

Pensieve header: February 3: Textbook (EIWL) chapters 13-18, evaluated.

13. Arrays, or Lists of Lists

`Table[x, 4]`

```
{x, x, x, x}
```

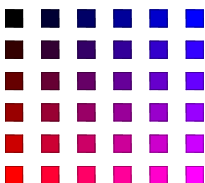
`Table[x, 4, 5]`

```
{{x, x, x, x, x}, {x, x, x, x, x}, {x, x, x, x, x}, {x, x, x, x, x}}
```

`Grid[Table[x, 4, 5]]`

```
x x x x x
x x x x x
x x x x x
x x x x x
```

`Grid[Table[RGBColor[r, 0, b], {r, 0, 1, .2}, {b, 0, 1, .2}]]`



`Grid[Table[GCD[i, j], {i, 10}, {j, 10}]]`

```
1 1 1 1 1 1 1 1 1 1
1 2 1 2 1 2 1 2 1 2
1 1 3 1 1 3 1 1 3 1
1 2 1 4 1 2 1 4 1 2
1 1 1 1 5 1 1 1 1 5
1 2 3 2 1 6 1 2 3 2
1 1 1 1 1 1 7 1 1 1
1 2 1 4 1 2 1 8 1 2
1 1 3 1 1 3 1 1 9 1
1 2 1 2 5 2 1 2 1 10
```

`Grid[Table[i, {i, 4}, {j, 5}]]`

```
1 1 1 1 1
2 2 2 2 2
3 3 3 3 3
4 4 4 4 4
```

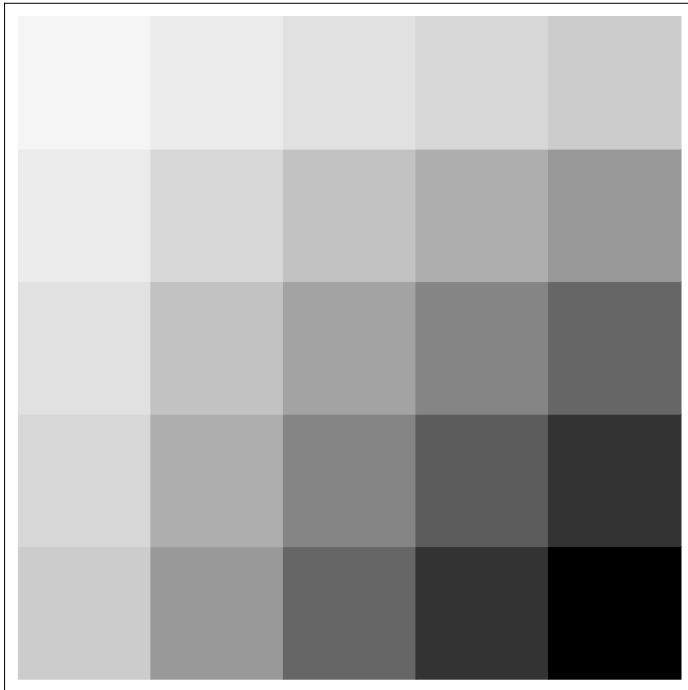
`Grid[Table[j, {i, 4}, {j, 5}]]`

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

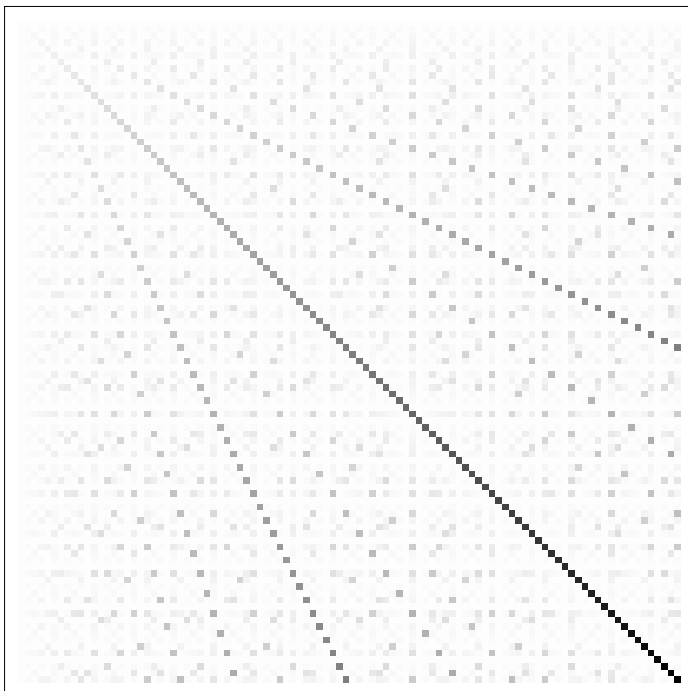
`Grid[Table[i + j, {i, 5}, {j, 5}]]`

```
2 3 4 5 6
3 4 5 6 7
4 5 6 7 8
5 6 7 8 9
6 7 8 9 10
```

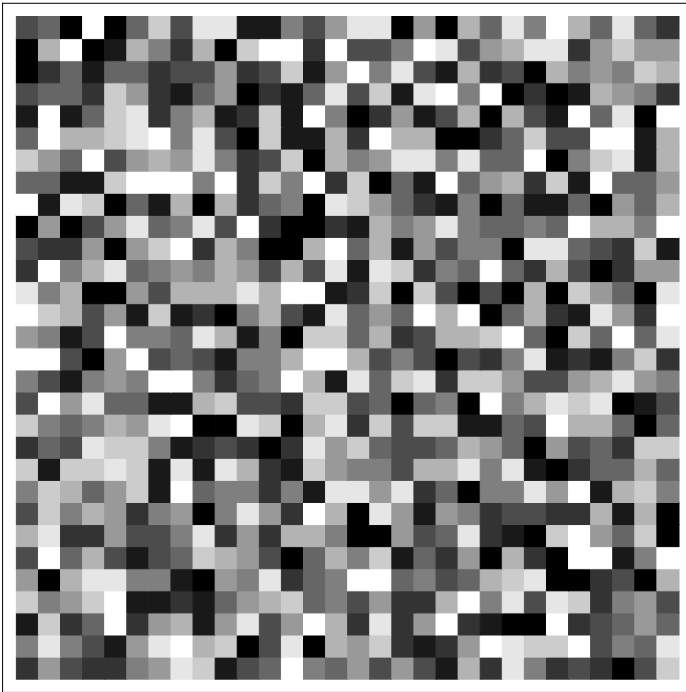
```
ArrayPlot[Table[i * j, {i, 5}, {j, 5}]]
```



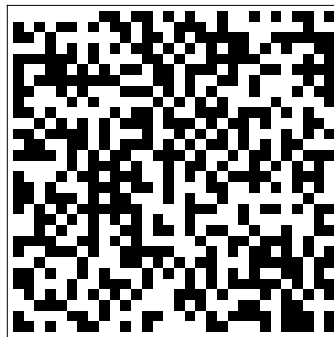
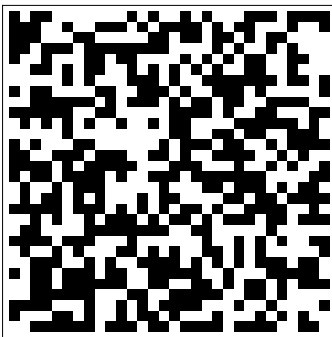
```
ArrayPlot[Table[GCD[i, j], {i, 100}, {j, 100}]]
```



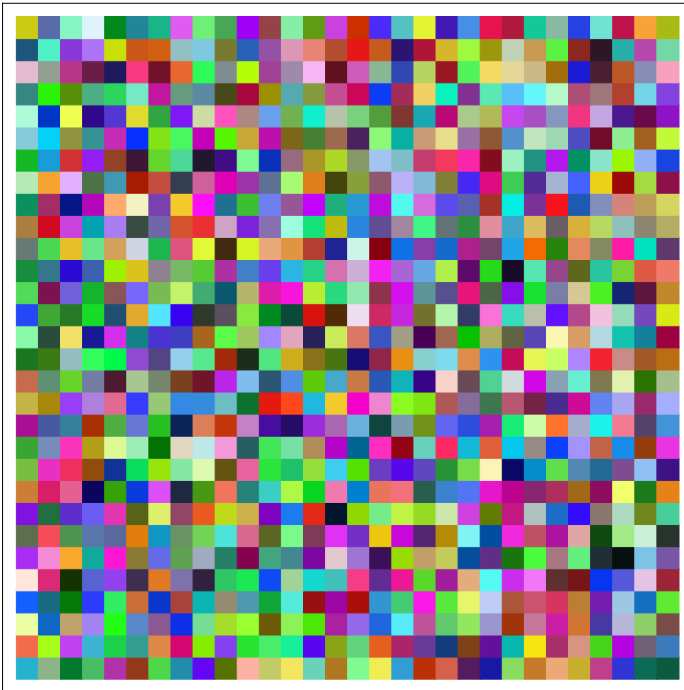
```
ArrayPlot[Table[RandomInteger[10], 30, 30]]
```



```
GraphicsRow[{  
  ArrayPlot[Table[RandomInteger[1], 30, 30]],  
  b = RandomInteger[1];  
  ArrayPlot[Table[b = If[Random[] < 0.6, 1 - b, b], 30, 30]]  
}]
```



```
ArrayPlot[Table[RandomColor[], 30, 30]]
```



```
x2
```

```
x2
```

```
x2 // Rasterize
```

```
x2 // Binarize
```

