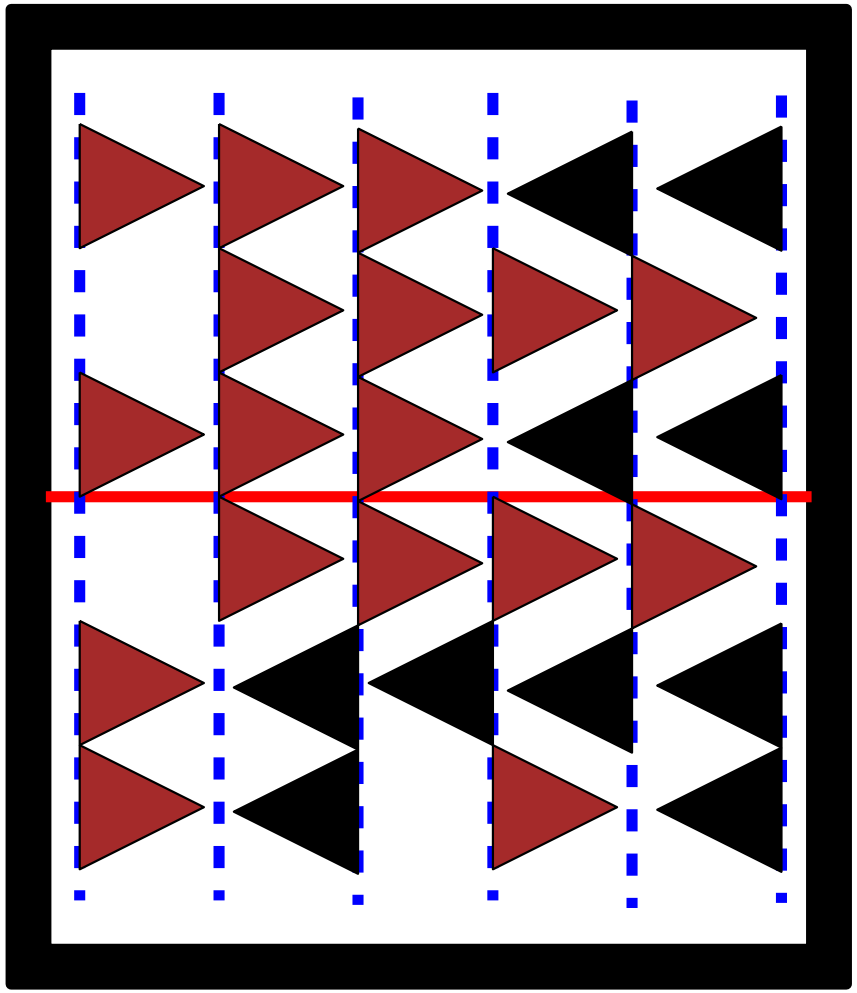


Figure: Caption Text

LogicEngineFrameFigure1Scaled.pdf

* item 1
* item 2

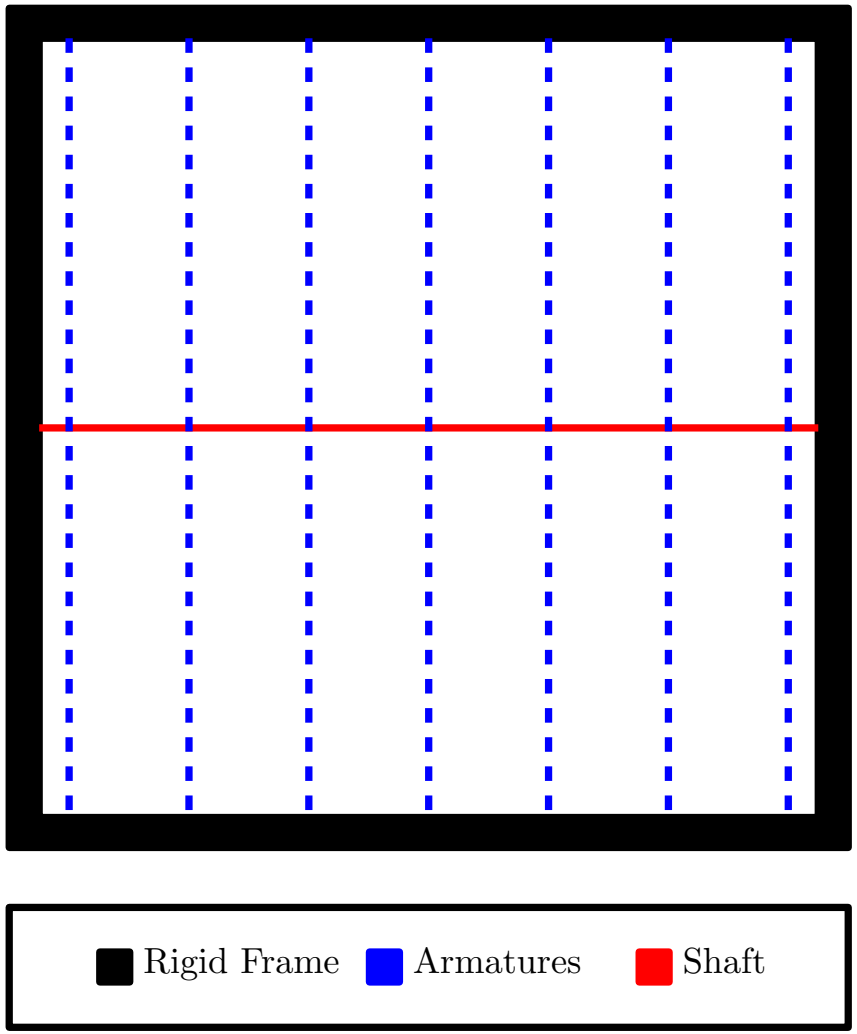


Figure: Caption Text

LogicEngineFrameFigure2.pdf

* item 1
* item 2

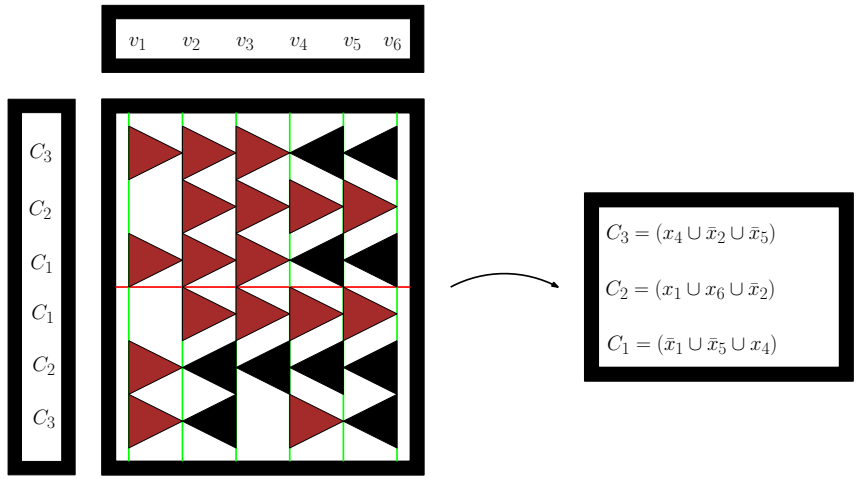
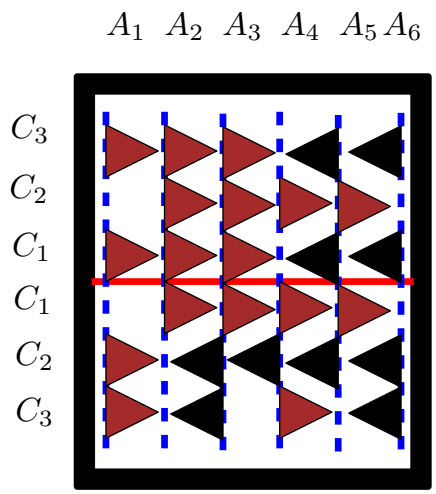


Figure: Caption Text

LogicEngineFrameFigure2Scaled.pdf

* item 1
* item 2



$C_3 = (x_4 \cup \bar{x}_2 \cup \bar{x}_5)$
$C_2 = (x_1 \cup x_6 \cup \bar{x}_2)$
$C_1 = (\bar{x}_1 \cup \bar{x}_5 \cup x_4)$

