AIMS DMG Sage Demonstration 07
AIMS 2013-14: Designs, Matroids and Graphs

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1 Designs in Sage

Constructors. How do we make designs in Sage? How do we make anything in Sage?

Use tab-completion with `designs.(tab)`, plus online help to explore Hadamard designs with $n = 13$ (which does not exist) and with $n = 15$.

Build it and save it.

```
H = designs.HadamardDesign(15)
```

Now explore it.

```
H.is_block_design()
```

```
H.blocks()
```

```
len(H.blocks())
```

Verify our computing formula for the blocks.

$$b = \frac{3\binom{15}{2}}{\binom{7}{2}}$$

```
len(H.blocks()) == 3*binomial(15, 2)/binomial(7, 2)
```

Connect with linear algebra and with graph theory.

```
H.incidence_matrix()
```

```
H.incidence_graph()
```

```
H.incidence_graph().plot()
```

What else can we learn about H?

```
H.
```

2   Designs from Scratch

We can roll our own in Sage, and check our work.

```
block_list = [
[0, 1, 2, 3, 4, 5, 6, 7],
[8, 9, 10, 11, 12, 13, 14, 15],
[0, 1, 2, 3, 8, 9, 10, 11],
[4, 5, 6, 7, 12, 13, 14, 15],
[0, 1, 2, 3, 12, 13, 14, 15],
[4, 5, 6, 7, 8, 9, 10, 11],
[0, 1, 4, 5, 8, 9, 12, 13],
[2, 3, 6, 7, 10, 11, 14, 15],
[0, 1, 4, 5, 10, 11, 14, 15],
[2, 3, 6, 7, 8, 9, 12, 13],
[0, 1, 6, 7, 8, 10, 12, 14],
[2, 3, 4, 5, 9, 11, 13, 15],
[0, 1, 6, 7, 9, 11, 13, 15],
[2, 3, 4, 5, 8, 10, 12, 14],
[0, 2, 4, 6, 8, 11, 13, 14],
[1, 3, 5, 7, 9, 10, 12, 15],
[0, 2, 4, 6, 9, 10, 12, 15],
[1, 3, 5, 7, 8, 11, 13, 14],
[0, 2, 5, 7, 8, 11, 12, 15],
[1, 3, 4, 6, 9, 10, 13, 14],
[0, 2, 5, 7, 9, 10, 13, 14],
[1, 3, 4, 6, 8, 11, 12, 15],
[0, 3, 4, 7, 8, 10, 13, 15],
[1, 2, 5, 6, 9, 11, 12, 14],
[0, 3, 4, 7, 9, 11, 12, 14],
[1, 2, 5, 6, 8, 10, 13, 15],
[0, 3, 5, 6, 8, 9, 14, 15],
[1, 2, 4, 7, 10, 11, 12, 13],
[0, 3, 5, 6, 10, 11, 12, 13],
[1, 2, 4, 7, 8, 9, 14, 15]
]
block_list
```

Constructor requires the number of points. 16 here, as we start counting from zero.

```
B = BlockDesign(16, block_list)
```

Now explore it.

```
B.is_block_design()
```

Notice that if we go back and ruin the list, Sage will complain.

```
ruined_list = block_list[:-1]
```

```
R = BlockDesign(16, ruined_list)
```

Where did my list of blocks come from??? Good question. Stay tuned.