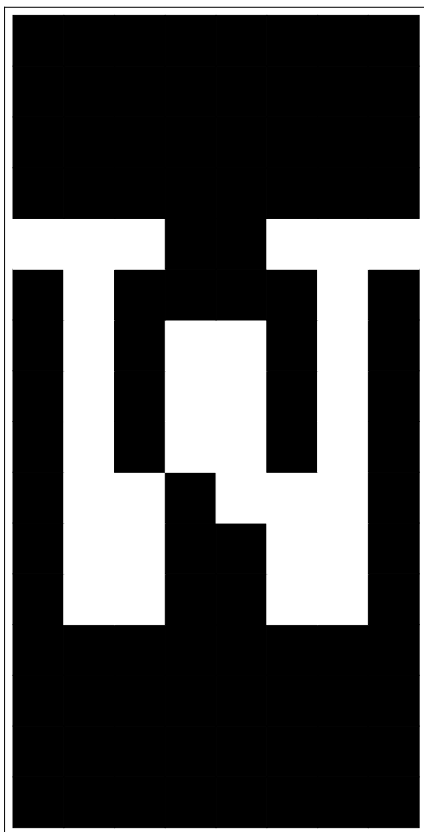
```
x2
```

```
ImageData[Binarize[Rasterize["W"]]]
```

```
{{1, 1, 1, 1, 1, 1, 1, 1}, {1, 1, 1, 1, 1, 1, 1, 1},
 {1, 1, 1, 1, 1, 1, 1, 1}, {1, 1, 1, 1, 1, 1, 1, 1},
 {0, 0, 0, 1, 1, 0, 0, 0}, {1, 0, 1, 1, 1, 1, 0, 1}, {1, 0, 1, 0, 0, 1, 0, 1},
 {1, 0, 1, 0, 0, 1, 0, 1}, {1, 0, 1, 0, 0, 1, 0, 1}, {1, 0, 0, 1, 0, 0, 0, 1},
 {1, 0, 0, 1, 1, 0, 0, 1}, {1, 0, 0, 1, 1, 0, 0, 1}, {1, 1, 1, 1, 1, 1, 1, 1},
 {1, 1, 1, 1, 1, 1, 1, 1}, {1, 1, 1, 1, 1, 1, 1, 1}}
```



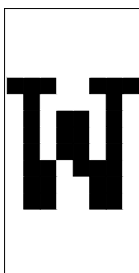
```
ArrayPlot[ImageData[Binarize[Rasterize["W"]]]]
```



```
1 - ImageData[Binarize[Rasterize["W"]]]
```

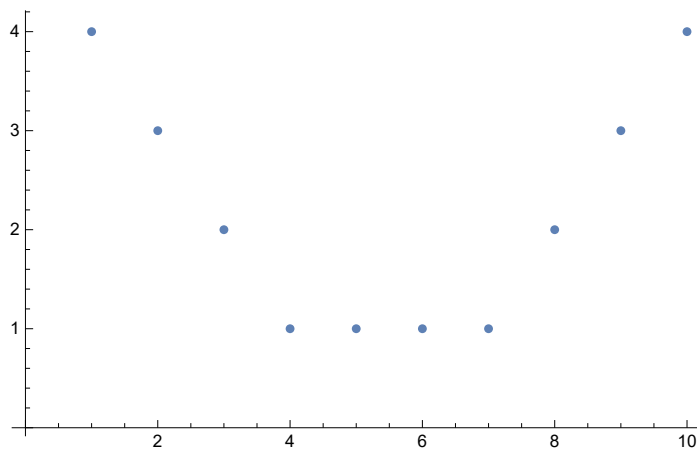
```
{0, 0, 0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0, 0, 0},
{1, 1, 1, 0, 0, 1, 1, 1}, {0, 1, 0, 0, 0, 0, 1, 0}, {0, 1, 0, 1, 1, 0, 1, 0},
{0, 1, 0, 1, 1, 0, 1, 0}, {0, 1, 0, 1, 1, 0, 1, 0}, {0, 1, 1, 0, 1, 1, 1, 0},
{0, 1, 1, 0, 0, 1, 1, 0}, {0, 1, 1, 0, 0, 1, 1, 0}, {0, 0, 0, 0, 0, 0, 0, 0},
{0, 0, 0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0, 0, 0}, {0, 0, 0, 0, 0, 0, 0, 0}
```

```
ArrayPlot[1 - ImageData[Binarize[Rasterize["W"]]]]
```

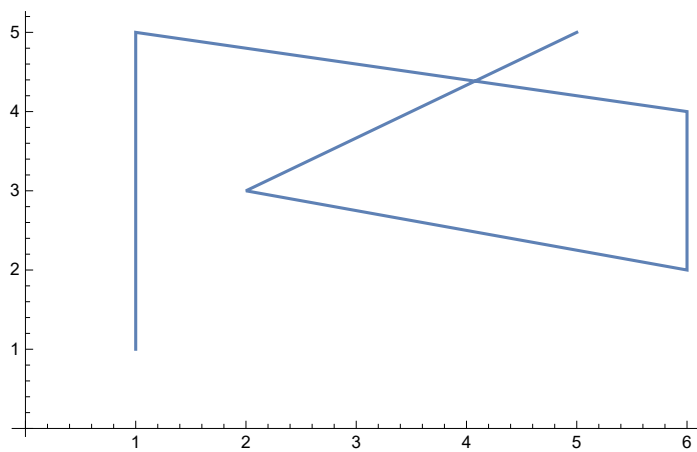


14. Coordinates and Graphics

```
ListPlot[{4, 3, 2, 1, 1, 1, 1, 2, 3, 4}]
```



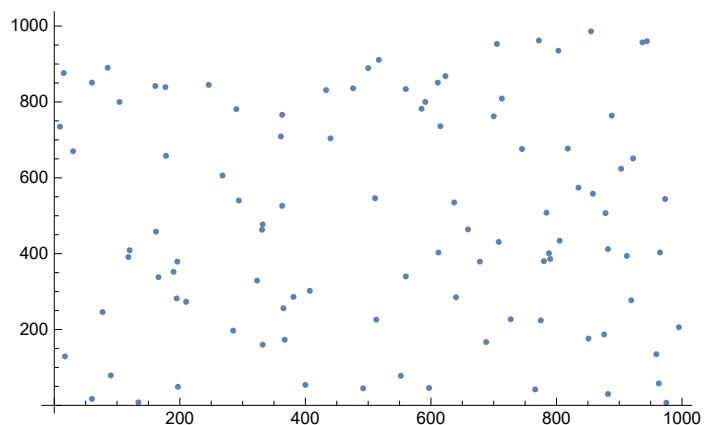
```
ListLinePlot[{{1, 1}, {1, 5}, {6, 4}, {6, 2}, {2, 3}, {5, 5}}]
```



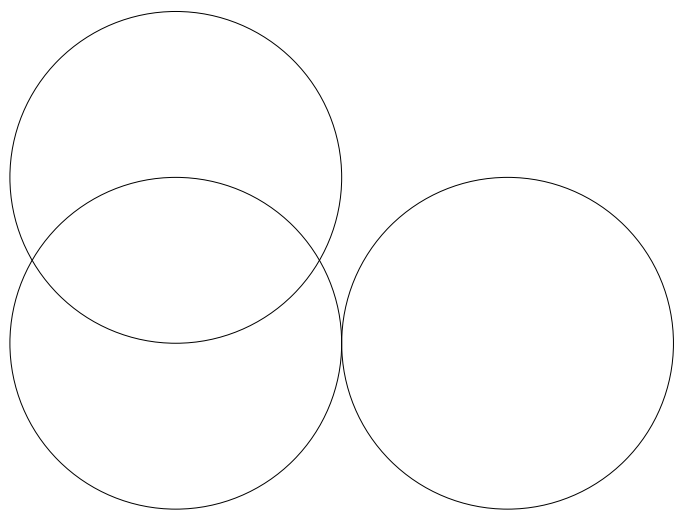
```
Table[RandomInteger[20], 10, 2]
```

```
RandomInteger[20, {10, 2}]
```