Figure: Caption Text

LogicEngineFrameFigure5.pdf

* item 1
* item 2

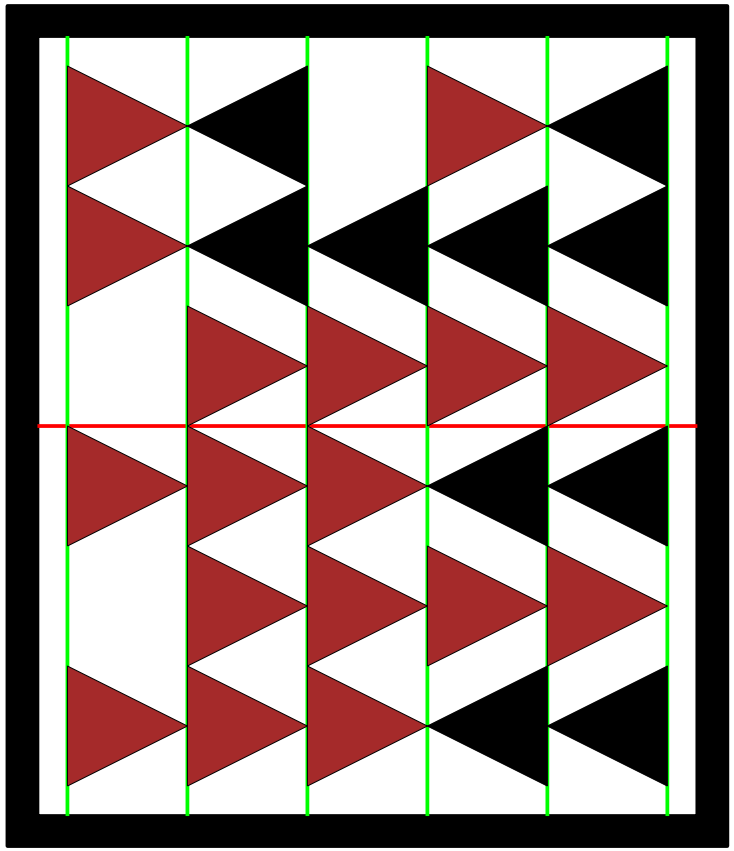


Figure: Caption Text

LogicEngineFrameFigure5Scaled.pdf

* item 1
* item 2

Figure: Caption Text

logicEngineValidConfigurations.pdf

* item 1
* item 2

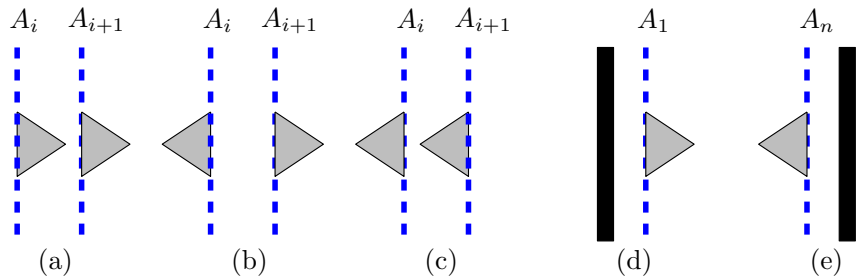


Figure: Caption Text

maximalHorizontalDisplacement.pdf

* item 1
* item 2

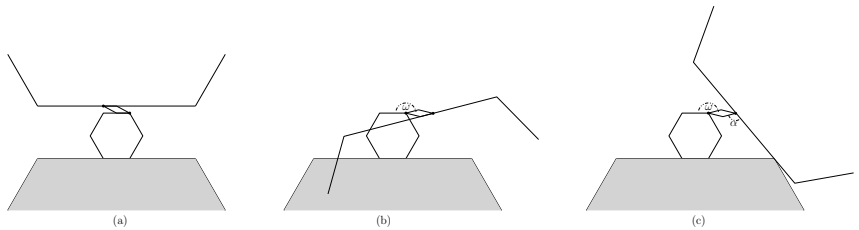


Figure: Caption Text

modifiedAuxilaryConstructionAsTree.pdf

* item 1
* item 2

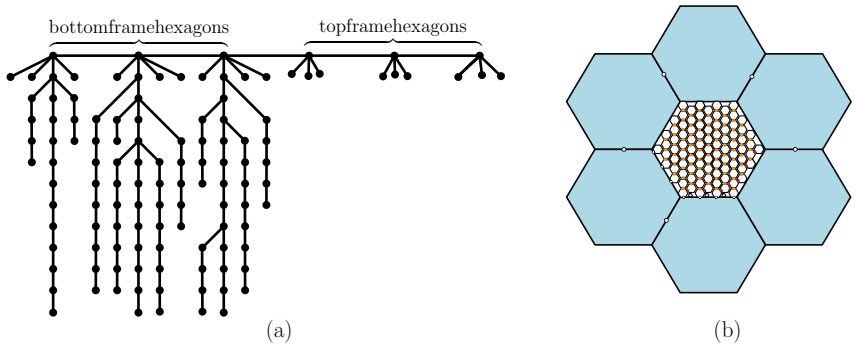


Figure: Caption Text

modifiedContactGraph.pdf

* item 1
* item 2

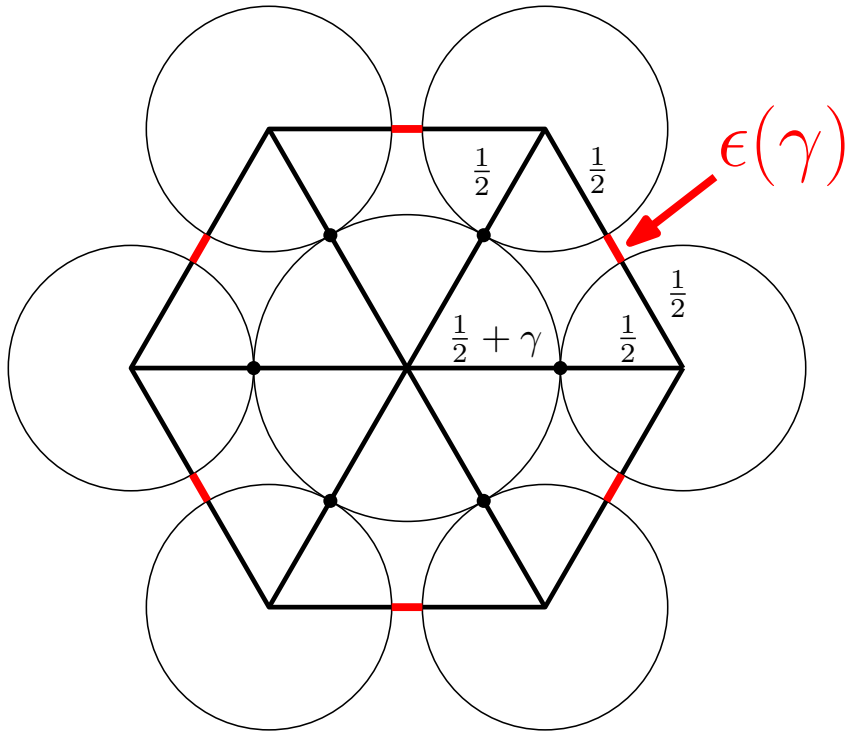


Figure: Caption Text

NonCanonicalPosition.pdf

* item 1
* item 2

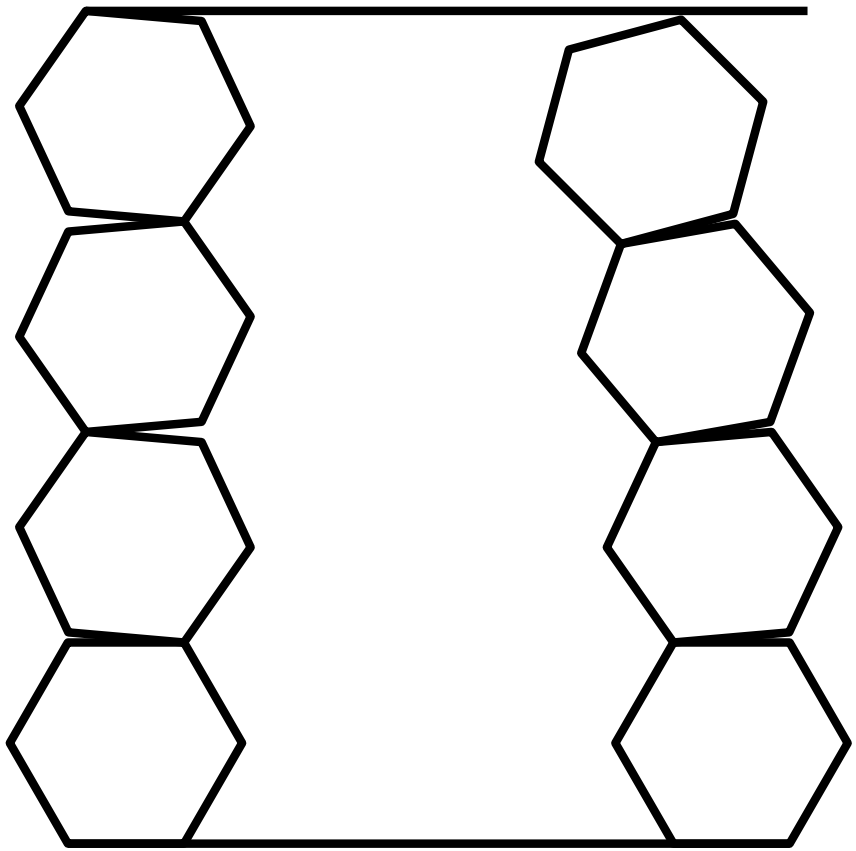


Figure: Caption Text

OctagonSquare.pdf

* item 1
* item 2

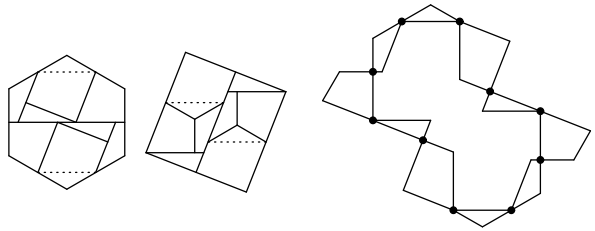


Figure: Caption Text

omegaAtPiOver2.pdf

* item 1
* item 2

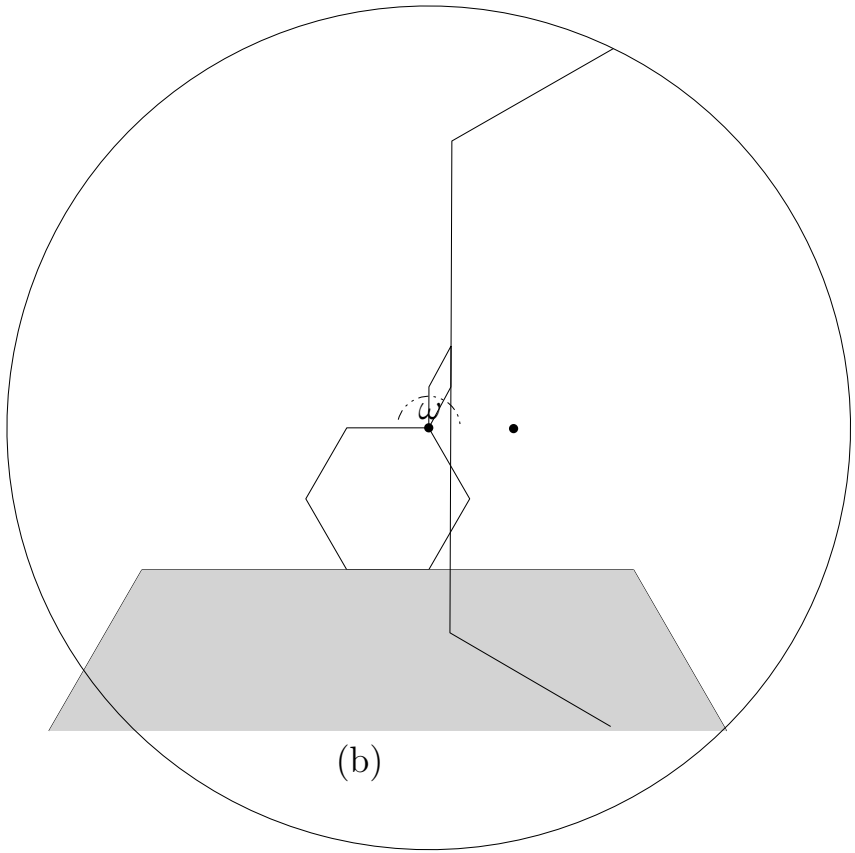
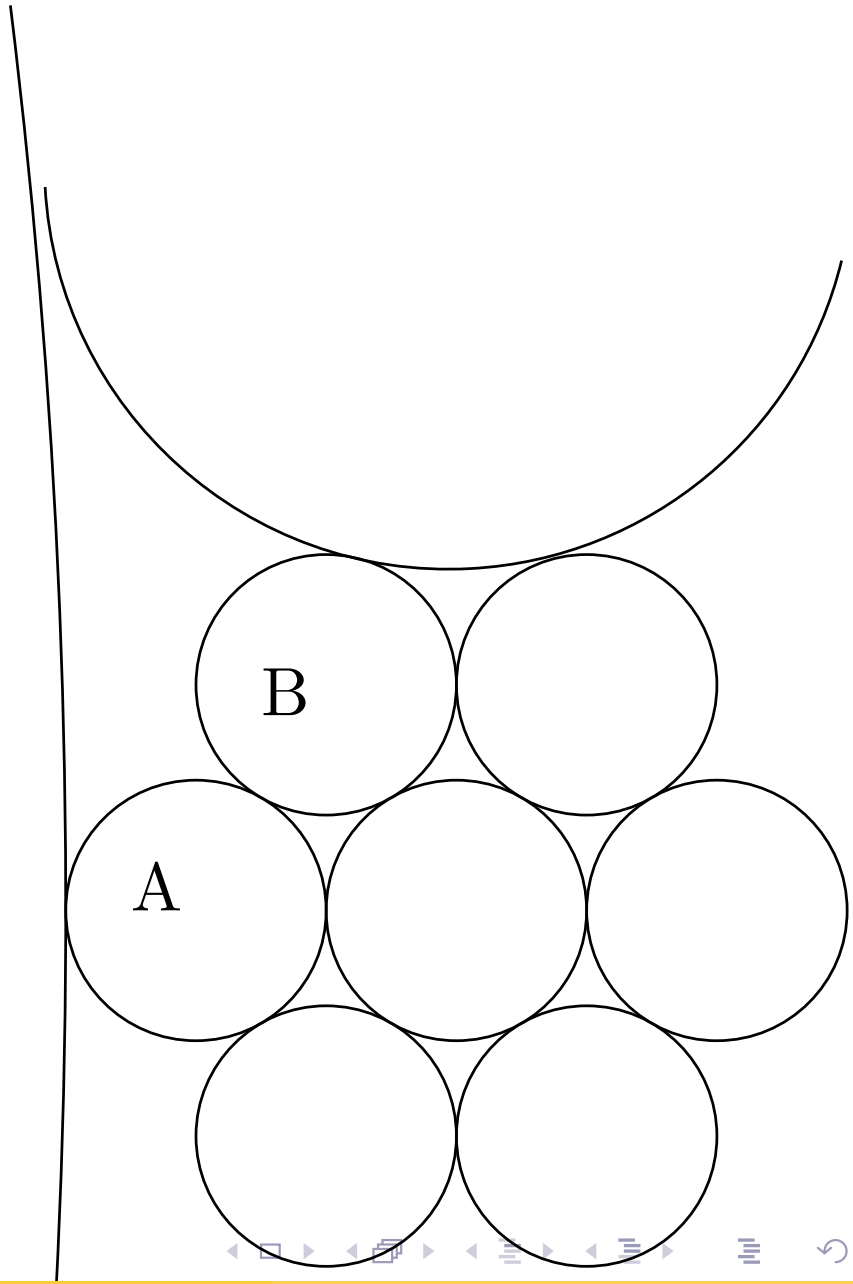


