Exercise: Dice roll sum

- Write a method `diceSum` similar to `diceRoll`, but it also accepts a desired sum and prints only arrangements that add up to exactly that sum.

```java
diceSum(2, 7);
diceSum(3, 7);
```

```
[1, 6]
[2, 5]
[3, 4]
[4, 3]
[5, 2]
[6, 1]
[1, 1, 5]
[1, 2, 4]
[1, 3, 3]
[1, 4, 2]
[1, 5, 1]
[2, 1, 4]
[2, 2, 3]
[2, 3, 2]
[2, 4, 1]
[3, 1, 3]
[3, 2, 2]
[3, 3, 1]
[4, 1, 2]
[4, 2, 1]
[5, 1, 1]
```
Consider all paths?

<table>
<thead>
<tr>
<th>chosen</th>
<th>available</th>
<th>desired sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>3 dice</td>
<td>5</td>
</tr>
</tbody>
</table>

...
New decision tree

<table>
<thead>
<tr>
<th>chosen</th>
<th>available</th>
<th>desired sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>3 dice</td>
<td>5</td>
</tr>
</tbody>
</table>

1 2 dice
1, 1 1 die
1, 1, 1

2 2 dice
1, 2 1 die
1, 1, 2

3 2 dice
1, 3 1 die
1, 1, 3

4 2 dice
1, 4 1 die
1, 1, 4

5 2 dice
1, 5 1 die
1, 1, 5

6 2 dice
1, 6 1 die
1, 1, 6

1, 6, 1
1, 6, 2

...
The "8 Queens" problem

- Consider the problem of trying to place 8 queens on a chess board such that no queen can attack another queen.
  - What are the "choices"?
  - How do we "make" or "un-make" a choice?
  - How do we know when to stop?
Naive algorithm

- for (each square on board):
  - Place a queen there.
  - Try to place the rest of the queens.
  - Un-place the queen.

- How large is the solution space for this algorithm?
  - $64 \times 63 \times 62 \times \ldots$
Better algorithm idea

- Observation: In a working solution, exactly 1 queen must appear in each row and in each column.

- Redefine a "choice" to be valid placement of a queen in a particular column.

- How large is the solution space now?
  - $8 \times 8 \times 8 \times \ldots$
Suppose we have a `Board` class with these methods:

<table>
<thead>
<tr>
<th>Method/Constructor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>public Board(int size)</code></td>
<td>construct empty board</td>
</tr>
<tr>
<td><code>public boolean isSafe(int row, int column)</code></td>
<td>true if queen can be safely placed here</td>
</tr>
<tr>
<td><code>public void place(int row, int column)</code></td>
<td>place queen here</td>
</tr>
<tr>
<td><code>public void remove(int row, int column)</code></td>
<td>remove queen from here</td>
</tr>
<tr>
<td><code>public String toString()</code></td>
<td>text display of board</td>
</tr>
</tbody>
</table>

Write a method `solveQueens` that accepts a `Board` as a parameter and tries to place 8 queens on it safely.