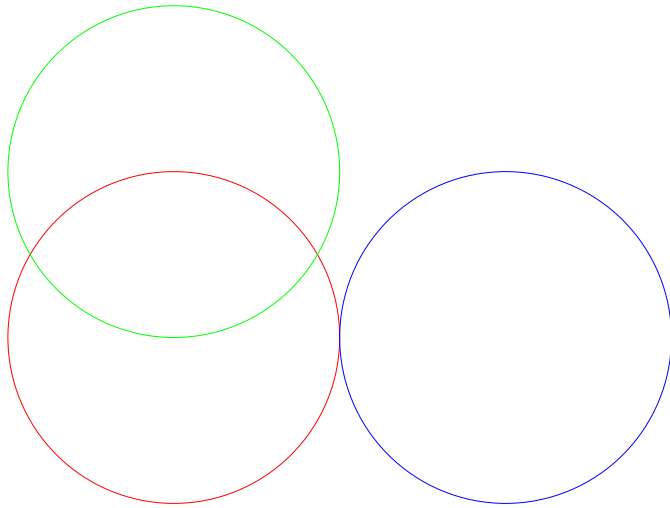
```
ListPlot[Table[RandomInteger[1000], 100, 2]]
```



```
Graphics[{Circle[{1, 1}], Circle[{1, 2}], Circle[{3, 1}]}]
```

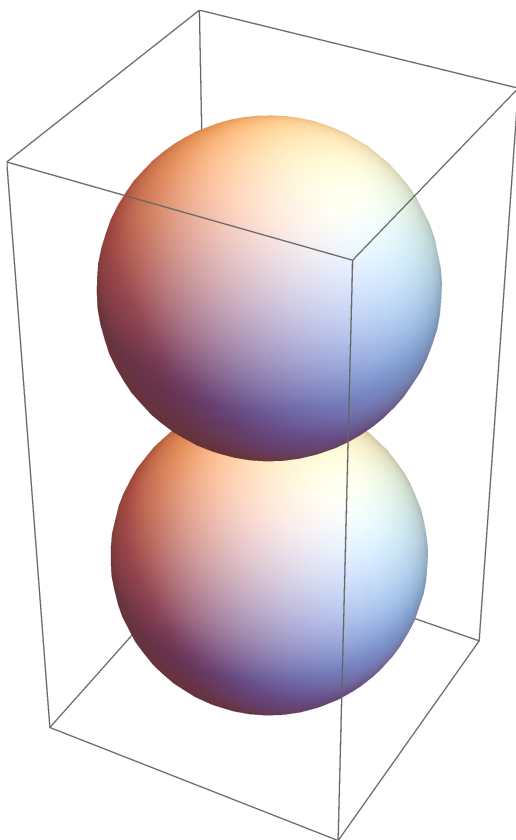


```
Graphics[{Style[Circle[{1, 1}], Red],
  Style[Circle[{1, 2}], Green], Style[Circle[{3, 1}], Blue]}]
```



```
Graphics[Table[Circle[RandomInteger[50, 2]], 100]]
Graphics[Table[Circle[{x, y}], {x, 0, 10, 2}, {y, 0, 10, 2}]]
Graphics[{Circle[{1, 1}, 0.5], Circle[{1, 2}, 1.2], Circle[{3, 1}, 0.8]}]
Graphics[Table[Circle[{0, 0}, r], {r, 10}]]
Graphics[Table[Circle[{x, 0}, x], {x, 10}]]
Graphics[Table[Circle[RandomInteger[50, 2], RandomInteger[10]], 100]]
Graphics[{RegularPolygon[{1, 1}, 1, 5], RegularPolygon[{3, 1}, 0.5, 7]}]
Graphics[{RegularPolygon[{1, 1}, 1, 5],
  Circle[{1, 1}, 1], RegularPolygon[{3, 1}, .5, 7], Disk[{2, 2}, .5]}]
Graphics[{Point[{0, 0}], Point[{2, 0}], Point[{1, 1.5}]}]
Graphics[Point[{{0, 0}, {2, 0}, {1, 1.5}}]]
Graphics[Line[{{0, 0}, {2, 0}, {1, 1.5}}]]
Graphics[Polygon[Table[RandomInteger[100], 20, 2]]]
```

```
Graphics3D[{Sphere[{0, 0, 0}], Sphere[{0, 0, 2}]}]
```

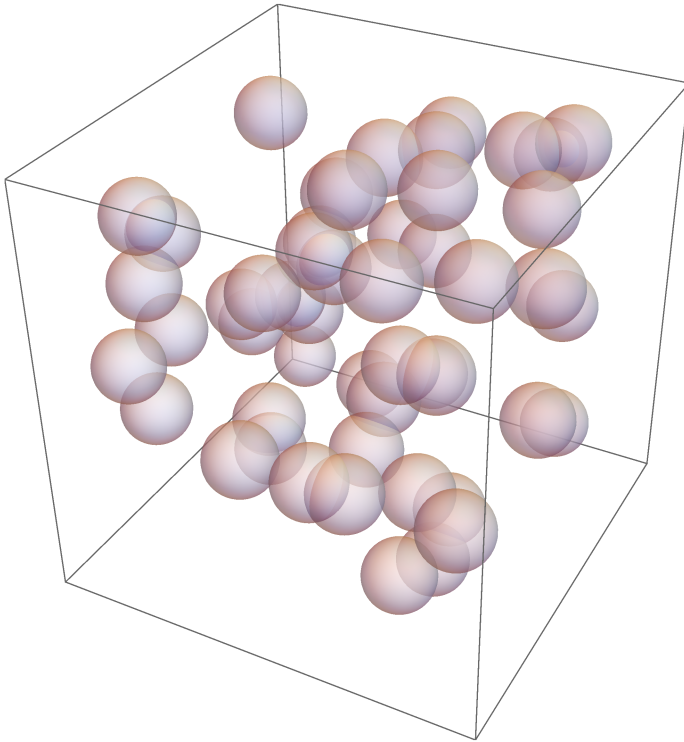


```
Graphics3D[Table[Sphere[{x, y, z}, 1/2], {x, 5}, {y, 5}, {z, 5}]]
```

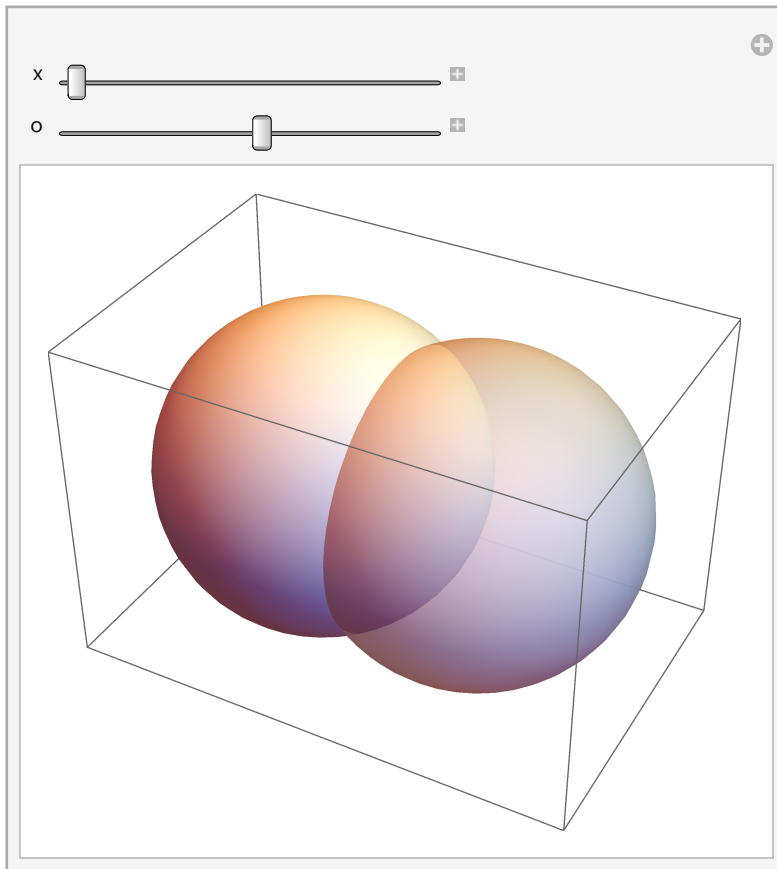
```
Graphics3D[Table[Point[{x, y, z}], {x, 10}, {y, 10}, {z, 10}]]
```

```
Graphics3D[Table[Sphere[RandomInteger[10, 3]], 50]]
```

```
Graphics3D[Table[Style[Sphere[RandomInteger[10, 3]], Opacity[0.5]], 50]]
```



```
Manipulate[Graphics3D[{Sphere[{0, 0, 0}], Style[Sphere[{x, 0, 0}], Opacity[o]]}],  
{x, 1, 3}, {o, 0.5, 1}]
```