Figure: Caption Text

OrderedDiskArrangementExample1.pdf

* item 1
* item 2



OrderedDiskArrangementExample2.pdf

* item 1
* item 2

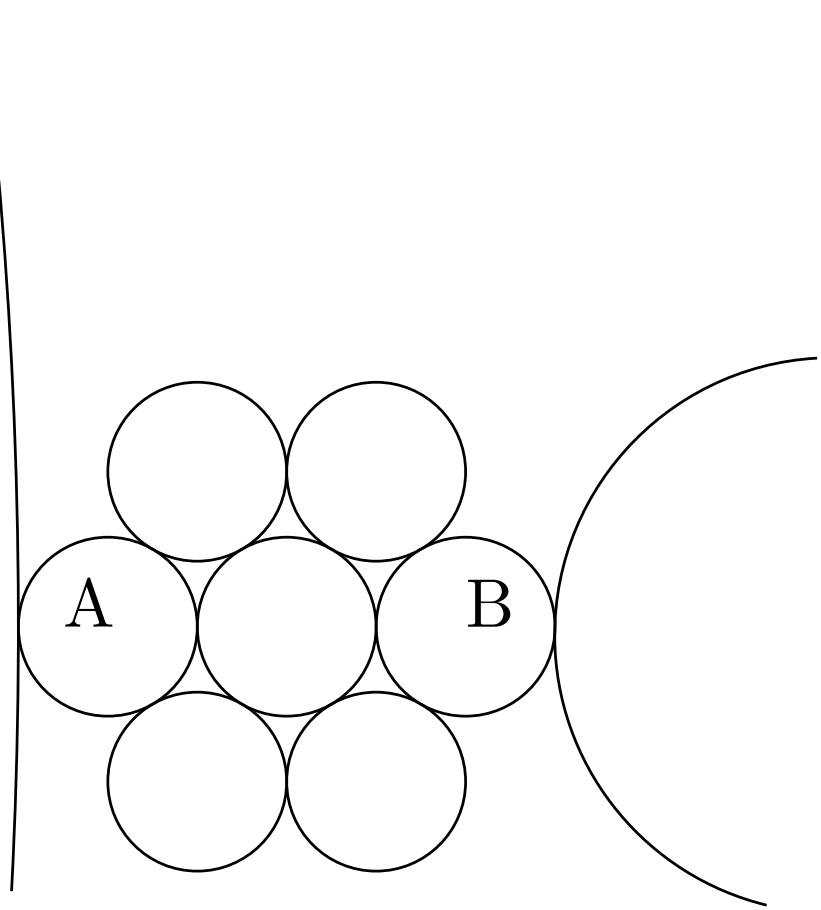


Figure: Caption Text

orderedFaces.pdf

* item 1
* item 2

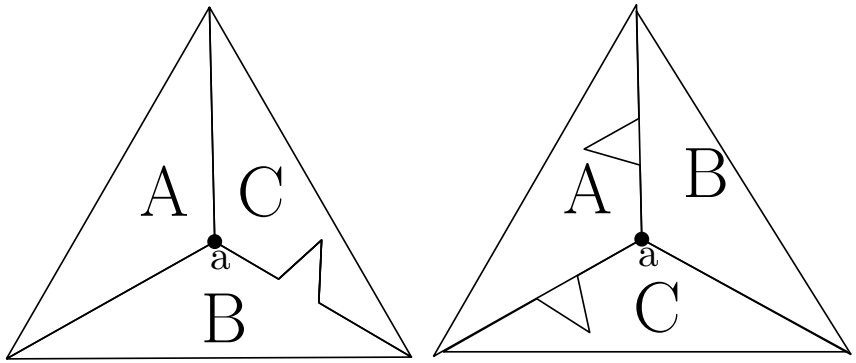


Figure: Caption Text

orderedLinkages.pdf

* item 1
* item 2

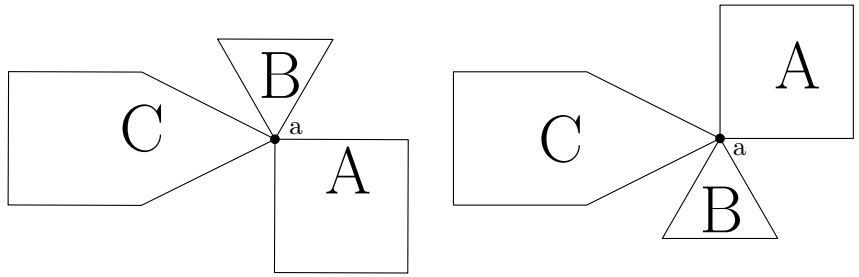


Figure: Caption Text

orderedPlaneIntersection.pdf

* item 1
* item 2

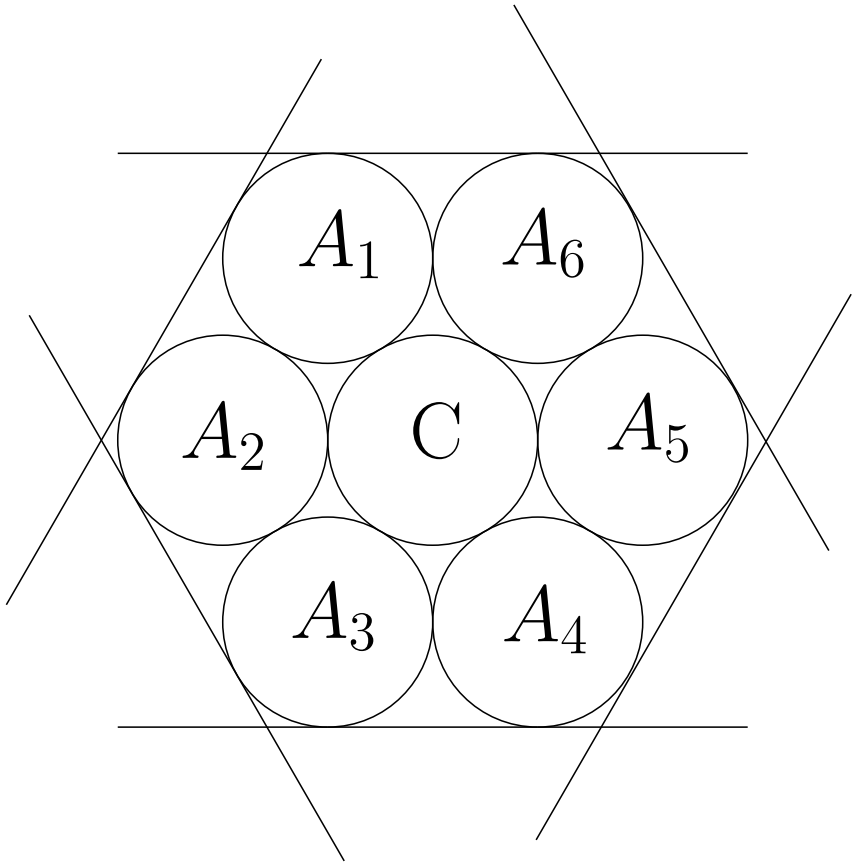


Figure: Caption Text

OrderedTreesExample.pdf

* item 1
* item 2

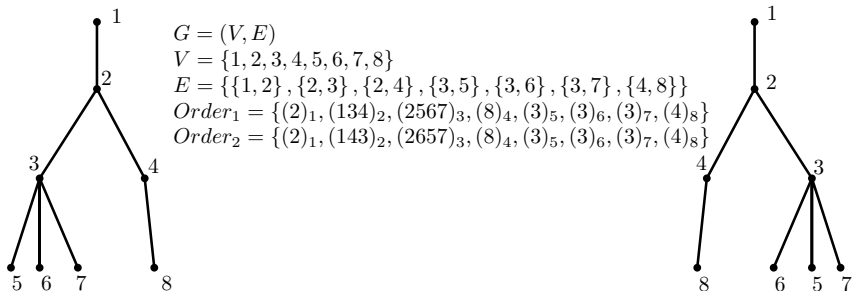


Figure: Caption Text

* item 1
* item 2

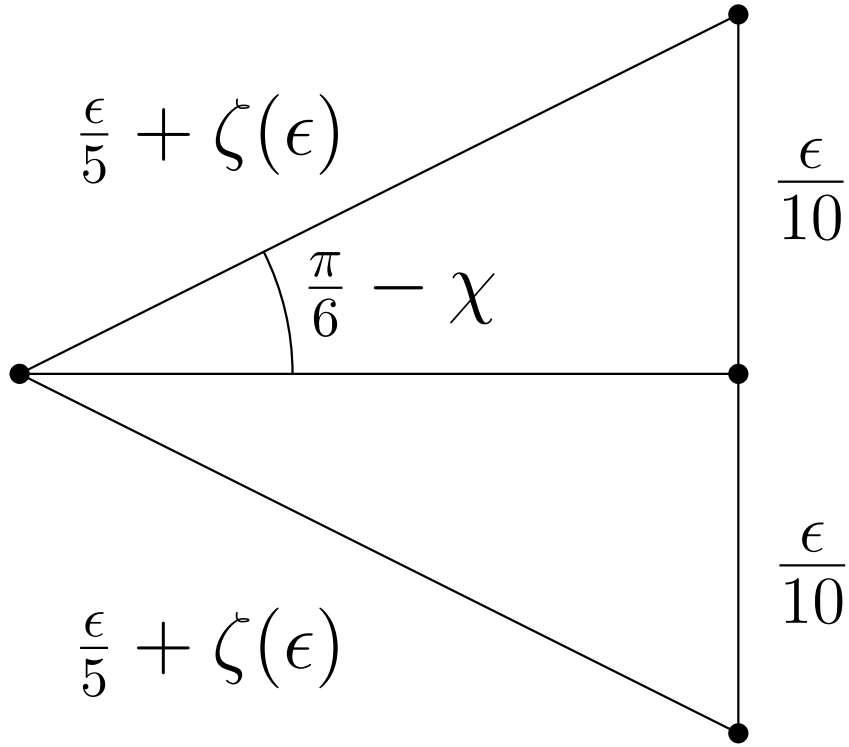


Figure: Caption Text

PerturbedContactGraphAnatomy.pdf

* item 1
* item 2

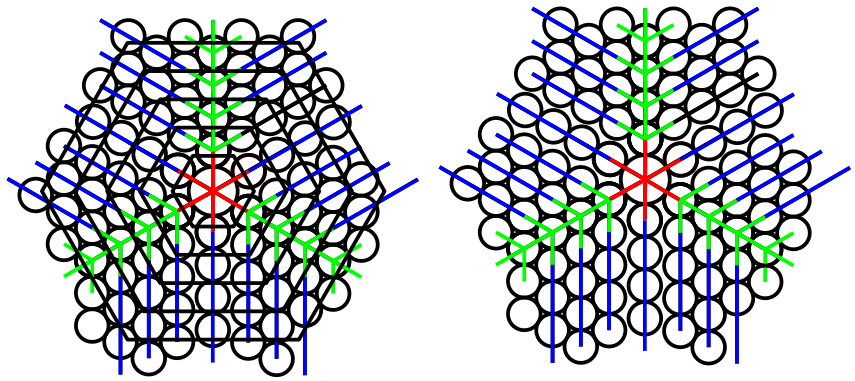


Figure: Caption Text

PerturbedSpine.pdf

* item 1
* item 2

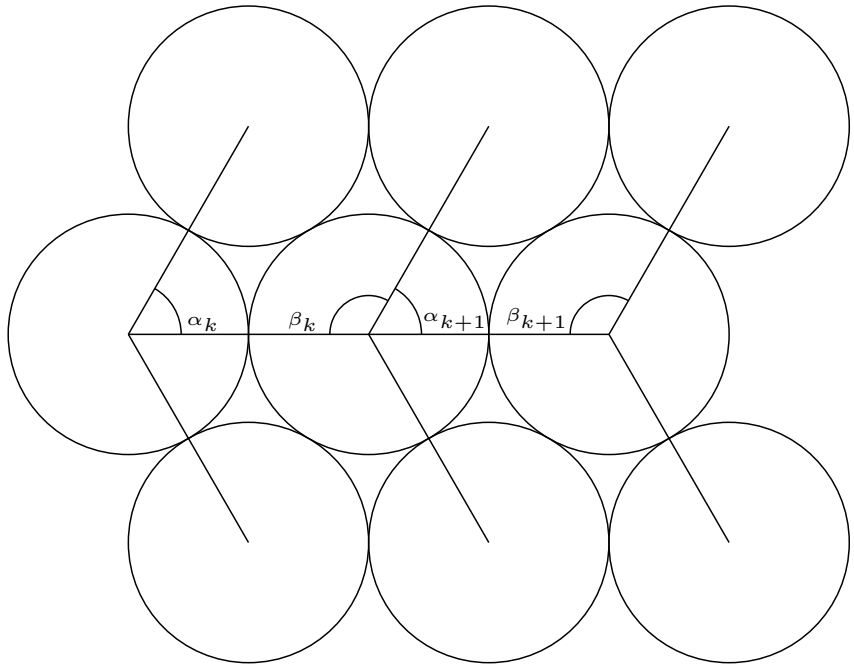


Figure: Caption Text

PerturbedVertebrae.pdf

* item 1
* item 2

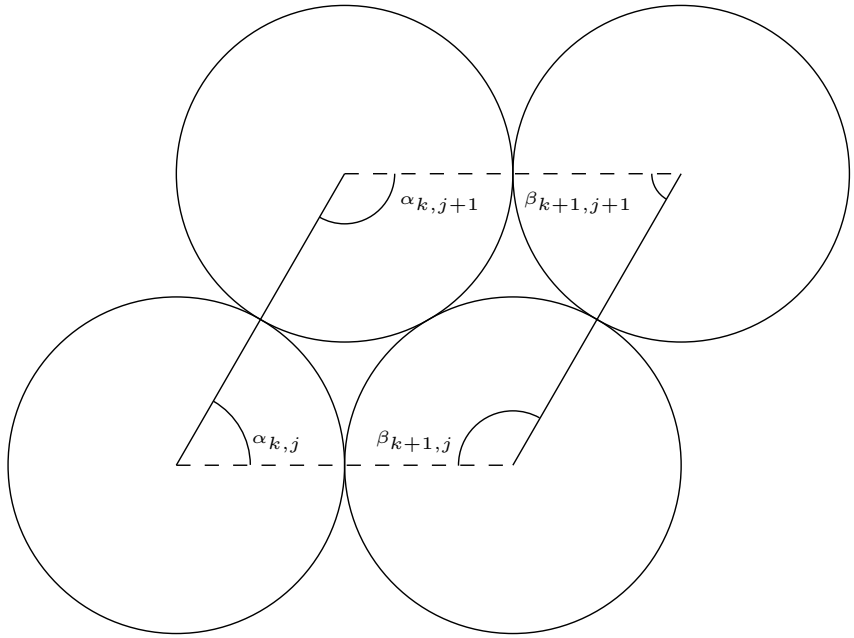


Figure: Caption Text

PetersonGraphAgain.pdf

* item 1
* item 2

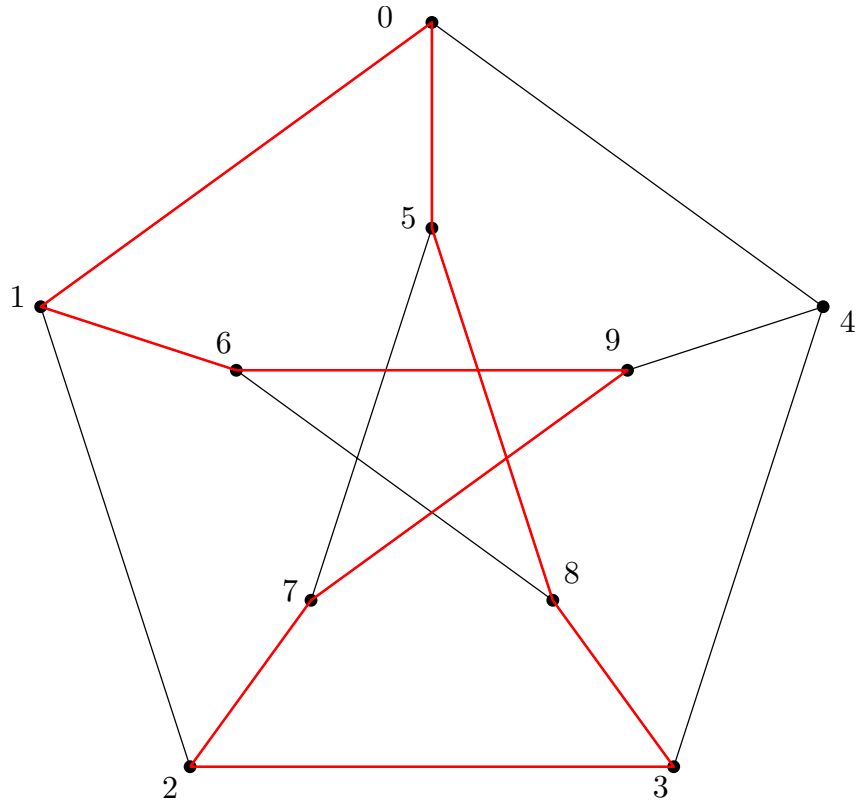


Figure: Caption Text

PetersonGraphBasic.pdf

* item 1
* item 2

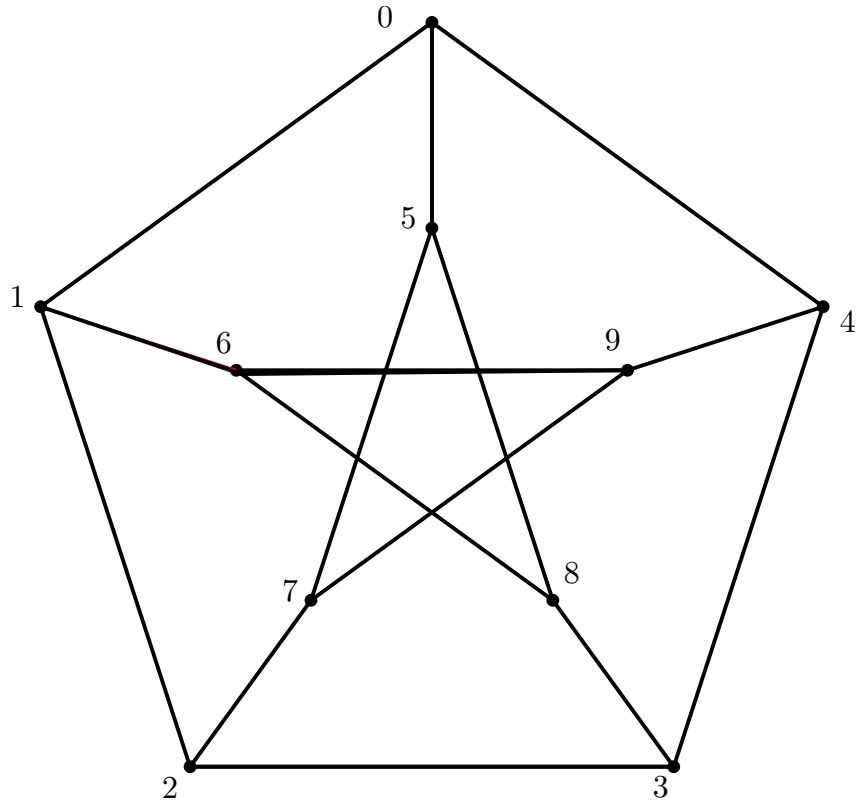
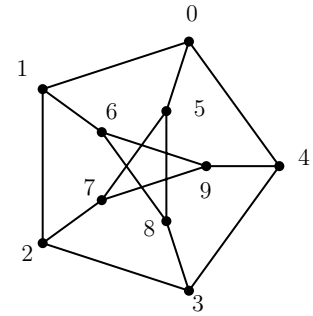


Figure: Caption Text

PetersonGraphExample.pdf

* item 1
* item 2



$$
\begin{aligned}
G &= (V, E) \\
V &= \{0,1,2,3,4,5,6,7,8,9\} \\
E &= \left\{ \begin{array}{l} \{0,1\},\{1,2\},\{2,3\},\{3,4\},\{4,0\},\{5,8\},\{8,6\}, \\ \{6,9\},\{9,7\},\{7,5\},\{0,5\},\{1,6\},\{2,7\},\{3,8\},\{4,9\} \end{array} \right\}
\end{aligned}
$$

