# COSC201: Tutorial Week 9
# BSTs and Hashing

1. The height of a binary tree is the maximum length of all the paths from the root to a leaf. A binary tree with a single node has height 0. Prove, by induction, that that a binary tree of height $h$, has at most $2^{h+1} - 1$ nodes.

2. A collection of various `String` objects in Java are shown below along with their hashcodes:

   | | |
   |---|---|
   | `"ant"` | 96742 |
   | `"cat"` | 98263 |
   | `"dog"` | 99644 |
   | `"hog"` | 103481 |
   | `"kea"` | 106054 |
   | `"moa"` | 108287 |
   | `"rat"` | 112677 |
   | `"yak"` | 119396 |

   Suppose that we constructed a hash set of these elements using an underlying array of 10 buckets, choosing the index by taking the remainder of the hashcode modulo 10, and added the elements in alphabetical order.

   (a) Show the contents of the underlying buckets if we use chaining to deal with collisions.

   (b) Show the contents of the underlying buckets if we use linear probing.

   (c) Suppose that we are using linear probing, that we remove `"yak"`, replacing it by a tombstone, and then add `"yyy"` with hashcode 120171. At what index would it be stored?