15. The Scope of the Wolfram Language

(aka RTFM)

Wolfram Language & System Documentation Center

Core Language & Structure	Data Manipulation & Analysis	Visualization & Graphics
Symbolic & Numeric Computation	Strings & Text	Graphs & Networks
Images	Geometry	Sound
Time-Related Computation	Geographic Data & Computation	Scientific and Medical Data & Computation
Engineering Data & Computation	Financial Data & Computation	Social, Cultural & Linguistic Data
Higher Mathematical Computation	Documents & Presentation	User Interface Construction
System Operation & Setup	External Interfaces & Connections	Cloud & Deployment

[Fast Introduction for Programmers](#) ▶ [Wolfram|Alpha Knowledgebase Examples](#) ▶ [Legacy Documentation](#) ▶

Images	Geometry	Sound
Time-Related Computation	Geometric Computation Overview <hr/> Plane Geometry Solid Geometry <hr/> Basic Geometric Regions Mesh-Based Geometric Regions Derived Geometric Regions <hr/> Geometric Properties Geometric Solvers Geometric Transformations <hr/> Importing & Exporting Geometry	Scientific and Medical Data & Computation
Engineering Data & Computation		Social, Cultural & Linguistic Data
Higher Mathematical Computation		User Interface Construction
System Operation & Setup		Cloud & Deployment

WOLFRAM LANGUAGE GUIDE Functions ▾ Related Guides ▾

Plane Geometry

The Wolfram Language provides fully integrated support for plane geometry, including basic regions such as points, lines, triangles, and disks; functions for computing basic properties such as arc length and area; and nearest points to solvers to find the intersection of regions or integrals over regions.

▾ Reference

Geometrical Objects ▸

SSSTriangle — a triangle specified by the length of its sides

Point ▸ **Line** ▸ **HalfLine** ▸ **InfiniteLine** ▸ **Circle**

SASTriangle ▸ **ASATriangle** ▸ **AASTriangle** ▸ **Triangle** ▸ **Rectangle** ▸ **Parallelogram** ▸ **Polygon** ▸ **HalfPlane** ▸ **InfinitePlane** ▸ **Disk**

Visualization

Graphics — visualize regions with different styles

Measures & Tests ▸

ArcLength — length of a curve

Area — area of a region

RegionMember — test whether a point is in a region

RegionNearest — nearest point in a region to a given point

RegionQ ▸ **RegionDimension** ▸ **RegionDistance** ▸ ...

Solving with Regions ▸

FindInstance — find examples of points in a region

Solve — find curve crossings etc.

NSolve ▸ **Reduce** ▸ **Minimize** ▸ **NMinimize** ▸ ...

BUILT-IN WOLFRAM LANGUAGE SYMBOL See Also ▾ Related Guides ▾

Parallelogram

Parallelogram[$p, \{v_1, v_2\}$]

represents a parallelogram with origin p and directions v_1 and v_2 .


▸ Details

▾ Examples open all

▾ Basic Examples (3)

A standard parallelogram:

In[1]:= `Graphics[Parallelogram[]]`

Out[1]= 

`Graphics[Parallelogram[]]`

16. Real- World Data

`c = Canada` (country)

Canada

```
c // InputForm
```

```
Entity["Country", "Canada"]
```

```
cf = c@"Flag"
```



```
ColorNegate[cf]
```



☰ Flag of Mann >> +
👉 **Mann** ?
👉 Basic information for the United States

rank	349 th
fraction	1 in 3330 people (0.03%)
number	81 022 people

(based on 2000 United States Census)

For the rest, RTFM. Yet,

Russia (country) ["BorderingCountries"]

{ Azerbaijan , Belarus , China , Estonia , Finland , Georgia , Kazakhstan ,
 Latvia , Lithuania , Mongolia , North Korea , Norway , Poland , Ukraine }

all countries, dependencies, and territories (countries) ...

all countries, dependencies, and territories

```
v = EntityList[  all countries, dependencies, and territories (countries) ]
```

{ Afghanistan , Albania , Algeria , American Samoa , Andorra , Angola , Anguilla ,
 Antigua and Barbuda , Argentina , Armenia , Aruba , Australia , Austria , Azerbaijan ,
 Bahamas , Bahrain , Bangladesh , Barbados , Belarus , Belgium , Belize ,

Benin , Bermuda , Bhutan , Bolivia , Bosnia and Herzegovina , Botswana , Brazil ,
British Virgin Islands , Brunei , Bulgaria , Burkina Faso , Burundi , Cambodia ,
Cameroon , Canada , Cape Verde , Cayman Islands , Central African Republic ,
Chad , Chile , China , Christmas Island , Cocos Keeling Islands , Colombia ,
Comoros , Cook Islands , Costa Rica , Croatia , Cuba , Curacao , Cyprus ,
Czech Republic , Democratic Republic of the Congo , Denmark , Djibouti , Dominica ,
Dominican Republic , East Timor , Ecuador , Egypt , El Salvador , Equatorial Guinea ,
Eritrea , Estonia , Ethiopia , Falkland Islands , Faroe Islands , Fiji , Finland ,
France , French Guiana , French Polynesia , Gabon , Gambia , Gaza Strip ,
Georgia , Germany , Ghana , Gibraltar , Greece , Greenland , Grenada ,
Guadeloupe , Guam , Guatemala , Guernsey , Guinea , Guinea-Bissau , Guyana ,
Haiti , Honduras , Hong Kong , Hungary , Iceland , India , Indonesia , Iran ,
Iraq , Ireland , Isle of Man , Israel , Italy , Ivory Coast , Jamaica , Japan ,
Jersey , Jordan , Kazakhstan , Kenya , Kiribati , Kosovo , Kuwait , Kyrgyzstan ,
Laos , Latvia , Lebanon , Lesotho , Liberia , Libya , Liechtenstein , Lithuania ,
Luxembourg , Macau , Macedonia , Madagascar , Malawi , Malaysia , Maldives ,
Mali , Malta , Marshall Islands , Martinique , Mauritania , Mauritius , Mayotte ,
Mexico , Micronesia , Moldova , Monaco , Mongolia , Montenegro , Montserrat ,
Morocco , Mozambique , Myanmar , Namibia , Nauru , Nepal , Netherlands ,
New Caledonia , New Zealand , Nicaragua , Niger , Nigeria , Niue , Norfolk Island ,
Northern Mariana Islands , North Korea , Norway , Oman , Pakistan , Palau ,
Panama , Papua New Guinea , Paraguay , Peru , Philippines , Pitcairn Islands ,
Poland , Portugal , Puerto Rico , Qatar , Republic of the Congo , Réunion , Romania ,
Russia , Rwanda , Saint Helena, Ascension and Tristan da Cunha , Saint Kitts and Nevis ,
Saint Lucia , Saint Pierre and Miquelon , Saint Vincent and the Grenadines , Samoa ,
San Marino , São Tomé and Príncipe , Saudi Arabia , Senegal , Serbia , Seychelles ,
Sierra Leone , Singapore , Sint Maarten , Slovakia , Slovenia , Solomon Islands ,
Somalia , South Africa , South Korea , South Sudan , Spain , Sri Lanka , Sudan ,