Figure: Caption Text

PetersonGraphWithPath.pdf

* item 1
* item 2

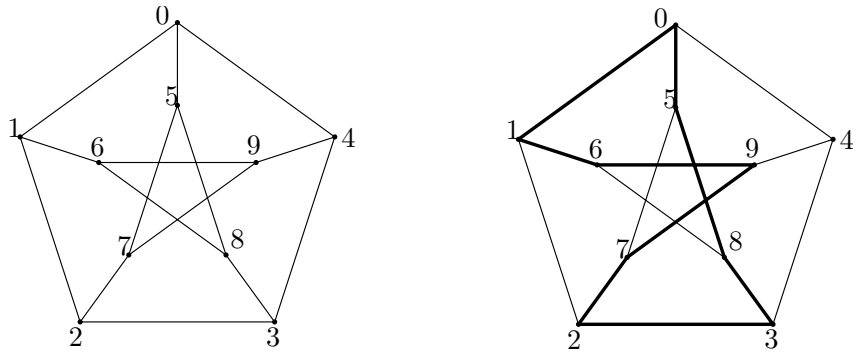


Figure: Caption Text

Petiole.pdf

* item 1
* item 2

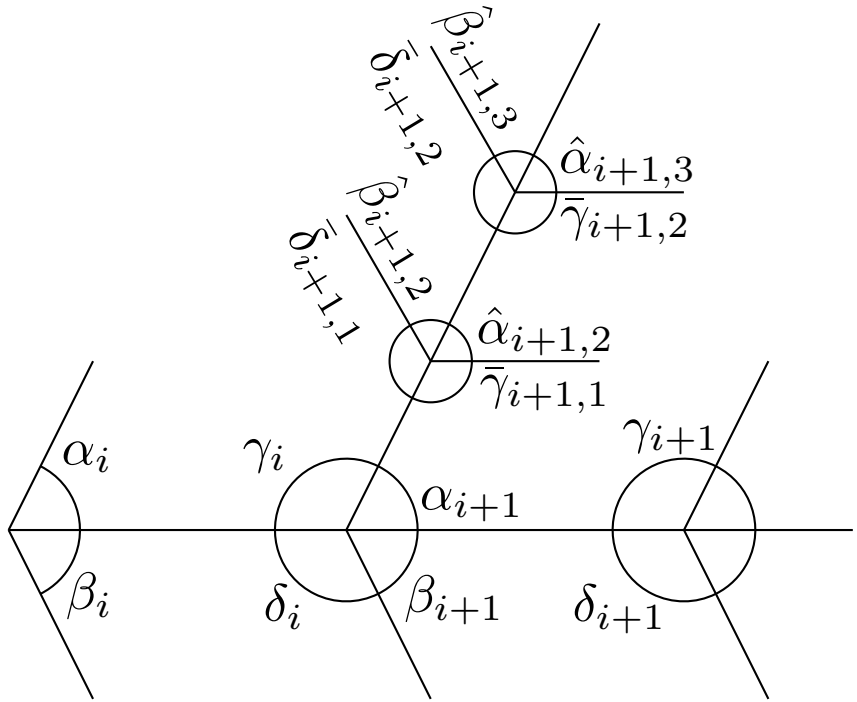


Figure: Caption Text

phiFigure.pdf

* item 1
* item 2

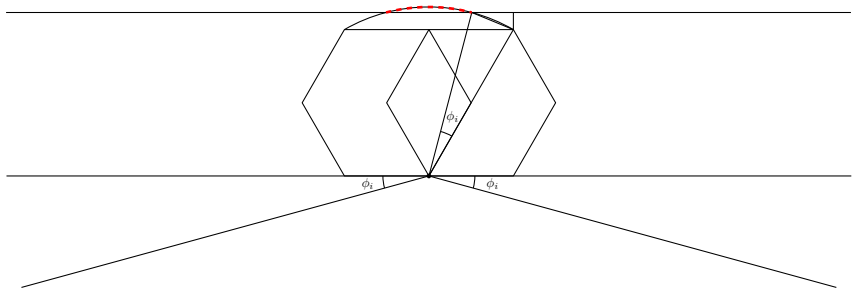


Figure: Caption Text

PolygonalLinkageExamples.pdf

* item 1
* item 2

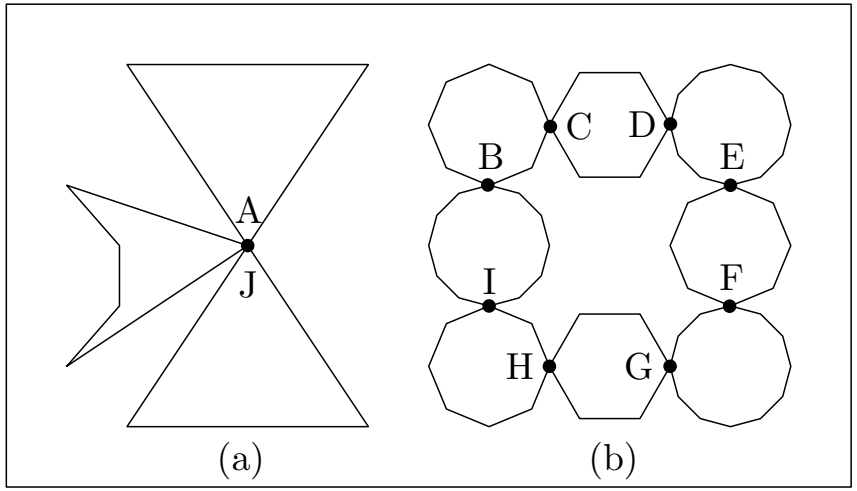


Figure: Caption Text

PolygonalLinkageWithConfigurationSpace.pdf

* item 1
* item 2

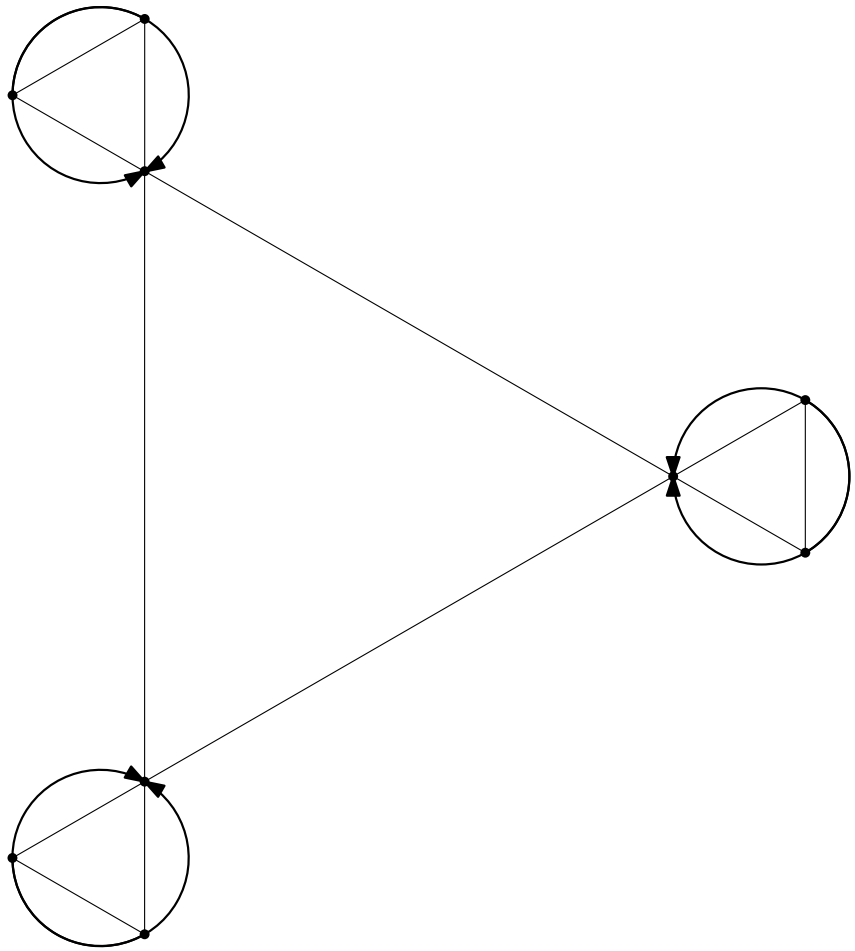


Figure: Caption Text

Problem1.pdf

* item 1
* item 2

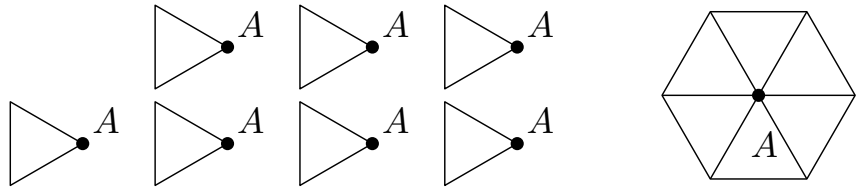


Figure: Caption Text

psiSegmentChange.pdf

* item 1
* item 2

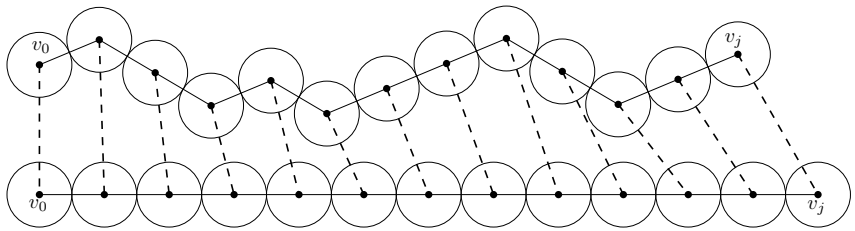


Figure: Caption Text

randomLinkage.pdf

* item 1
* item 2

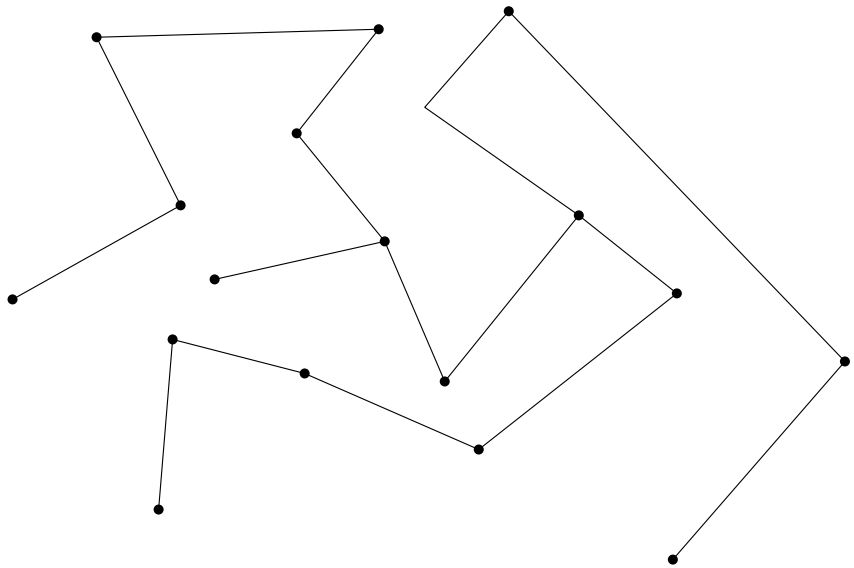


Figure: Caption Text

RandomTree.pdf

* item 1
* item 2

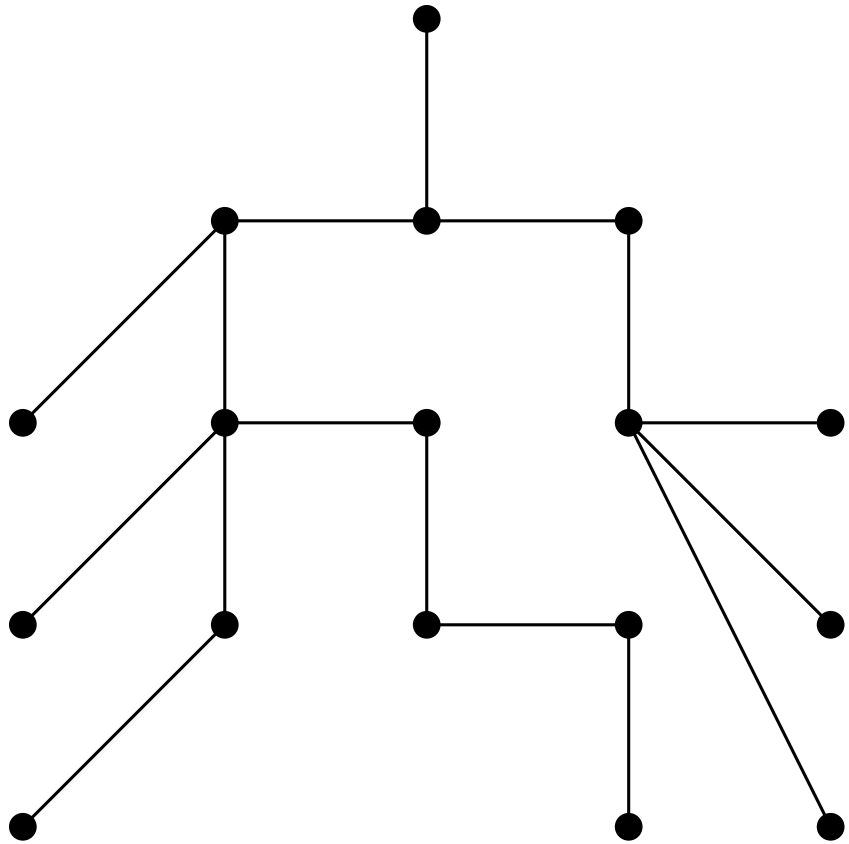


Figure: Caption Text

rangeOfMotionSkinnyRhombus.pdf

* item 1
* item 2

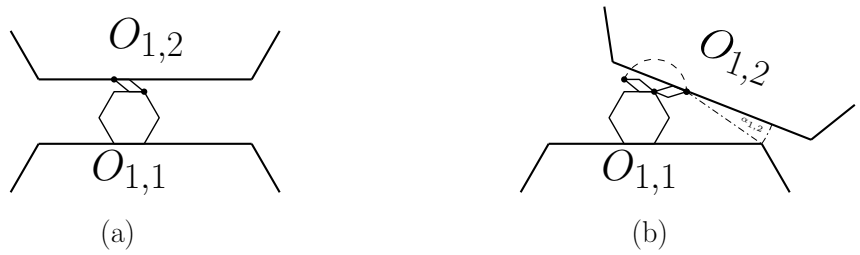
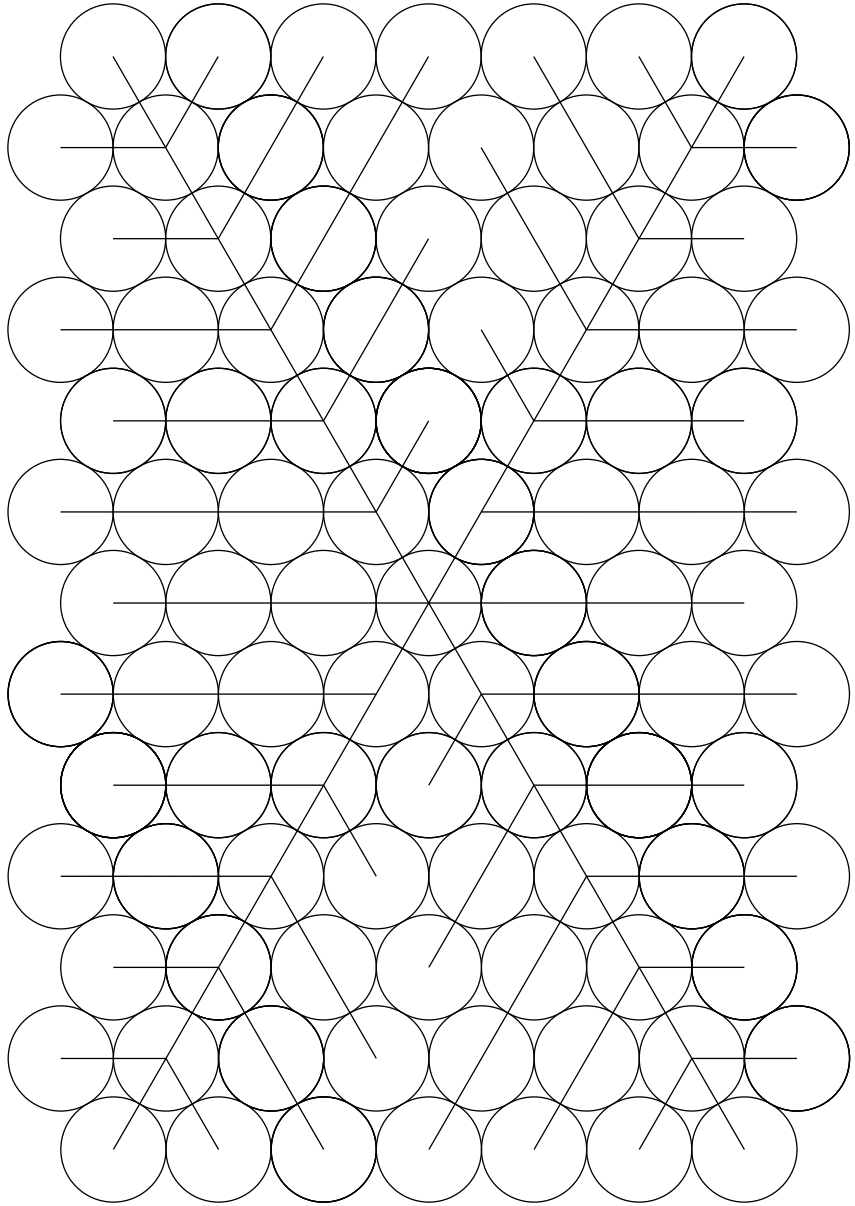


