Level 4 Special Project

Sponges

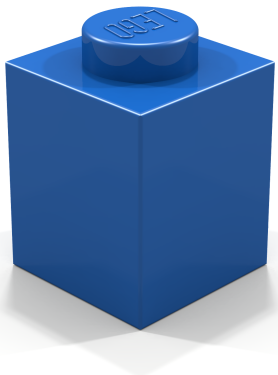
Prerequisite Concepts	Concept 12
Key Concepts	Concept 19

We will use the term *sponge* to refer to a three dimensional LEGO® artifact created using *geometric repetition algorithm*. Typically, the seed of a sponge is a bit-brick (i.e., a $1 \times 1 \times 1$ brick). Using this seed, an $n \times n \times n$ cube is created with some pieces removed. The resulting structure/pattern is a sponge. Note that the creation of a $3 \times 3 \times 3$ sponge involves the consideration of 27 bit-brick positions. Larger sponges can be created by repeating smaller sponge patterns in a geometric fashion.

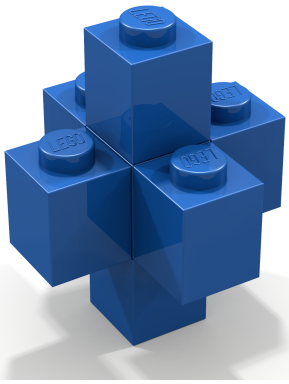
Example 1 *Using a bit-brick as the seed a* $3 \times 3 \times 3$ *Menger sponge pattern is created by omitting 7 bit-bricks from a solid* $3 \times 3 \times 3$ *cube. Specifically, the center brick of each of the six faces of the cube is omitted as is the center of the cube itself. This construction pattern is then repeated to create larger and larger Menger sponges.*

A *dual* of a sponge is created using a sponge pattern that is the opposite of the pattern used to create the original sponge. More specifically, if the original pattern used to create a sponge omits a particular position in a cube, the dual pattern will include that position in its construction. Similarly, if the original pattern used to create a sponge includes a particular position in a cube, the dual pattern will omit that position in its construction.

Using this definition, the dual of the Menger sponge is created using the pattern shown in Figure 1.



(a) Seed Artifact



(b) Level 1 Menger Dual Sponge

Figure 1: Constructing the Menger Dual Sponge.

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Adding Color

Bricklayer provides the ability to create a function that, when called, will return a brick randomly selected from a list of bricks. The val-declaration below gives an example of how you could declare a function that randomly generates bricks.

```
val randomBrickFn = generateRandomBrickFn blueScale
```

In this example, the function declared is *randomBrickFn*. The list of bricks it randomly selects from is *blueScale*, a brick list defined in the Pieces structure of Bricklayer. The function is called by applying it to the unit value: *randomBrickFn()*. The result of a function call will be a brick randomly selected from the blueScale list.

The Pieces structure of Bricklayer defines a number of lists that can be used in random generation. However, you can also define your own list as shown in the example below.

```
val myList         = [BLUE,RED,WHITE]
val randomBrickFn = generateRandomBrickFn myList
```

Sponges having interesting colors can be created by from generators that use random bricks to construct all sponges of a certain level. For example, a level 1 sponge could be generated using a single brick, but whenever a different level 1 sponge is to be generated the brick used is randomly selected. Figure 2 shows how such a uniform use of randomly generated bricks can be used to add color to the Menger Dual sponge.

Create a Bricklayer program that builds a level 4 Menger Dual sponge similar to the ones shown in Figure 2 .

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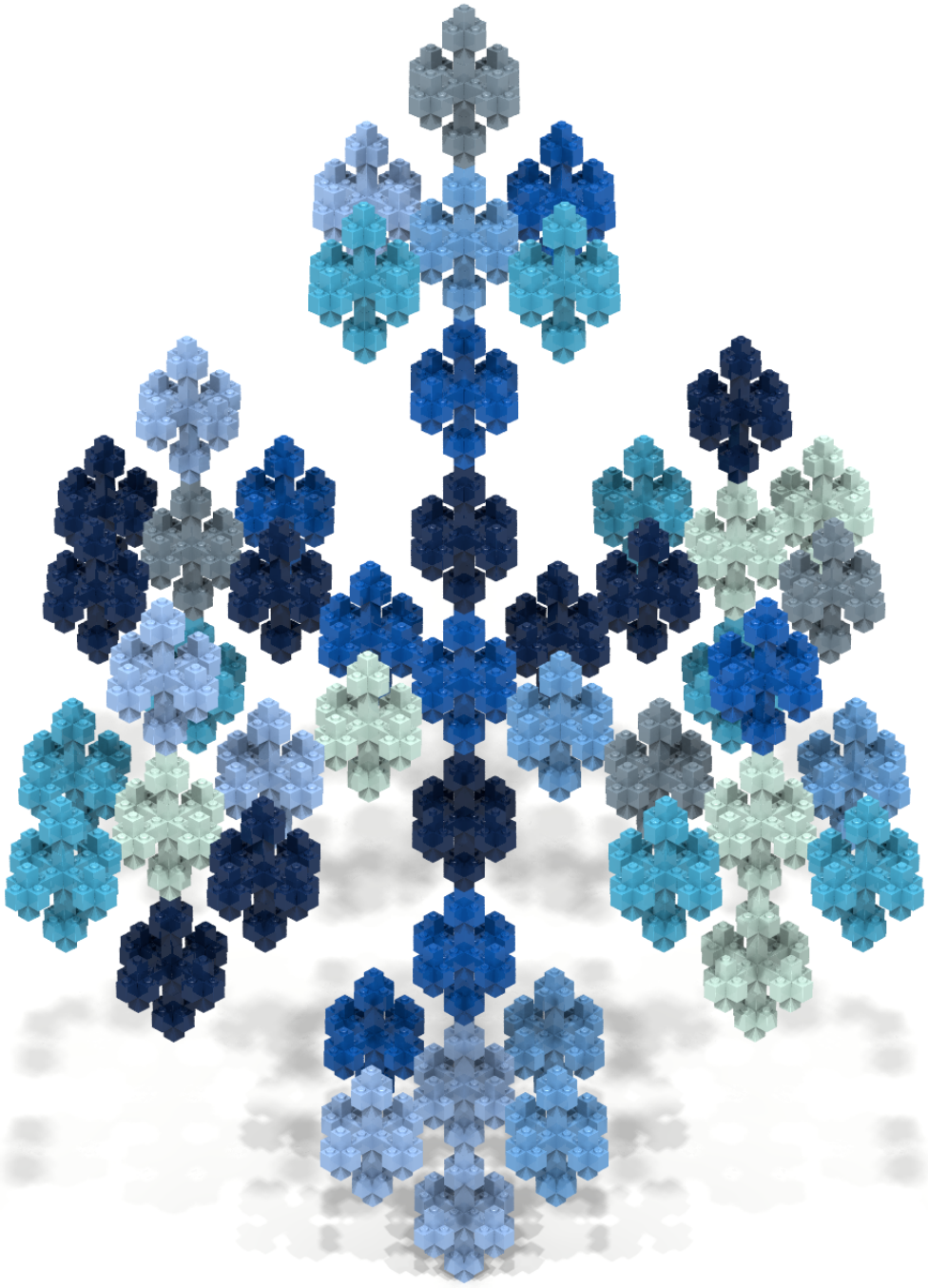

Figure 2: Using random bluescale bricks to color the level 4 Menger Dual sponge.

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