Suriname , Svalbard , Swaziland , Sweden , Switzerland , Syria , Taiwan , Tajikistan ,
 Tanzania , Thailand , Togo , Tokelau , Tonga , Trinidad and Tobago , Tunisia ,
 Turkey , Turkmenistan , Turks and Caicos Islands , Tuvalu , Uganda , Ukraine ,
 United Arab Emirates , United Kingdom , United States , United States Virgin Islands ,
 Uruguay , Uzbekistan , Vanuatu , Vatican City , Venezuela , Vietnam ,
 Wallis and Futuna Islands , West Bank , Western Sahara , Yemen , Zambia , Zimbabwe }

```
#[ "BorderingCountries" ] & /@ v
```

```
$Aborted
```

```
v = CountryData [ "Countries" ]
```

```

{ Afghanistan , Albania , Algeria , American Samoa , Andorra , Angola , Anguilla ,
  Antigua and Barbuda , Argentina , Armenia , Aruba , Australia , Austria , Azerbaijan ,
  Bahamas , Bahrain , Bangladesh , Barbados , Belarus , Belgium , Belize ,
  Benin , Bermuda , Bhutan , Bolivia , Bosnia and Herzegovina , Botswana , Brazil ,
  British Virgin Islands , Brunei , Bulgaria , Burkina Faso , Burundi , Cambodia ,
  Cameroon , Canada , Cape Verde , Cayman Islands , Central African Republic ,
  Chad , Chile , China , Christmas Island , Cocos Keeling Islands , Colombia ,
  Comoros , Cook Islands , Costa Rica , Croatia , Cuba , Curacao , Cyprus ,
  Czech Republic , Democratic Republic of the Congo , Denmark , Djibouti , Dominica ,
  Dominican Republic , East Timor , Ecuador , Egypt , El Salvador , Equatorial Guinea ,
  Eritrea , Estonia , Ethiopia , Falkland Islands , Faroe Islands , Fiji , Finland ,
  France , French Guiana , French Polynesia , Gabon , Gambia , Gaza Strip ,
  Georgia , Germany , Ghana , Gibraltar , Greece , Greenland , Grenada ,
  Guadeloupe , Guam , Guatemala , Guernsey , Guinea , Guinea-Bissau , Guyana ,
  Haiti , Honduras , Hong Kong , Hungary , Iceland , India , Indonesia , Iran ,
  Iraq , Ireland , Isle of Man , Israel , Italy , Ivory Coast , Jamaica , Japan ,
  Jersey , Jordan , Kazakhstan , Kenya , Kiribati , Kosovo , Kuwait , Kyrgyzstan ,
  Laos , Latvia , Lebanon , Lesotho , Liberia , Libya , Liechtenstein , Lithuania ,
  Luxembourg , Macau , Macedonia , Madagascar , Malawi , Malaysia , Maldives ,

```

Mali , Malta , Marshall Islands , Martinique , Mauritania , Mauritius , Mayotte ,
 Mexico , Micronesia , Moldova , Monaco , Mongolia , Montenegro , Montserrat ,
 Morocco , Mozambique , Myanmar , Namibia , Nauru , Nepal , Netherlands ,
 New Caledonia , New Zealand , Nicaragua , Niger , Nigeria , Niue , Norfolk Island ,
 Northern Mariana Islands , North Korea , Norway , Oman , Pakistan , Palau ,
 Panama , Papua New Guinea , Paraguay , Peru , Philippines , Pitcairn Islands ,
 Poland , Portugal , Puerto Rico , Qatar , Republic of the Congo , Réunion , Romania ,
 Russia , Rwanda , Saint Helena, Ascension and Tristan da Cunha , Saint Kitts and Nevis ,
 Saint Lucia , Saint Pierre and Miquelon , Saint Vincent and the Grenadines , Samoa ,
 San Marino , São Tomé and Príncipe , Saudi Arabia , Senegal , Serbia , Seychelles ,
 Sierra Leone , Singapore , Sint Maarten , Slovakia , Slovenia , Solomon Islands ,
 Somalia , South Africa , South Korea , South Sudan , Spain , Sri Lanka , Sudan ,
 Suriname , Svalbard , Swaziland , Sweden , Switzerland , Syria , Taiwan , Tajikistan ,
 Tanzania , Thailand , Togo , Tokelau , Tonga , Trinidad and Tobago , Tunisia ,
 Turkey , Turkmenistan , Turks and Caicos Islands , Tuvalu , Uganda , Ukraine ,
 United Arab Emirates , United Kingdom , United States , United States Virgin Islands ,
 Uruguay , Uzbekistan , Vanuatu , Vatican City , Venezuela , Vietnam ,
 Wallis and Futuna Islands , West Bank , Western Sahara , Yemen , Zambia , Zimbabwe }

Table[CountryData[c, "BorderingCountries"], {c, v}]

```
{ { China , Iran , Pakistan , Tajikistan , Turkmenistan , Uzbekistan } ,
  { Greece , Kosovo , Macedonia , Montenegro } ,
  { Libya , Mali , Mauritania , Morocco , Niger , Tunisia , Western Sahara } ,
  {} , { France , Spain } ,
  { Democratic Republic of the Congo , Namibia , Republic of the Congo , Zambia } ,
  {} , {} , { Bolivia , Brazil , Chile , Paraguay , Uruguay } ,
  { Azerbaijan , Georgia , Iran , Turkey } , {} , {} , { Czech Republic , Germany ,
  Hungary , Italy , Liechtenstein , Slovakia , Slovenia , Switzerland } ,
```

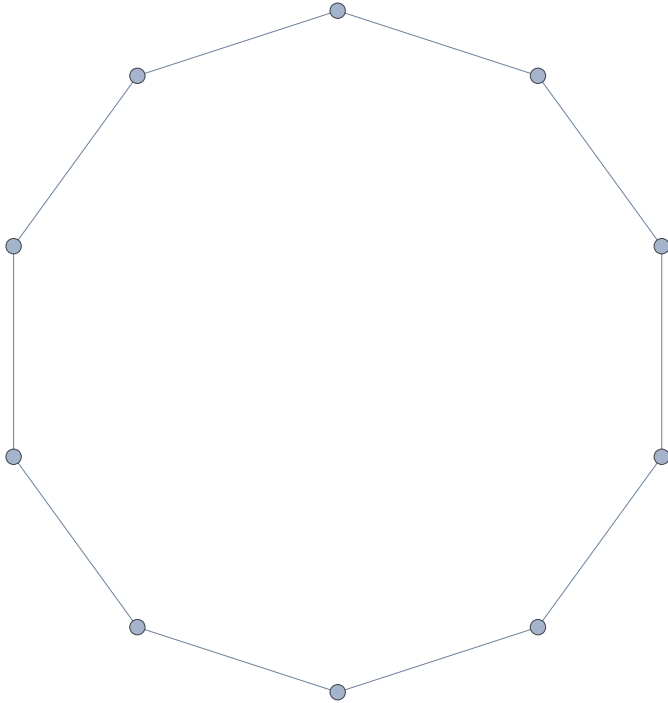
{ Armenia , Georgia , Iran , Russia , Turkey } , { } , { } , { India , Myanmar } ,
 { } , { Latvia , Lithuania , Poland , Russia , Ukraine } ,
 { France , Germany , Luxembourg , Netherlands } , { Guatemala , Mexico } ,
 { Burkina Faso , Niger , Nigeria , Togo } , { } , { China , India } ,
 { Argentina , Brazil , Chile , Paraguay , Peru } , { Croatia , Montenegro , Serbia } ,
 { Namibia , South Africa , Zambia , Zimbabwe } , { Argentina , Bolivia , Colombia ,
 French Guiana , Guyana , Paraguay , Peru , Suriname , Uruguay , Venezuela } ,
 { } , { Malaysia } , { Greece , Macedonia , Romania , Serbia , Turkey } ,
 { Benin , Ghana , Ivory Coast , Mali , Niger , Togo } ,
 { Democratic Republic of the Congo , Rwanda , Tanzania } , { Laos , Thailand , Vietnam } ,
 { Central African Republic , Chad , Equatorial Guinea , Gabon , Nigeria ,
 Republic of the Congo } , { United States } , { } , { } , { Cameroon , Chad ,
 Democratic Republic of the Congo , Republic of the Congo , South Sudan , Sudan } ,
 { Cameroon , Central African Republic , Libya , Niger , Nigeria , Sudan } ,
 { Argentina , Bolivia , Peru } , { Afghanistan , Bhutan , Hong Kong ,
 India , Kazakhstan , Kyrgyzstan , Laos , Macau , Mongolia , Myanmar ,
 Nepal , North Korea , Pakistan , Russia , Tajikistan , Vietnam } , { } , { } ,
 { Brazil , Ecuador , Panama , Peru , Venezuela } , { } , { } , { Nicaragua , Panama } ,
 { Bosnia and Herzegovina , Hungary , Montenegro , Serbia , Slovenia } , { } , { } , { } ,
 { Austria , Germany , Poland , Slovakia } , { Angola , Burundi , Central African Republic ,
 Republic of the Congo , Rwanda , South Sudan , Tanzania , Uganda , Zambia } ,
 { Germany } , { Eritrea , Ethiopia , Somalia } , { } , { Haiti } , { Indonesia } ,
 { Colombia , Peru } , { Gaza Strip , Israel , Libya , Sudan } ,
 { Guatemala , Honduras } , { Cameroon , Gabon } , { Djibouti , Ethiopia , Sudan } ,
 { Latvia , Russia } , { Djibouti , Eritrea , Kenya , Somalia , South Sudan , Sudan } ,
 { } , { } , { } , { Norway , Russia , Sweden } ,
 { Andorra , Belgium , Germany , Italy , Luxembourg , Monaco , Spain , Switzerland } ,
 { Brazil , Suriname } , { } , { Cameroon , Equatorial Guinea , Republic of the Congo } ,