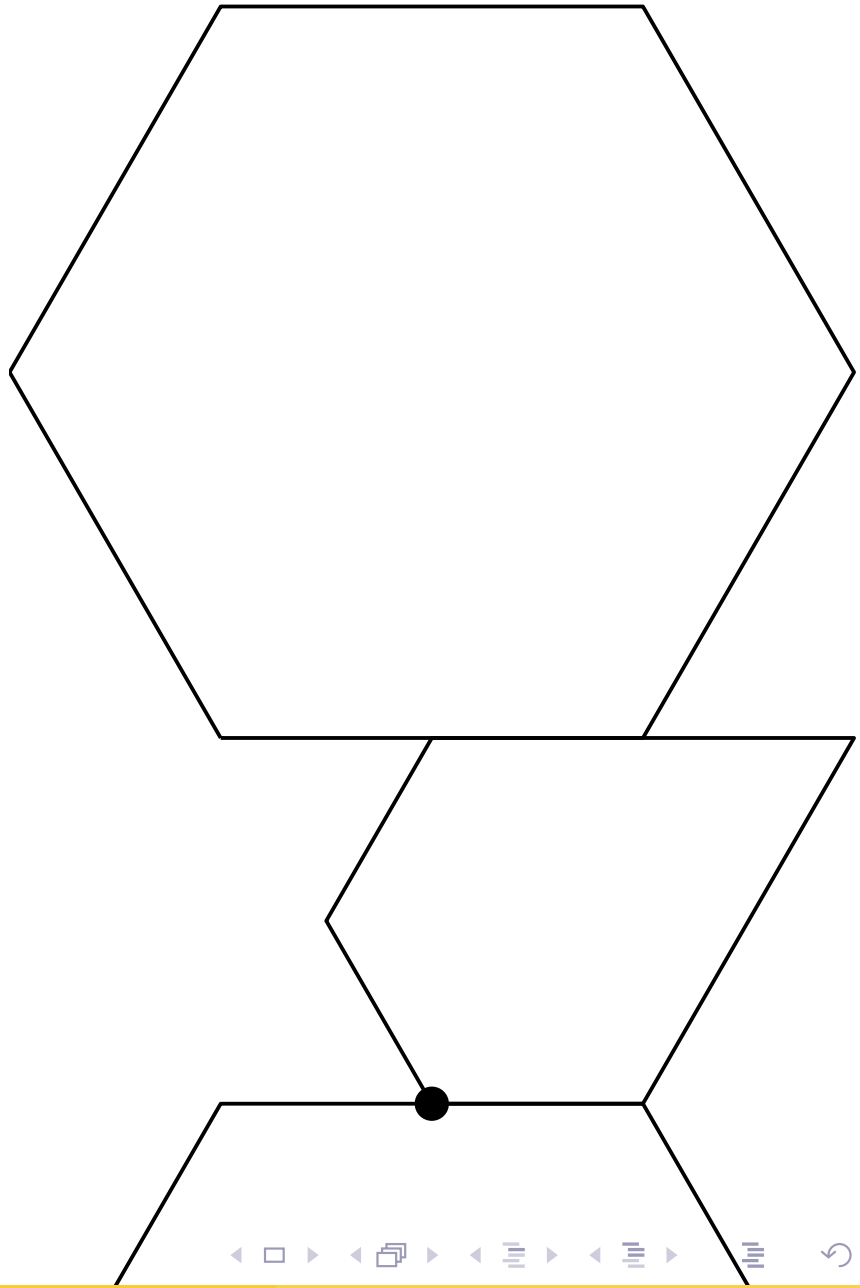
Figure: Caption Text

RectangularContactGraph.pdf

* item 1
* item 2



RightSwitchBetweenTwoPolygons.pdf



* item 1
* item 2

ScalingForCorridors.pdf

* item 1
* item 2

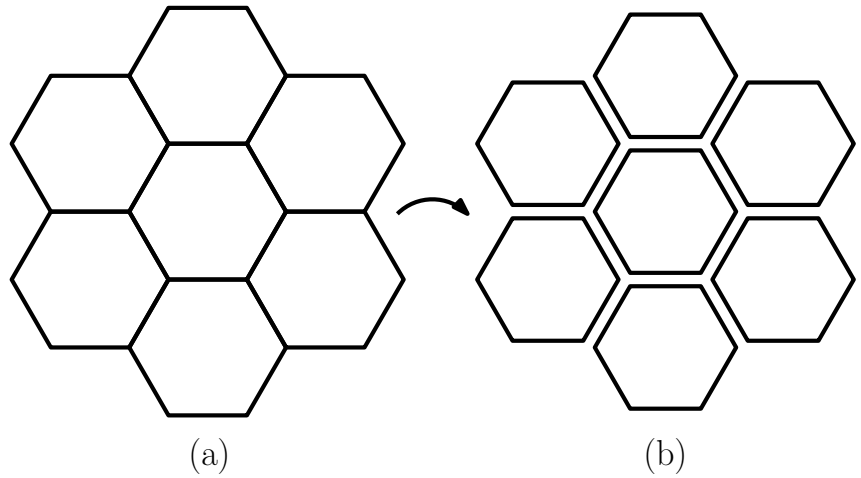


Figure: Caption Text

shapeInChannel.pdf

* item 1
* item 2

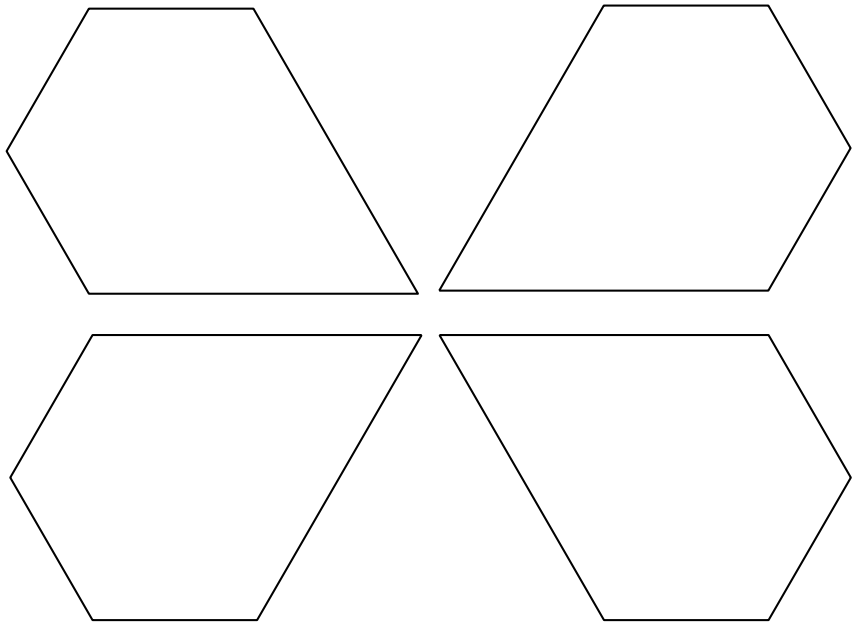


Figure: Caption Text

smallHexagonalGridWithEll.pdf

* item 1
* item 2

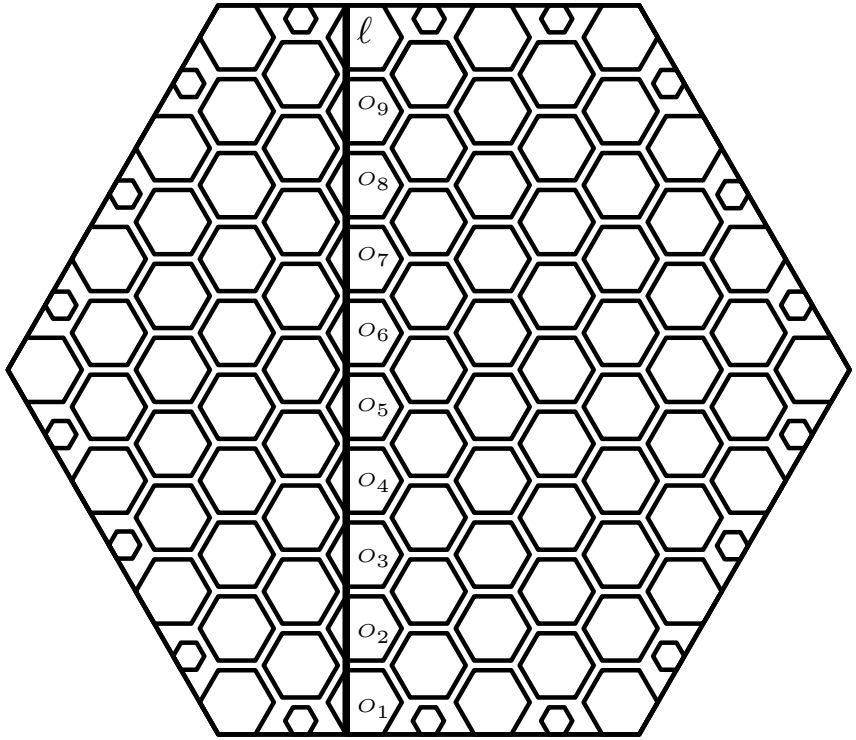


Figure: Caption Text

smallHexagonalGridWithTwoLines.pdf

* item 1
* item 2

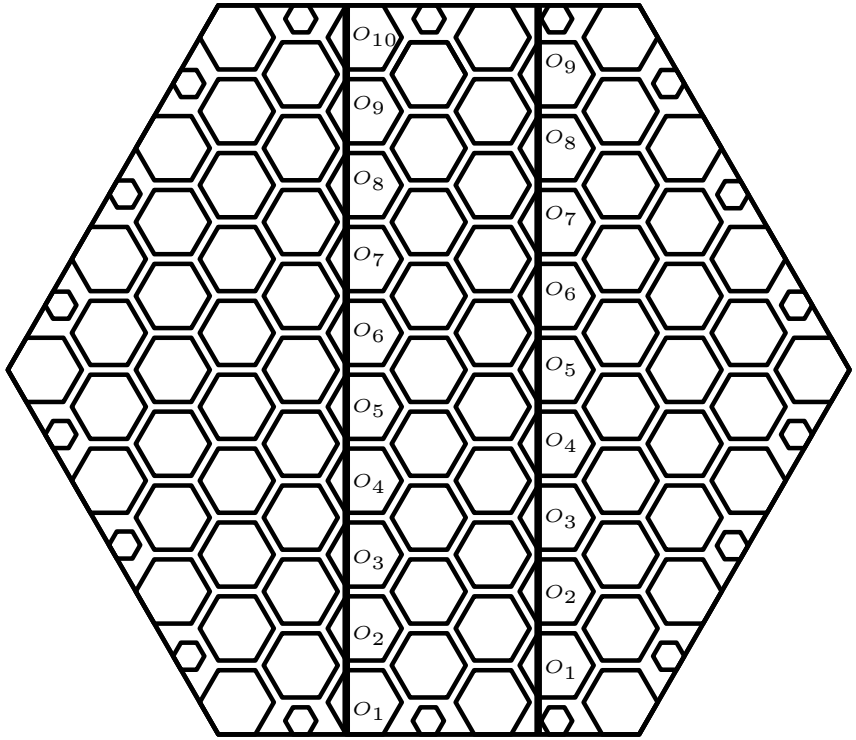


Figure: Caption Text

snowflakeOutline2Layer.pdf

* item 1
* item 2

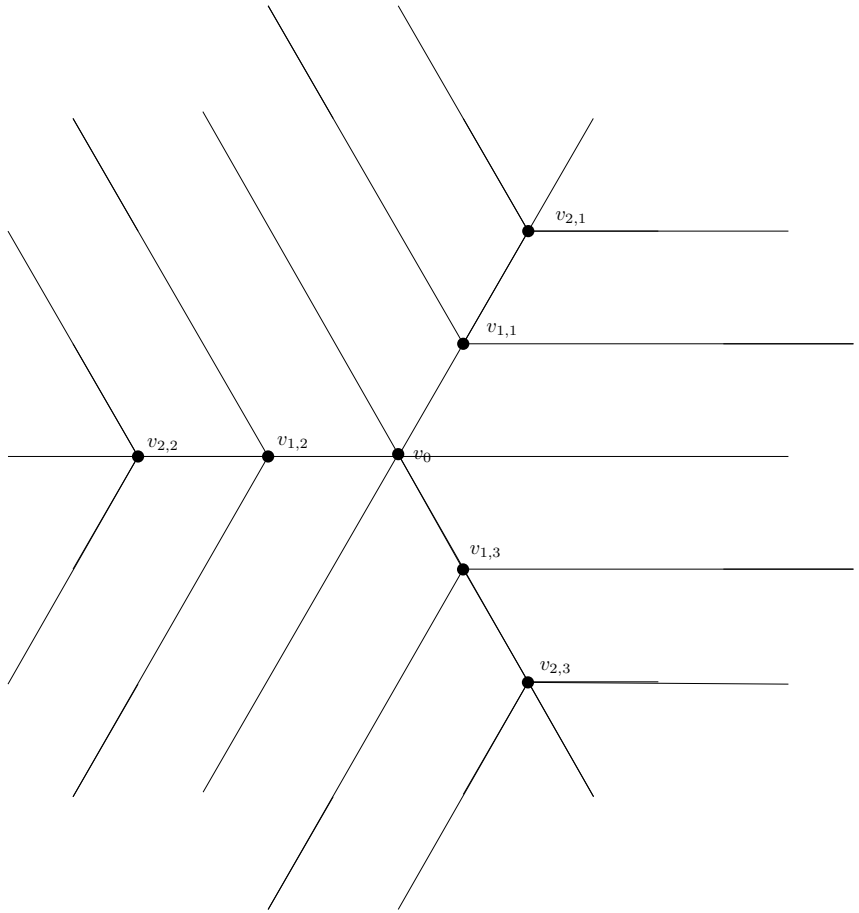


Figure: Caption Text

snowflakeOutline5Layer.pdf

* item 1
* item 2

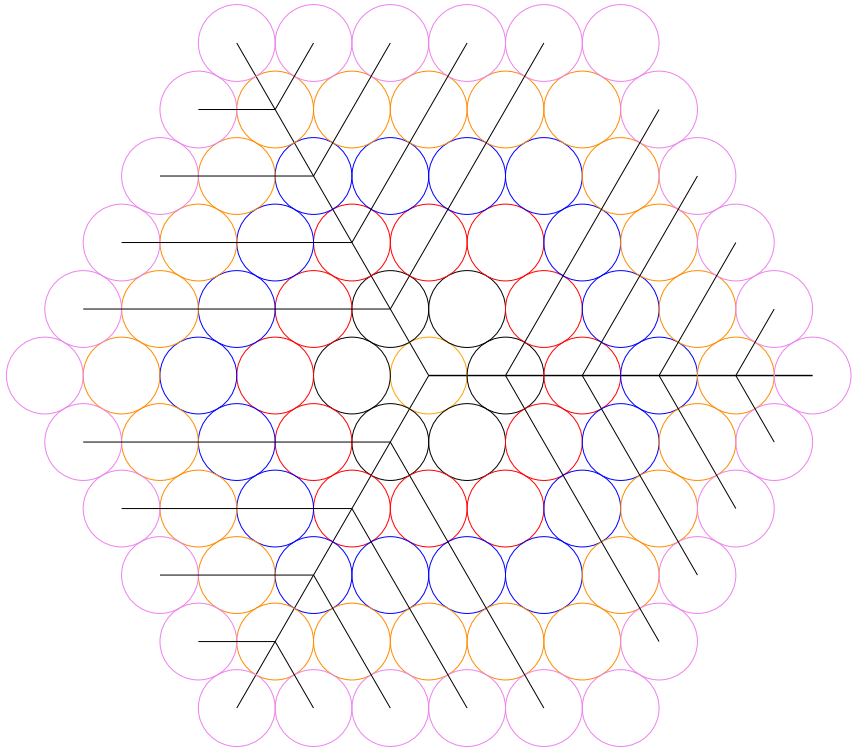


Figure: Caption Text

snowflakeOutline5LayerModified.pdf

* item 1
* item 2

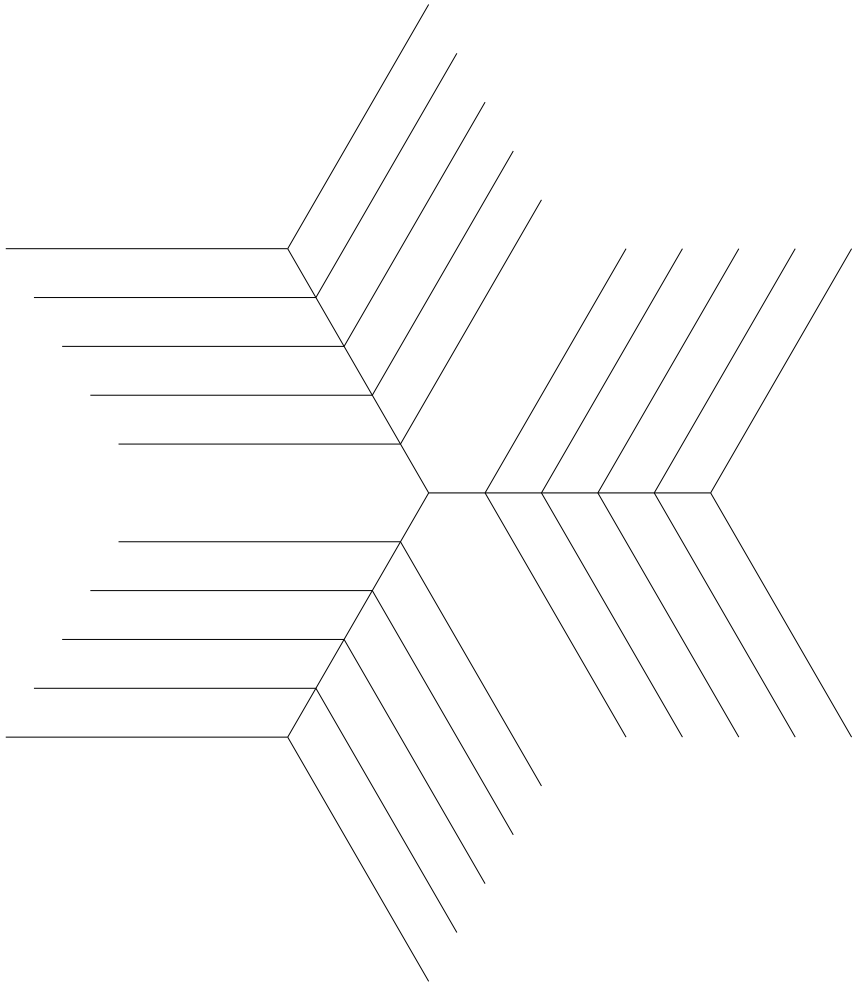


Figure: Caption Text

snowflakeOutline5LayerSmall.pdf

* item 1
* item 2

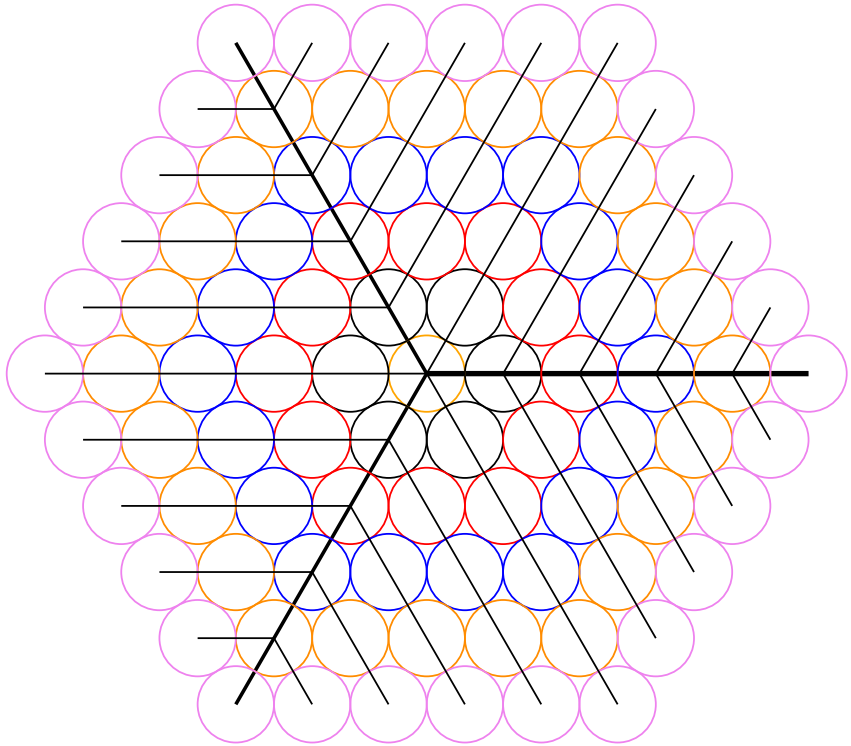


Figure: Caption Text

snowflakeOutline5LayerSmallNoCircles.pdf

* item 1
* item 2

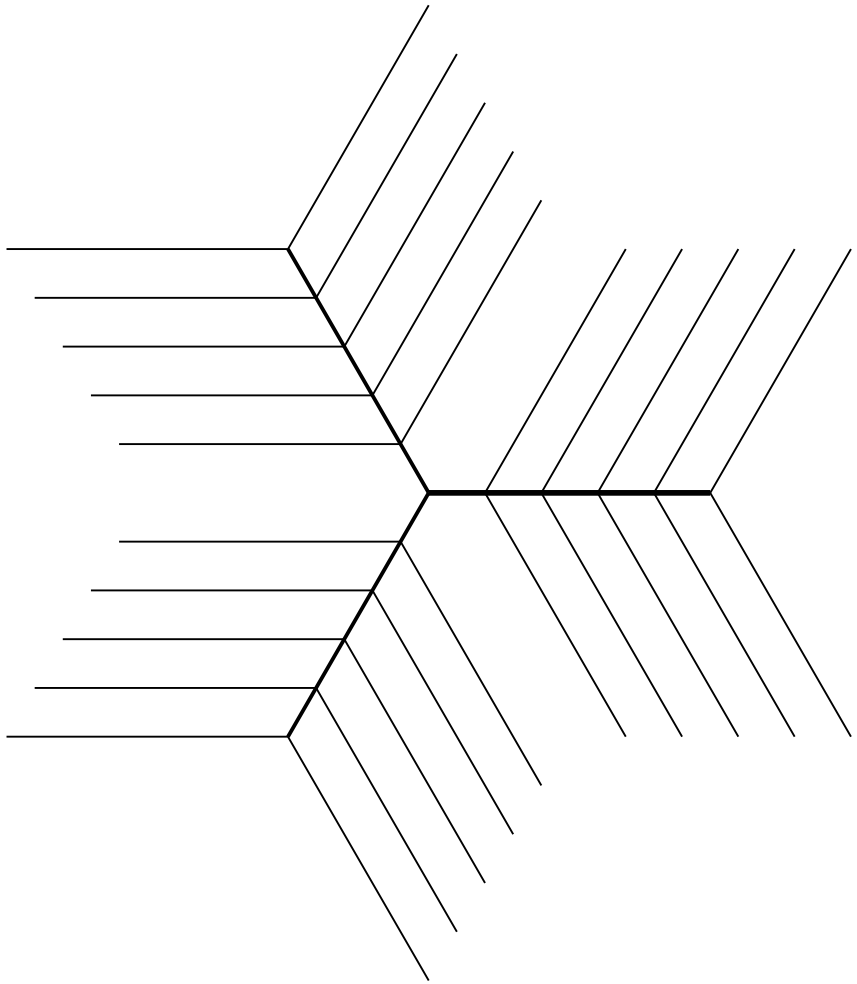


Figure: Caption Text

snowflakePerturbedAngularGrid.pdf

* item 1
* item 2

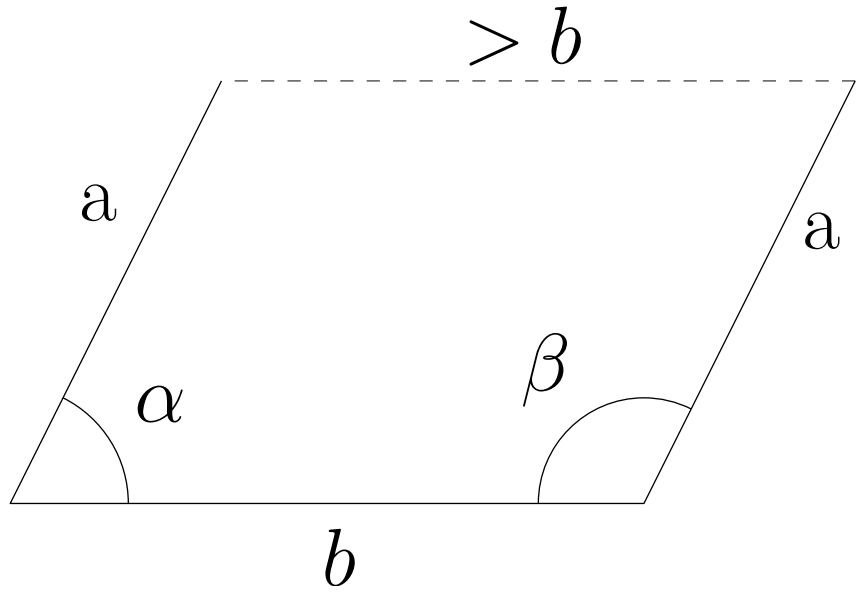


Figure: Caption Text

someRangeSkinny.pdf

* item 1
* item 2

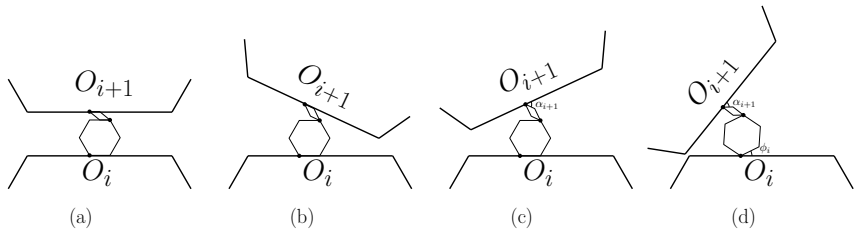


Figure: Caption Text

switchTerminalFinalized1.pdf

* item 1
* item 2

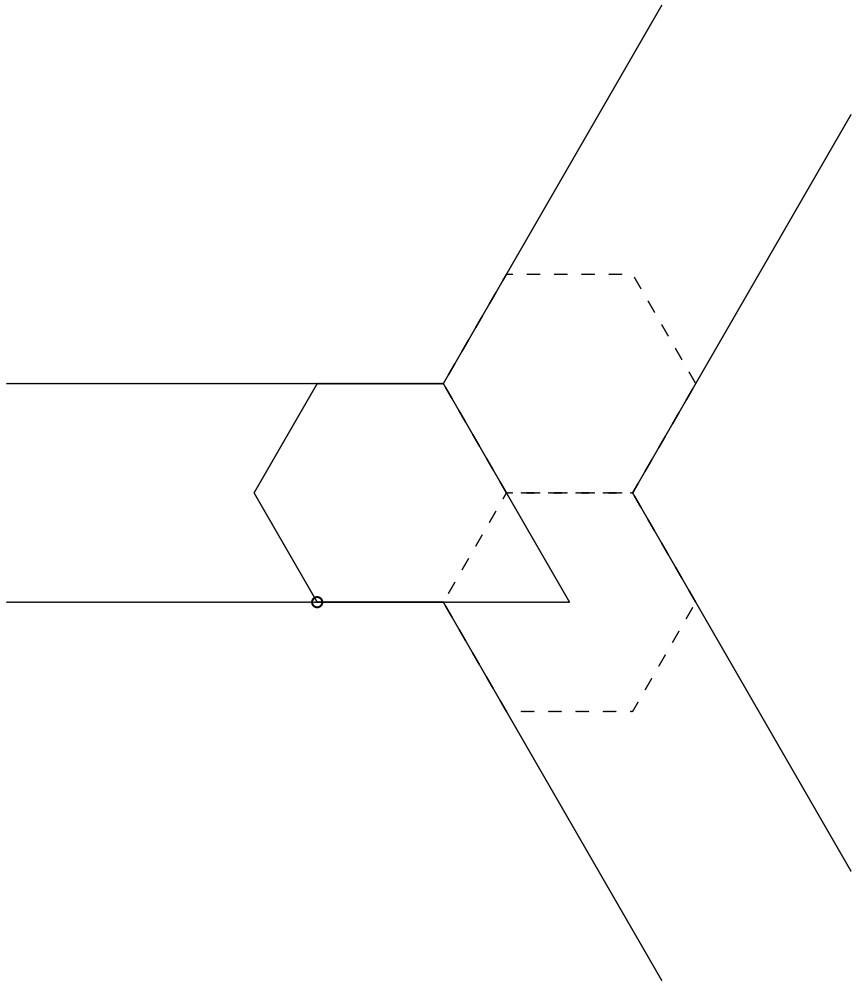


Figure: Caption Text

switchTerminalFinalized2.pdf

* item 1
* item 2

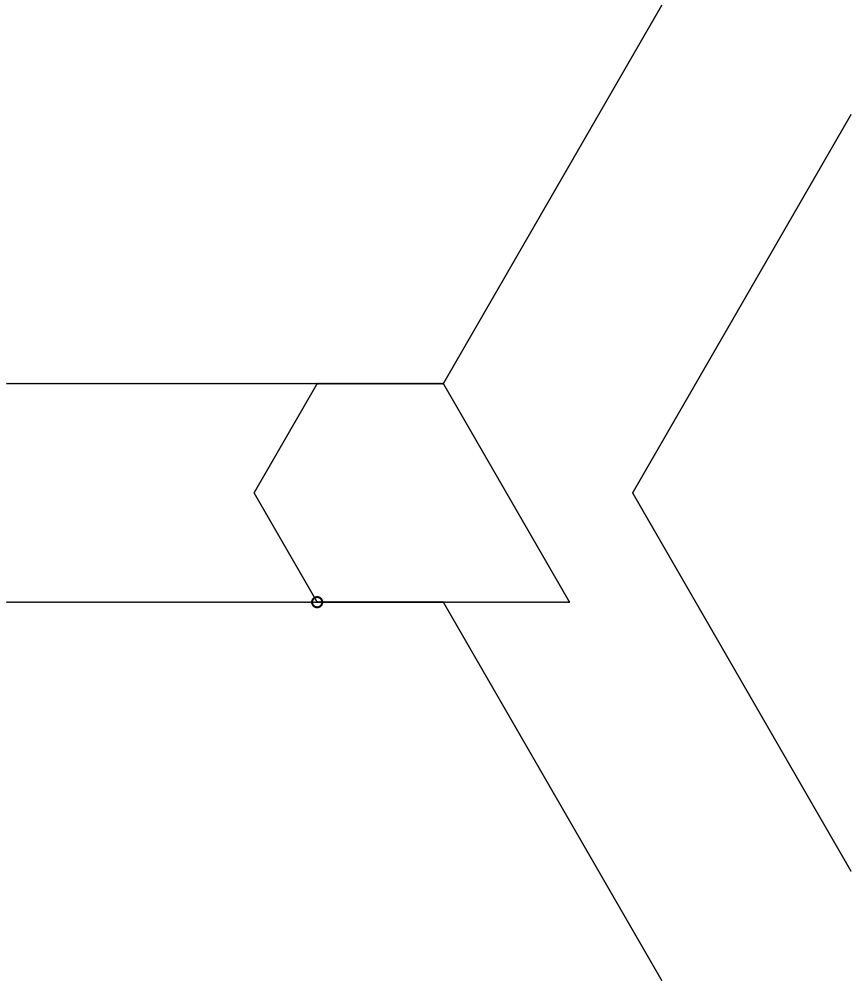


Figure: Caption Text

switchTerminalFinalized3.pdf

* item 1
* item 2

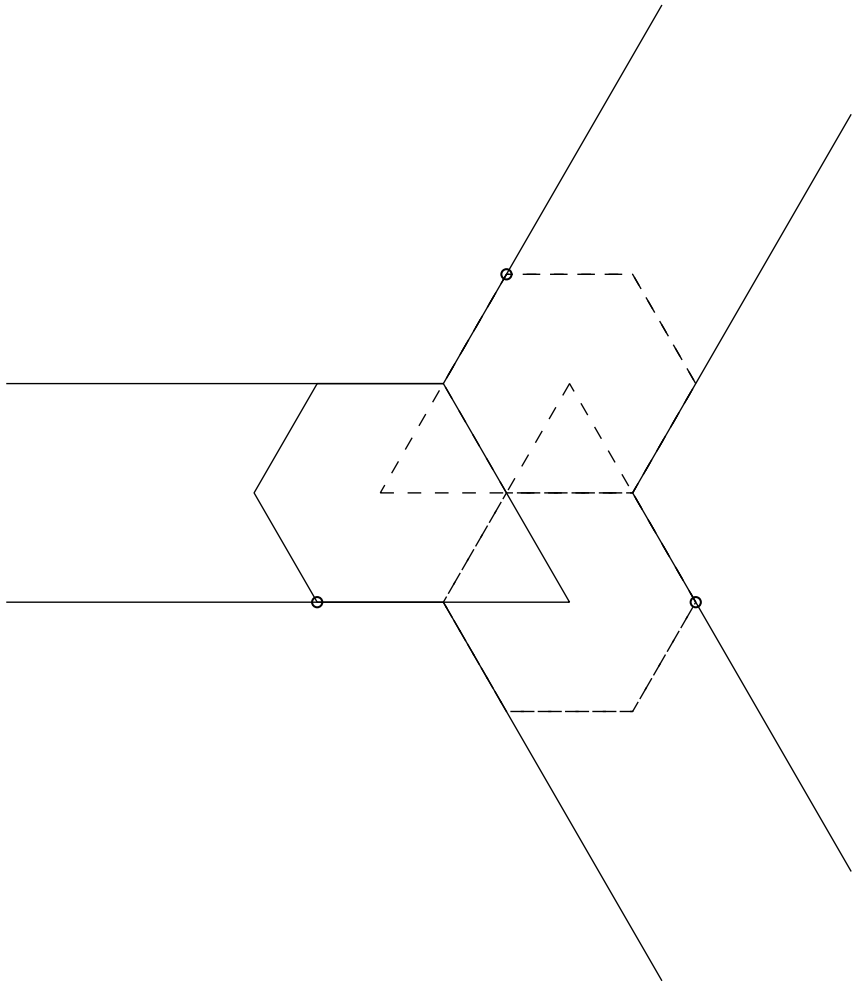


Figure: Caption Text

tangentalpha.pdf

* item 1
* item 2

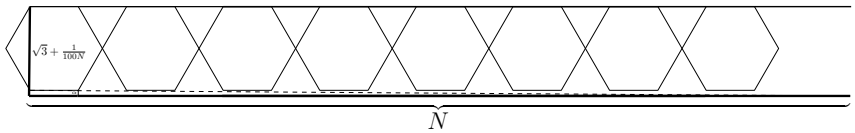


Figure: Caption Text

TheOmegaFigure.pdf

* item 1
* item 2

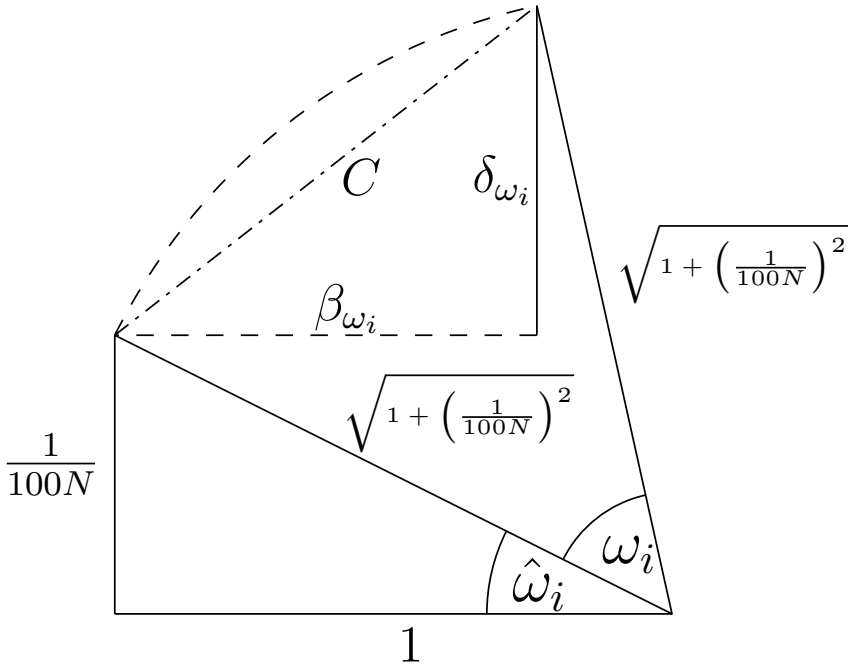


Figure: Caption Text

tiltedObstaclesInFrame.pdf

* item 1
* item 2

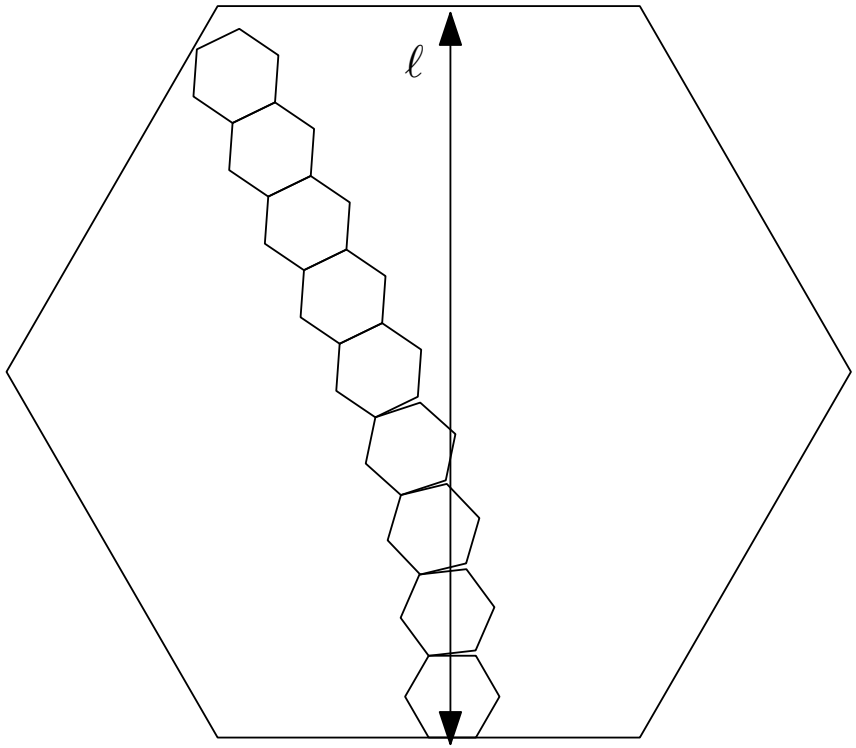


Figure: Caption Text

TransmitterDrawingTranslation.pdf

* item 1
* item 2

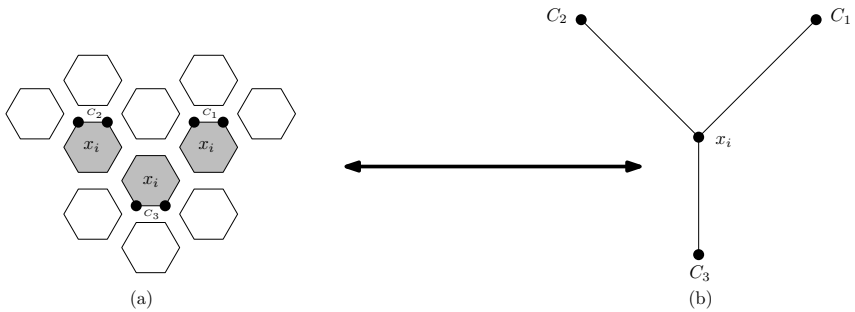