{ Senegal }, { Egypt , Israel }, { Armenia , Azerbaijan , Russia , Turkey },
 { Austria , Belgium , Czech Republic , Denmark , France , Luxembourg ,
 Netherlands , Poland , Switzerland }, { Burkina Faso , Ivory Coast , Togo },
 { Spain }, { Albania , Bulgaria , Macedonia , Turkey }, {}, {},
 {}, {}, { Belize , El Salvador , Honduras , Mexico }, {},
 { Guinea-Bissau , Ivory Coast , Liberia , Mali , Senegal , Sierra Leone },
 { Guinea , Senegal }, { Brazil , Suriname , Venezuela },
 { Dominican Republic }, { El Salvador , Guatemala , Nicaragua }, { China },
 { Austria , Croatia , Romania , Serbia , Slovakia , Slovenia , Ukraine },
 {}, { Bangladesh , Bhutan , China , Myanmar , Nepal , Pakistan },
 { East Timor , Malaysia , Papua New Guinea },
 { Afghanistan , Armenia , Azerbaijan , Iraq , Pakistan , Turkey , Turkmenistan },
 { Iran , Jordan , Kuwait , Saudi Arabia , Syria , Turkey }, { United Kingdom },
 {}, { Egypt , Gaza Strip , Jordan , Lebanon , Syria , West Bank },
 { Austria , France , San Marino , Slovenia , Switzerland , Vatican City },
 { Burkina Faso , Ghana , Guinea , Liberia , Mali }, {},
 {}, {}, { Iraq , Israel , Saudi Arabia , Syria , West Bank },
 { China , Kyrgyzstan , Russia , Turkmenistan , Uzbekistan },
 { Ethiopia , Somalia , South Sudan , Tanzania , Uganda },
 {}, { Albania , Macedonia , Montenegro , Serbia },
 { Iraq , Saudi Arabia }, { China , Kazakhstan , Tajikistan , Uzbekistan },
 { Cambodia , China , Myanmar , Thailand , Vietnam },
 { Belarus , Estonia , Lithuania , Russia }, { Israel , Syria },
 { South Africa }, { Guinea , Ivory Coast , Sierra Leone },
 { Algeria , Chad , Egypt , Niger , Sudan , Tunisia }, { Austria , Switzerland },
 { Belarus , Latvia , Poland , Russia }, { Belgium , France , Germany },
 { China }, { Albania , Bulgaria , Greece , Kosovo , Serbia }, {},
 { Mozambique , Tanzania , Zambia }, { Brunei , Indonesia , Thailand }, {},

{ Algeria , Burkina Faso , Guinea , Ivory Coast , Mauritania , Niger , Senegal } ,
 { , { , { , { Algeria , Mali , Senegal , Western Sahara } , { , { ,
 { Belize , Guatemala , United States } , { , { Romania , Ukraine } , { France } ,
 { China , Russia } , { Albania , Bosnia and Herzegovina , Croatia , Kosovo , Serbia } ,
 { , { Algeria , Spain , Western Sahara } ,
 { Malawi , South Africa , Swaziland , Tanzania , Zambia , Zimbabwe } ,
 { Bangladesh , China , India , Laos , Thailand } ,
 { Angola , Botswana , South Africa , Zambia } , { , { China , India } ,
 { Belgium , Germany } , { , { , { Costa Rica , Honduras } ,
 { Algeria , Benin , Burkina Faso , Chad , Libya , Mali , Nigeria } ,
 { Benin , Cameroon , Chad , Niger } , { , { , { China , Russia , South Korea } ,
 { Finland , Russia , Sweden } , { Saudi Arabia , United Arab Emirates , Yemen } ,
 { Afghanistan , China , India , Iran } , { , { Colombia , Costa Rica } , { Indonesia } ,
 { Argentina , Bolivia , Brazil } , { Bolivia , Brazil , Chile , Colombia , Ecuador } , { ,
 { , { Belarus , Czech Republic , Germany , Lithuania , Russia , Slovakia , Ukraine } ,
 { Spain } , { , { Saudi Arabia } ,
 { Angola , Cameroon , Central African Republic , Democratic Republic of the Congo , Gabon } ,
 { , { Bulgaria , Hungary , Moldova , Serbia , Ukraine } ,
 { Azerbaijan , Belarus , China , Estonia , Finland , Georgia , Kazakhstan ,
 Latvia , Lithuania , Mongolia , North Korea , Norway , Poland , Ukraine } ,
 { Burundi , Democratic Republic of the Congo , Tanzania , Uganda } ,
 { , { , { , { , { , { , { Italy } , { ,
 { Iraq , Jordan , Kuwait , Oman , Qatar , United Arab Emirates , Yemen } ,
 { Gambia , Guinea , Guinea-Bissau , Mali , Mauritania } , { Bosnia and Herzegovina ,
 Bulgaria , Croatia , Hungary , Kosovo , Macedonia , Montenegro , Romania } , { ,
 { Guinea , Liberia } , { , { , { Austria , Czech Republic , Hungary , Poland , Ukraine } ,
 { Austria , Croatia , Hungary , Italy } , { , { Djibouti , Ethiopia , Kenya } ,
 { Botswana , Lesotho , Mozambique , Namibia , Swaziland , Zimbabwe } ,


```
{ North Korea }, { Central African Republic },
Democratic Republic of the Congo , Ethiopia , Kenya , Sudan , Uganda },
{ Andorra , France , Gibraltar , Morocco , Portugal }, {},
{ Central African Republic , Chad , Egypt , Eritrea , Ethiopia , Libya , South Sudan },
{ Brazil , French Guiana , Guyana }, {}, { Mozambique , South Africa },
{ Finland , Norway }, { Austria , France , Germany , Italy , Liechtenstein },
{ Iraq , Israel , Jordan , Lebanon , Turkey }, {},
{ Afghanistan , China , Kyrgyzstan , Uzbekistan },
{ Burundi , Democratic Republic of the Congo , Kenya , Malawi , Mozambique ,
Rwanda , Uganda , Zambia }, { Cambodia , Laos , Malaysia , Myanmar },
{ Benin , Burkina Faso , Ghana }, {}, {}, {}, { Algeria , Libya },
{ Armenia , Azerbaijan , Bulgaria , Georgia , Greece , Iran , Iraq , Syria },
{ Afghanistan , Iran , Kazakhstan , Uzbekistan }, {}, {},
{ Democratic Republic of the Congo , Kenya , Rwanda , South Sudan , Tanzania },
{ Belarus , Hungary , Moldova , Poland , Romania , Russia , Slovakia },
{ Oman , Saudi Arabia }, { Ireland }, { Canada , Mexico }, {}, { Argentina , Brazil },
{ Afghanistan , Kazakhstan , Kyrgyzstan , Tajikistan , Turkmenistan }, {},
{ Italy }, { Brazil , Colombia , Guyana }, { Cambodia , China , Laos },
{}, { Israel , Jordan }, { Algeria , Mauritania , Morocco },
{ Oman , Saudi Arabia }, { Angola , Botswana , Democratic Republic of the Congo ,
Malawi , Mozambique , Namibia , Tanzania , Zimbabwe },
{ Botswana , Mozambique , South Africa , Zambia } }
```

```
g = Graph[Table[i, {i, 0, 9}], Table[i -> Mod[i + 1, 10], {i, 0, 9}]]
```



```
Graph[{1, 2}, {1 ↔ 2}]
```



```
Sort[{2, 3, 1}]
```

{1, 2, 3}

```
Sort[f[1, 3, 2]]
```

f[1, 2, 3]

```
Ed = Union[Flatten[Table[
  Table[Sort[c ↔ c1], {c1, CountryData[c, "BorderingCountries"]}],
  {c, v}]]]
```

```
{ Afghanistan ↔ China , Afghanistan ↔ Iran , Afghanistan ↔ Pakistan ,
  Afghanistan ↔ Tajikistan , Afghanistan ↔ Turkmenistan , Afghanistan ↔ Uzbekistan ,
  Albania ↔ Greece , Albania ↔ Kosovo , Albania ↔ Macedonia ,
  Albania ↔ Montenegro , Algeria ↔ Libya , Algeria ↔ Mali ,
  Algeria ↔ Mauritania , Algeria ↔ Morocco , Algeria ↔ Niger ,
  Algeria ↔ Tunisia , Algeria ↔ Western Sahara , Andorra ↔ France ,
  Andorra ↔ Spain , Angola ↔ Democratic Republic of the Congo , Angola ↔ Namibia ,
  Angola ↔ Republic of the Congo , Angola ↔ Zambia , Argentina ↔ Bolivia ,
```