Figure: Caption Text

TransmitterGadgetSmall.pdf

* item 1
* item 2

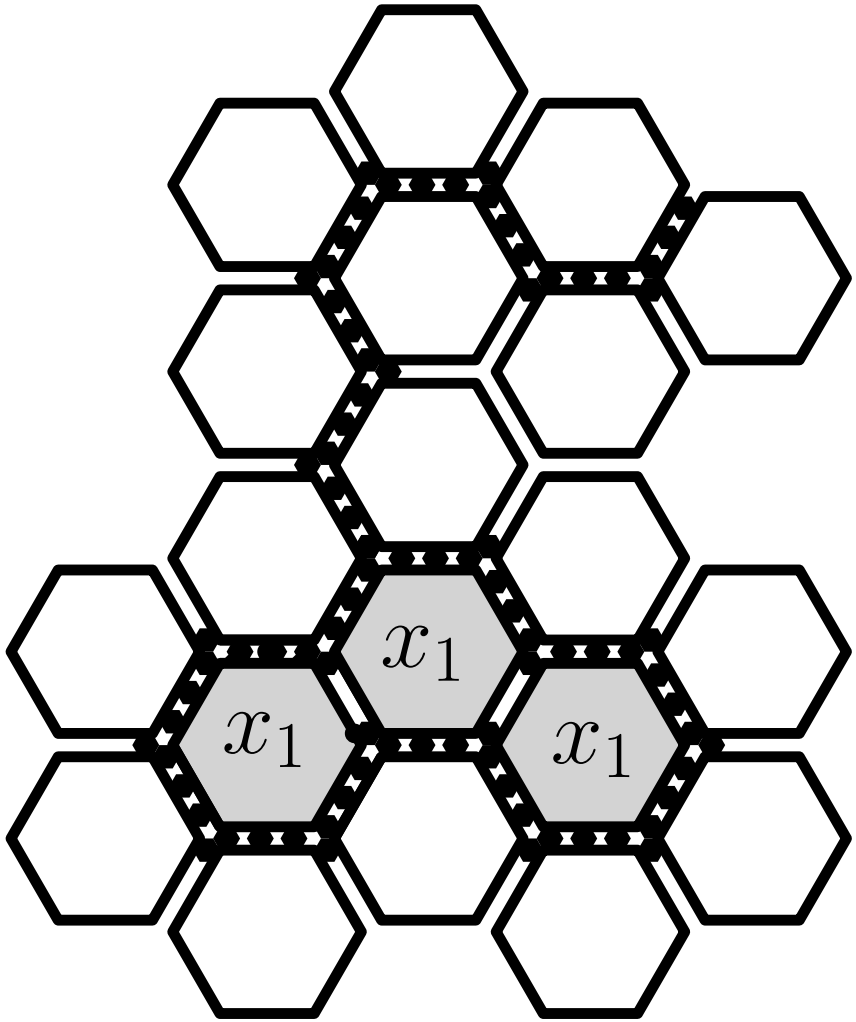


Figure: Caption Text

transmitterjunction.pdf

* item 1
* item 2

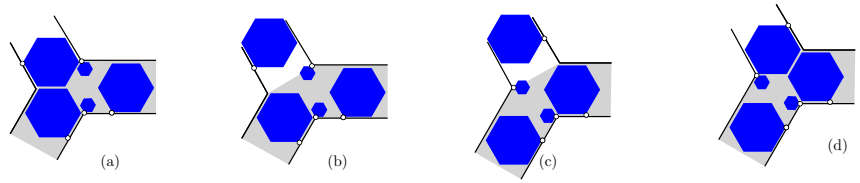


Figure: Caption Text

TreeCh4.pdf

* item 1
* item 2

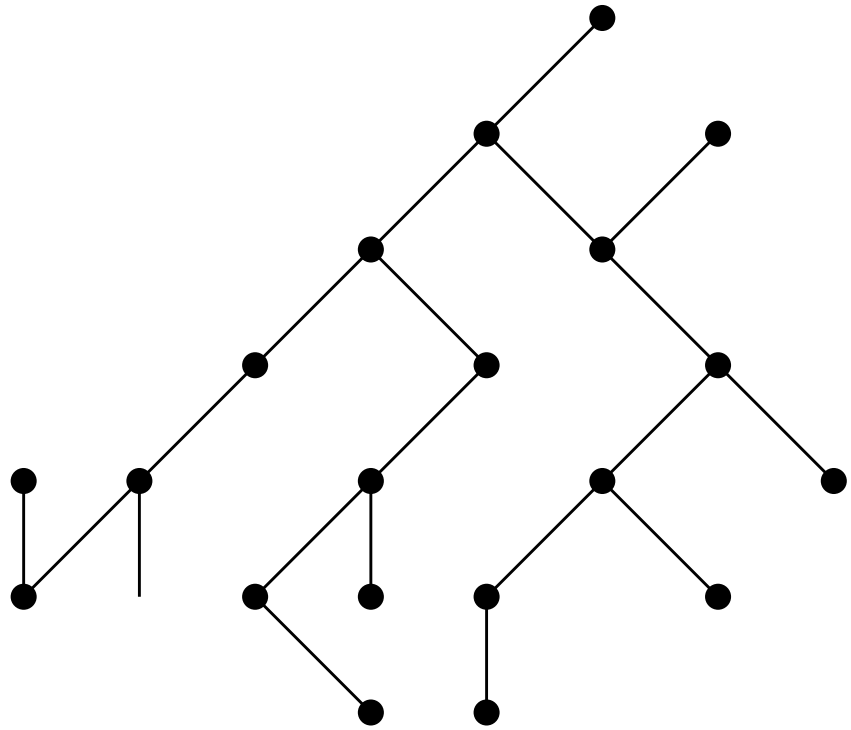


Figure: Caption Text

TriangluarDissection.pdf

* item 1
* item 2

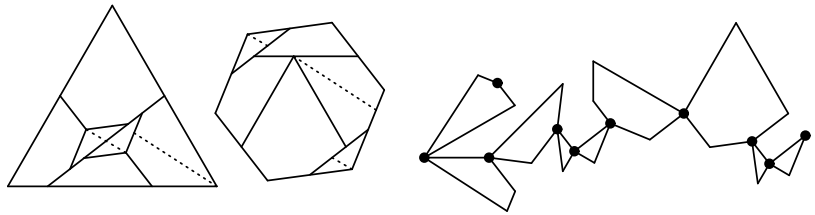


Figure: Caption Text

TrueVariableGadget.pdf

* item 1
* item 2

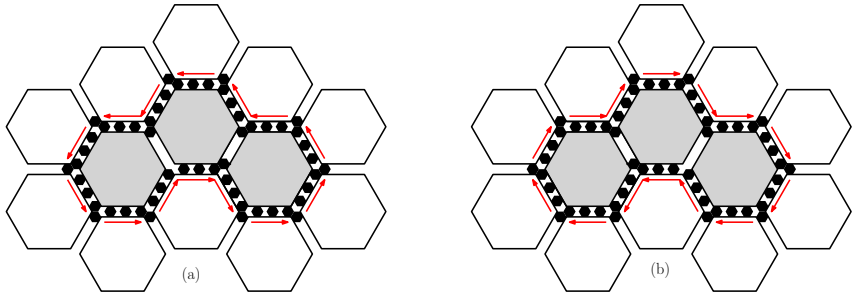


Figure: Caption Text

TrueVariableNegatedLiteralTransmitter.pdf

* item 1
* item 2

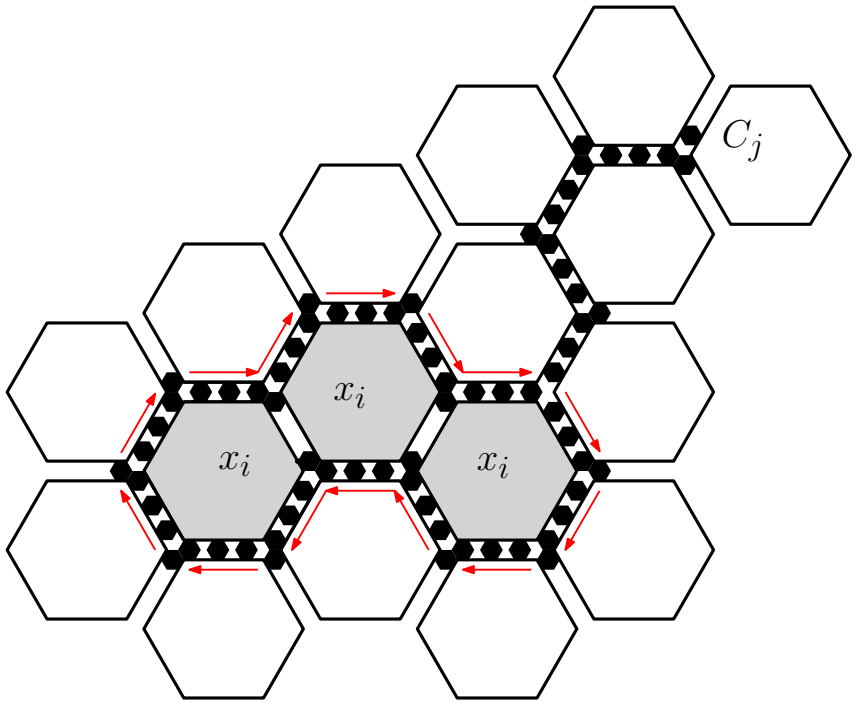


Figure: Caption Text

twoEmbeddingsOfSameLinkage.pdf

* item 1
* item 2

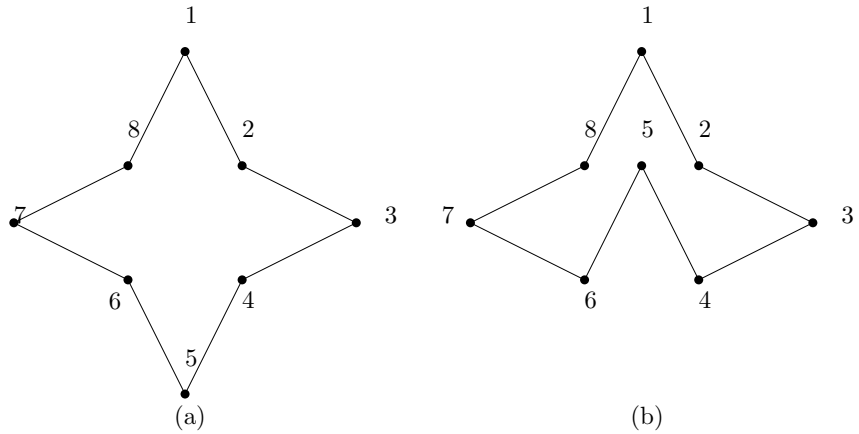


Figure: Caption Text

VariableFalseTransmitterClause.pdf

* item 1
* item 2

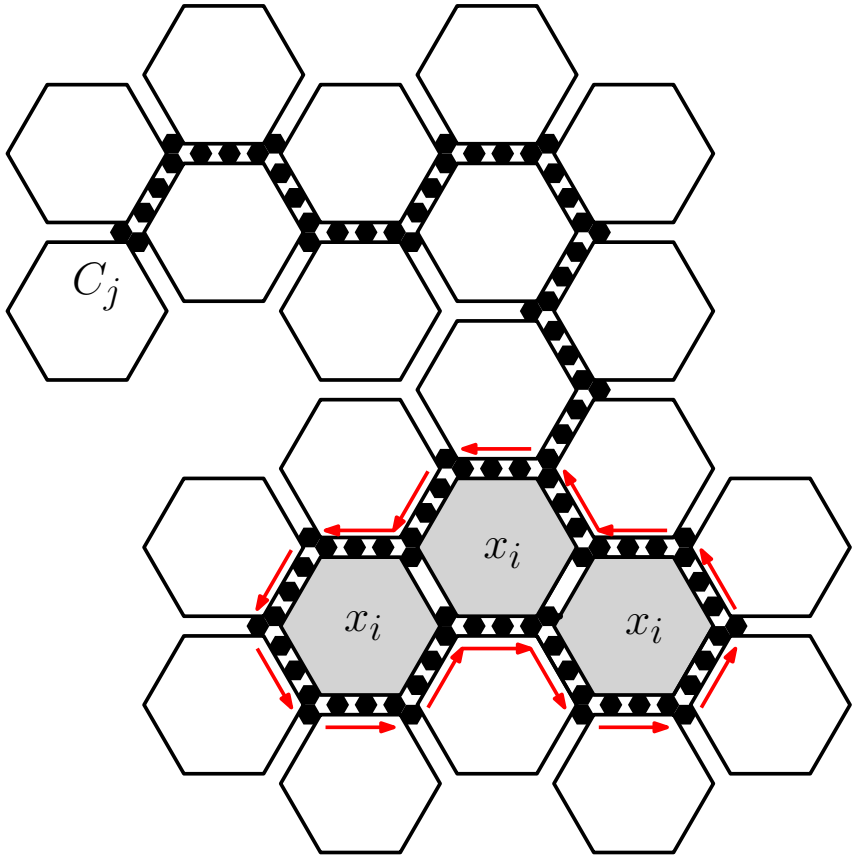


Figure: Caption Text

VariableGadget.pdf

* item 1
* item 2

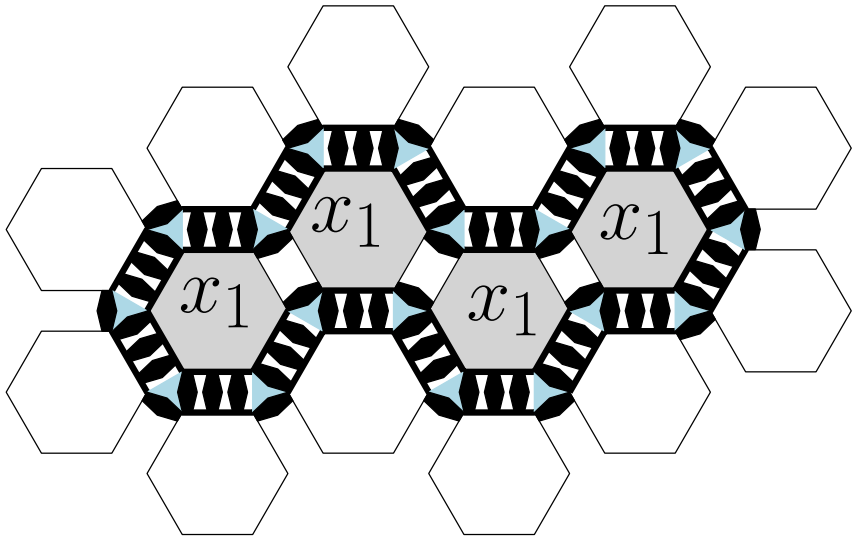


Figure: Caption Text

VariableGadgetSmall.pdf

* item 1
* item 2