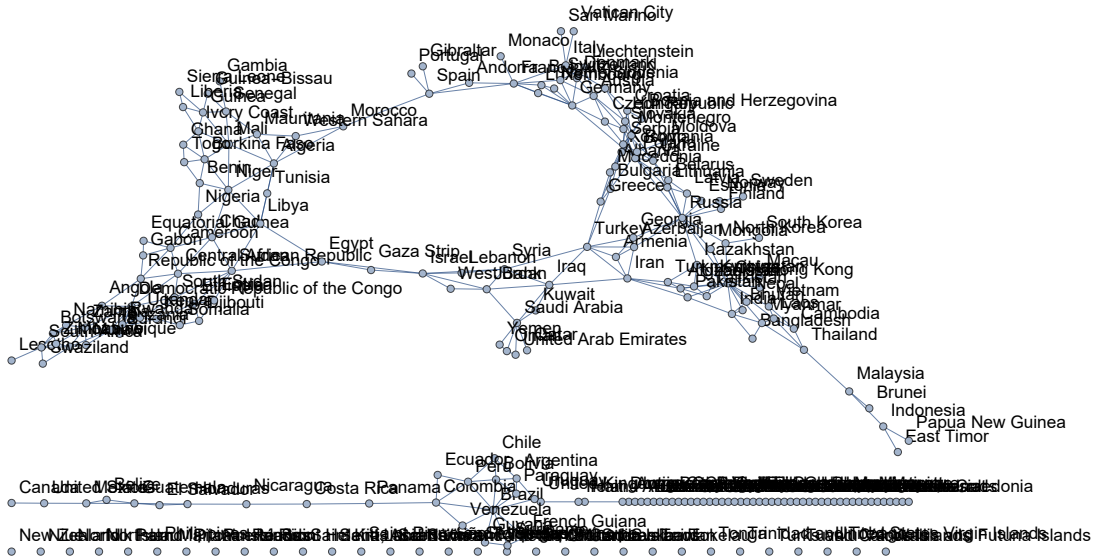
Argentina ↔ Brazil , Argentina ↔ Chile , Argentina ↔ Paraguay ,
 Argentina ↔ Uruguay , Armenia ↔ Azerbaijan , Armenia ↔ Georgia ,
 Armenia ↔ Iran , Armenia ↔ Turkey , Austria ↔ Czech Republic ,
 Austria ↔ Germany , Austria ↔ Hungary , Austria ↔ Italy ,
 Austria ↔ Liechtenstein , Austria ↔ Slovakia , Austria ↔ Slovenia ,
 Austria ↔ Switzerland , Azerbaijan ↔ Georgia , Azerbaijan ↔ Iran ,
 Azerbaijan ↔ Russia , Azerbaijan ↔ Turkey , Bangladesh ↔ India ,
 Bangladesh ↔ Myanmar , Belarus ↔ Latvia , Belarus ↔ Lithuania ,
 Belarus ↔ Poland , Belarus ↔ Russia , Belarus ↔ Ukraine , Belgium ↔ France ,
 Belgium ↔ Germany , Belgium ↔ Luxembourg , Belgium ↔ Netherlands ,
 Belize ↔ Guatemala , Belize ↔ Mexico , Benin ↔ Burkina Faso , Benin ↔ Niger ,
 Benin ↔ Nigeria , Benin ↔ Togo , Bhutan ↔ China , Bhutan ↔ India ,
 Bolivia ↔ Brazil , Bolivia ↔ Chile , Bolivia ↔ Paraguay , Bolivia ↔ Peru ,
 Bosnia and Herzegovina ↔ Croatia , Bosnia and Herzegovina ↔ Montenegro ,
 Bosnia and Herzegovina ↔ Serbia , Botswana ↔ Namibia , Botswana ↔ South Africa ,
 Botswana ↔ Zambia , Botswana ↔ Zimbabwe , Brazil ↔ Colombia ,
 Brazil ↔ French Guiana , Brazil ↔ Guyana , Brazil ↔ Paraguay , Brazil ↔ Peru ,
 Brazil ↔ Suriname , Brazil ↔ Uruguay , Brazil ↔ Venezuela , Brunei ↔ Malaysia ,
 Bulgaria ↔ Greece , Bulgaria ↔ Macedonia , Bulgaria ↔ Romania ,
 Bulgaria ↔ Serbia , Bulgaria ↔ Turkey , Burkina Faso ↔ Ghana ,
 Burkina Faso ↔ Ivory Coast , Burkina Faso ↔ Mali , Burkina Faso ↔ Niger ,
 Burkina Faso ↔ Togo , Burundi ↔ Democratic Republic of the Congo ,
 Burundi ↔ Rwanda , Burundi ↔ Tanzania , Cambodia ↔ Laos ,
 Cambodia ↔ Thailand , Cambodia ↔ Vietnam , Cameroon ↔ Central African Republic ,
 Cameroon ↔ Chad , Cameroon ↔ Equatorial Guinea , Cameroon ↔ Gabon ,
 Cameroon ↔ Nigeria , Cameroon ↔ Republic of the Congo ,
 Canada ↔ United States , Central African Republic ↔ Chad ,
 Central African Republic ↔ Democratic Republic of the Congo ,

Central African Republic ↔ Republic of the Congo , Central African Republic ↔ South Sudan ,
 Central African Republic ↔ Sudan , Chad ↔ Libya , Chad ↔ Niger ,
 Chad ↔ Nigeria , Chad ↔ Sudan , Chile ↔ Peru , China ↔ Hong Kong ,
 China ↔ India , China ↔ Kazakhstan , China ↔ Kyrgyzstan , China ↔ Laos ,
 China ↔ Macau , China ↔ Mongolia , China ↔ Myanmar , China ↔ Nepal ,
 China ↔ North Korea , China ↔ Pakistan , China ↔ Russia , China ↔ Tajikistan ,
 China ↔ Vietnam , Colombia ↔ Ecuador , Colombia ↔ Panama , Colombia ↔ Peru ,
 Colombia ↔ Venezuela , Costa Rica ↔ Nicaragua , Costa Rica ↔ Panama ,
 Croatia ↔ Hungary , Croatia ↔ Montenegro , Croatia ↔ Serbia ,
 Croatia ↔ Slovenia , Czech Republic ↔ Germany , Czech Republic ↔ Poland ,
 Czech Republic ↔ Slovakia , Democratic Republic of the Congo ↔ Republic of the Congo ,
 Democratic Republic of the Congo ↔ Rwanda ,
 Democratic Republic of the Congo ↔ South Sudan ,
 Democratic Republic of the Congo ↔ Tanzania , Democratic Republic of the Congo ↔ Uganda ,
 Democratic Republic of the Congo ↔ Zambia , Denmark ↔ Germany , Djibouti ↔ Eritrea ,
 Djibouti ↔ Ethiopia , Djibouti ↔ Somalia , Dominican Republic ↔ Haiti ,
 East Timor ↔ Indonesia , Ecuador ↔ Peru , Egypt ↔ Gaza Strip ,
 Egypt ↔ Israel , Egypt ↔ Libya , Egypt ↔ Sudan , El Salvador ↔ Guatemala ,
 El Salvador ↔ Honduras , Equatorial Guinea ↔ Gabon , Eritrea ↔ Ethiopia ,
 Eritrea ↔ Sudan , Estonia ↔ Latvia , Estonia ↔ Russia , Ethiopia ↔ Kenya ,
 Ethiopia ↔ Somalia , Ethiopia ↔ South Sudan , Ethiopia ↔ Sudan ,
 Finland ↔ Norway , Finland ↔ Russia , Finland ↔ Sweden , France ↔ Germany ,
 France ↔ Italy , France ↔ Luxembourg , France ↔ Monaco , France ↔ Spain ,
 France ↔ Switzerland , French Guiana ↔ Suriname , Gabon ↔ Republic of the Congo ,
 Gambia ↔ Senegal , Gaza Strip ↔ Israel , Georgia ↔ Russia ,
 Georgia ↔ Turkey , Germany ↔ Luxembourg , Germany ↔ Netherlands ,
 Germany ↔ Poland , Germany ↔ Switzerland , Ghana ↔ Ivory Coast ,
 Ghana ↔ Togo , Gibraltar ↔ Spain , Greece ↔ Macedonia , Greece ↔ Turkey ,