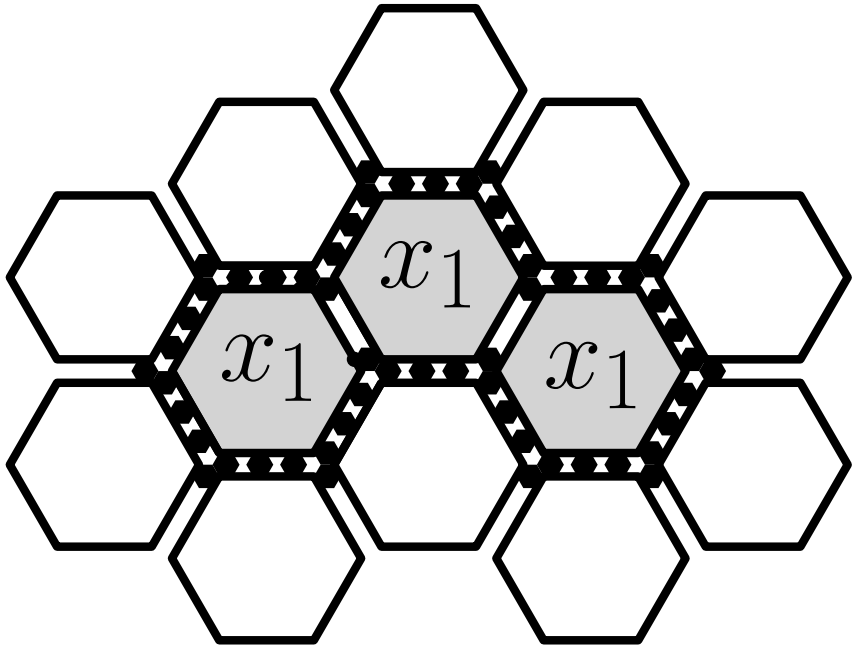


Figure: Caption Text

VariableGadgetTruthness.pdf

* item 1
* item 2

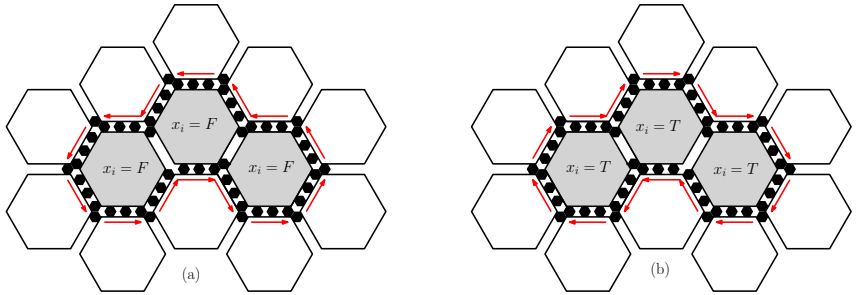


Figure: Caption Text

VariableGadgetTruthnessZoom.pdf

* item 1
* item 2

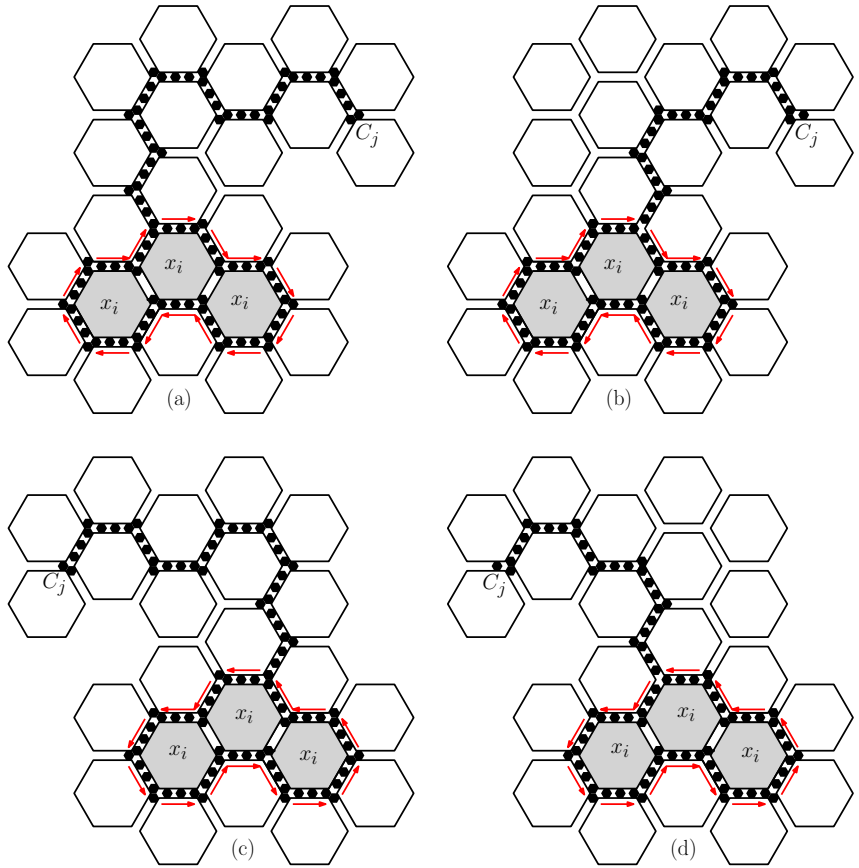


Figure: Caption Text

VariableJunctionTransmitterSelection.pdf

* item 1
* item 2

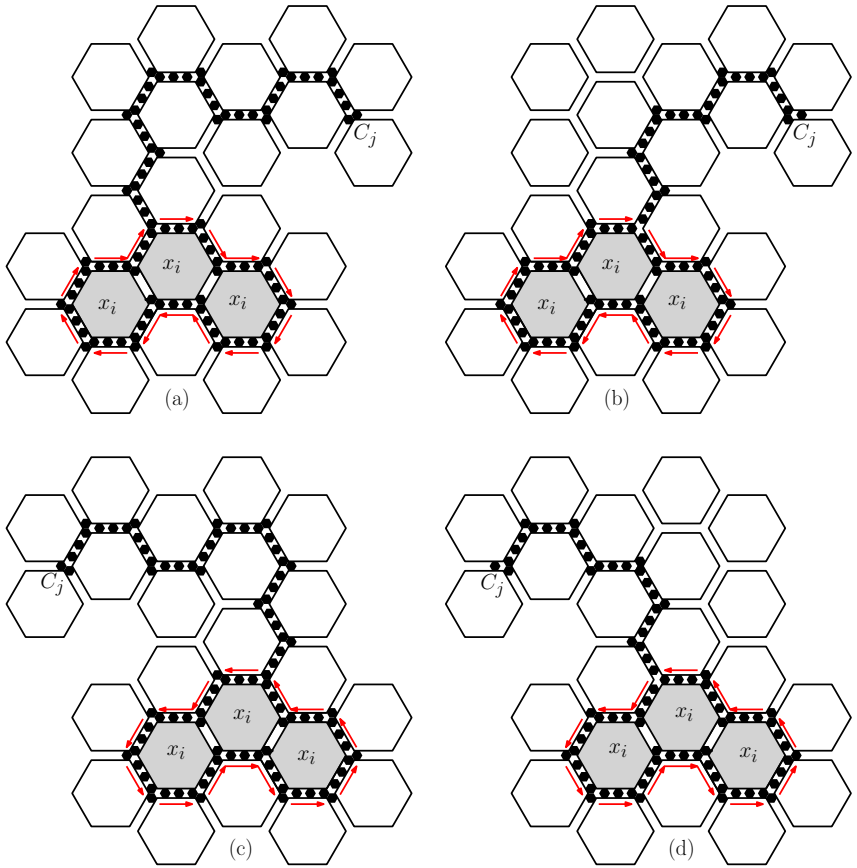


Figure: Caption Text

VariableJunctionTransmitterSelection2.pdf

* item 1
* item 2

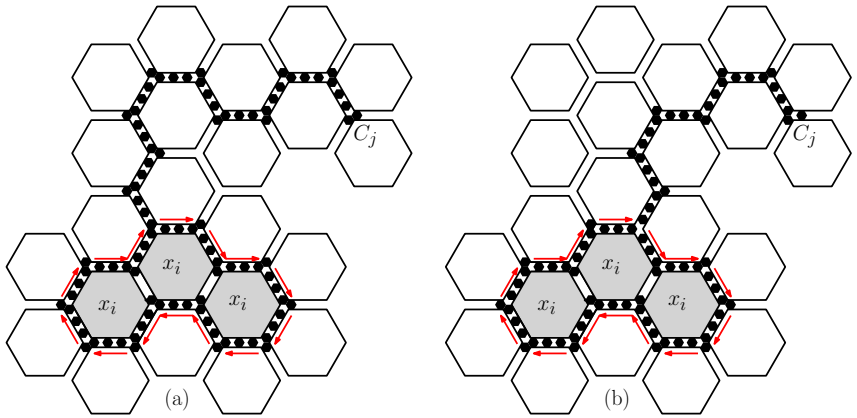


Figure: Caption Text

VariablesExample.pdf

* item 1
* item 2

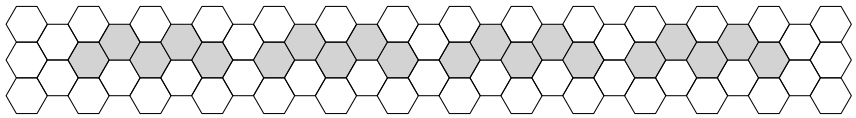


Figure: Caption Text

VariableTrueTransmitterClause.pdf

* item 1
* item 2

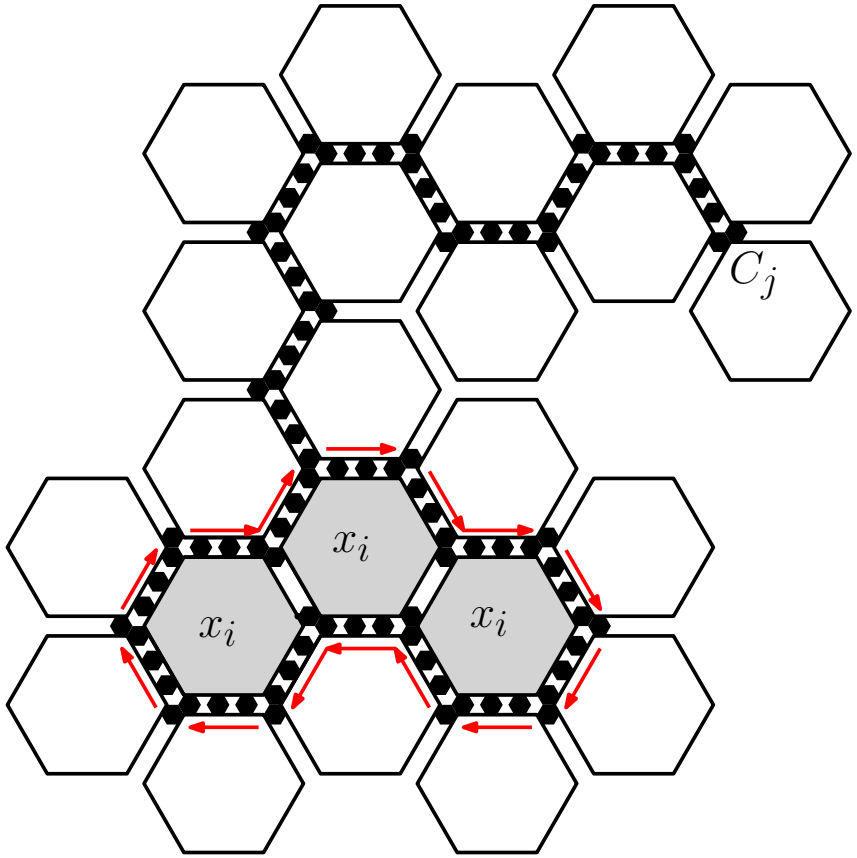


Figure: Caption Text

Vertebrae.pdf

* item 1
* item 2

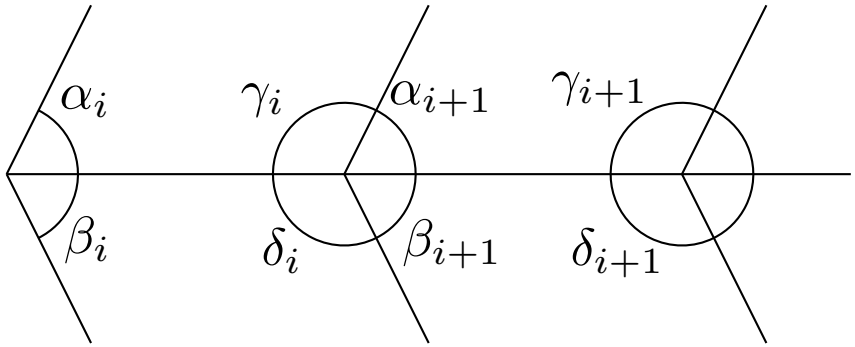


Figure: Caption Text

verticalDisplacementArgument.pdf

* item 1
* item 2

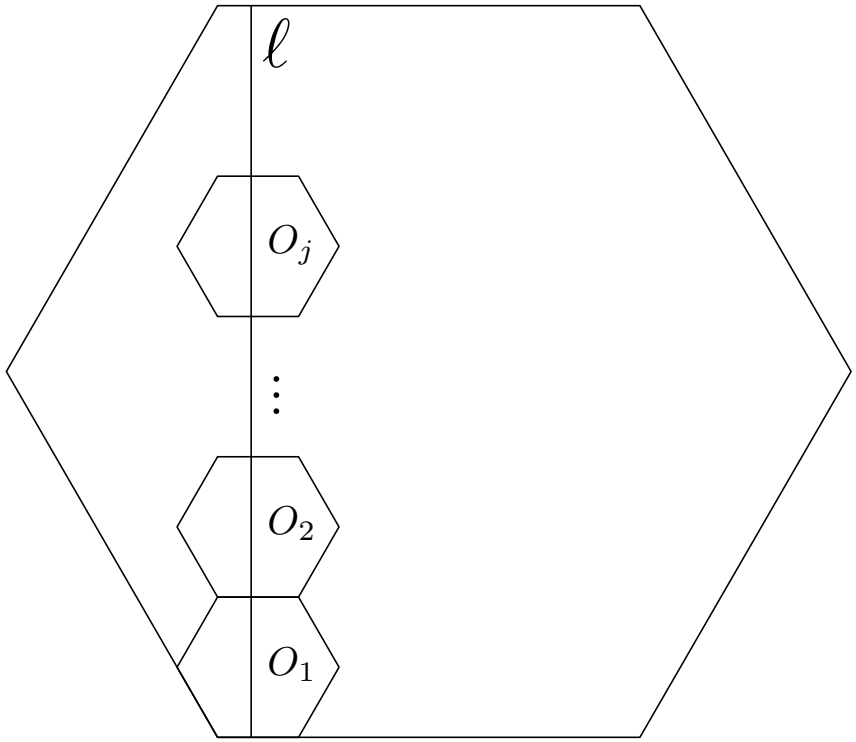


Figure: Caption Text

WrapAround.pdf

* item 1
* item 2

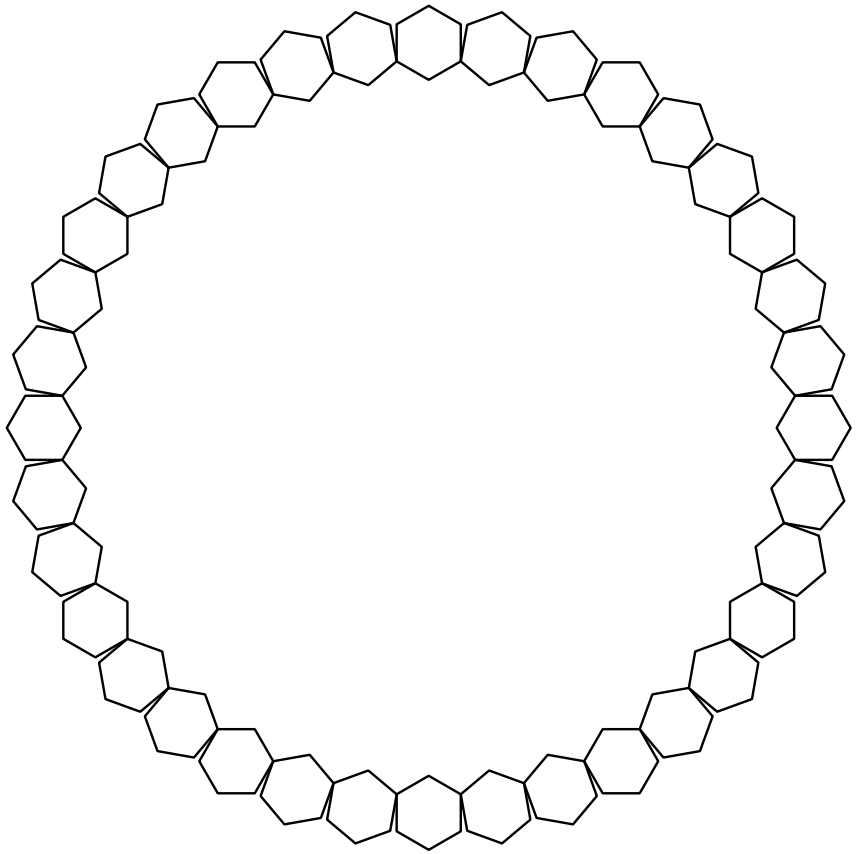


Figure: Caption Text