Guatemala ↔ Honduras , Guatemala ↔ Mexico , Guinea ↔ Guinea-Bissau ,
 Guinea ↔ Ivory Coast , Guinea ↔ Liberia , Guinea ↔ Mali , Guinea ↔ Senegal ,
 Guinea ↔ Sierra Leone , Guinea-Bissau ↔ Senegal , Guyana ↔ Suriname ,
 Guyana ↔ Venezuela , Honduras ↔ Nicaragua , Hungary ↔ Romania ,
 Hungary ↔ Serbia , Hungary ↔ Slovakia , Hungary ↔ Slovenia ,
 Hungary ↔ Ukraine , India ↔ Myanmar , India ↔ Nepal , India ↔ Pakistan ,
 Indonesia ↔ Malaysia , Indonesia ↔ Papua New Guinea , Iran ↔ Iraq ,
 Iran ↔ Pakistan , Iran ↔ Turkey , Iran ↔ Turkmenistan , Iraq ↔ Jordan ,
 Iraq ↔ Kuwait , Iraq ↔ Saudi Arabia , Iraq ↔ Syria , Iraq ↔ Turkey ,
 Ireland ↔ United Kingdom , Israel ↔ Jordan , Israel ↔ Lebanon ,
 Israel ↔ Syria , Israel ↔ West Bank , Italy ↔ San Marino , Italy ↔ Slovenia ,
 Italy ↔ Switzerland , Italy ↔ Vatican City , Ivory Coast ↔ Liberia ,
 Ivory Coast ↔ Mali , Jordan ↔ Saudi Arabia , Jordan ↔ Syria ,
 Jordan ↔ West Bank , Kazakhstan ↔ Kyrgyzstan , Kazakhstan ↔ Russia ,
 Kazakhstan ↔ Turkmenistan , Kazakhstan ↔ Uzbekistan , Kenya ↔ Somalia ,
 Kenya ↔ South Sudan , Kenya ↔ Tanzania , Kenya ↔ Uganda ,
 Kosovo ↔ Macedonia , Kosovo ↔ Montenegro , Kosovo ↔ Serbia ,
 Kuwait ↔ Saudi Arabia , Kyrgyzstan ↔ Tajikistan , Kyrgyzstan ↔ Uzbekistan ,
 Laos ↔ Myanmar , Laos ↔ Thailand , Laos ↔ Vietnam , Latvia ↔ Lithuania ,
 Latvia ↔ Russia , Lebanon ↔ Syria , Lesotho ↔ South Africa ,
 Liberia ↔ Sierra Leone , Libya ↔ Niger , Libya ↔ Sudan , Libya ↔ Tunisia ,
 Liechtenstein ↔ Switzerland , Lithuania ↔ Poland , Lithuania ↔ Russia ,
 Macedonia ↔ Serbia , Malawi ↔ Mozambique , Malawi ↔ Tanzania ,
 Malawi ↔ Zambia , Malaysia ↔ Thailand , Mali ↔ Mauritania , Mali ↔ Niger ,
 Mali ↔ Senegal , Mauritania ↔ Senegal , Mauritania ↔ Western Sahara ,
 Mexico ↔ United States , Moldova ↔ Romania , Moldova ↔ Ukraine ,
 Mongolia ↔ Russia , Montenegro ↔ Serbia , Morocco ↔ Spain ,
 Morocco ↔ Western Sahara , Mozambique ↔ South Africa , Mozambique ↔ Swaziland ,

Mozambique ↔ Tanzania , Mozambique ↔ Zambia , Mozambique ↔ Zimbabwe ,
 Myanmar ↔ Thailand , Namibia ↔ South Africa , Namibia ↔ Zambia ,
 Niger ↔ Nigeria , North Korea ↔ Russia , North Korea ↔ South Korea ,
 Norway ↔ Russia , Norway ↔ Sweden , Oman ↔ Saudi Arabia ,
 Oman ↔ United Arab Emirates , Oman ↔ Yemen , Poland ↔ Russia ,
 Poland ↔ Slovakia , Poland ↔ Ukraine , Portugal ↔ Spain , Qatar ↔ Saudi Arabia ,
 Romania ↔ Serbia , Romania ↔ Ukraine , Russia ↔ Ukraine ,
 Rwanda ↔ Tanzania , Rwanda ↔ Uganda , Saudi Arabia ↔ United Arab Emirates ,
 Saudi Arabia ↔ Yemen , Slovakia ↔ Ukraine , South Africa ↔ Swaziland ,
 South Africa ↔ Zimbabwe , South Sudan ↔ Sudan , South Sudan ↔ Uganda ,
 Syria ↔ Turkey , Tajikistan ↔ Uzbekistan , Tanzania ↔ Uganda ,
 Tanzania ↔ Zambia , Turkmenistan ↔ Uzbekistan , Zambia ↔ Zimbabwe }

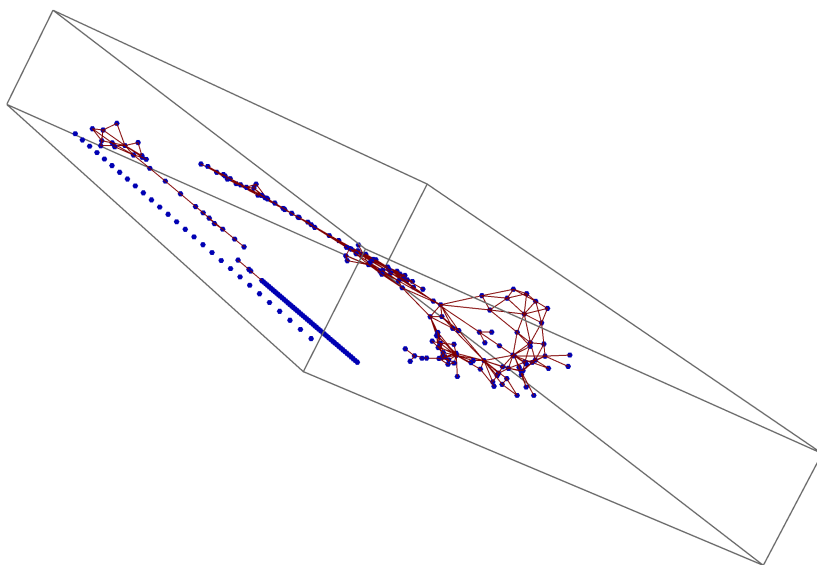
```
G = Graph[V, Ed, VertexLabels -> "Name"]
```



```
PlanarGraphQ[G]
```

False

`GraphPlot3D[G]`



17. Units

`Sin[30]`

`Sin[30]`

`Sin[30] // N`

`-0.988032`

`Sin[30 °]`

$\frac{1}{2}$

`Sin[30 °]`

$\frac{1}{2}$

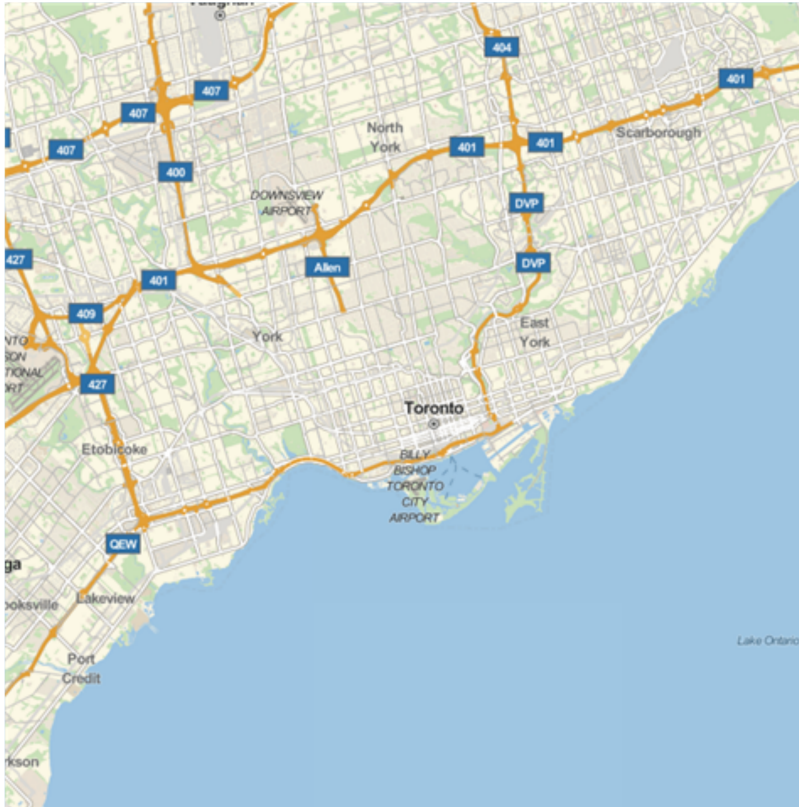
`UnitConvert[C$, $, ✓], $, ✓]`

`$0.72`

For the rest, RTFM.

18. Geocomputation

Here // GeoGraphics



For the rest, RTFM.