Complexity of Breadth First Search

- **b**: branching factor; **d**: depth of the search tree

- Number of nodes: $1 + b + b^2 + b^3 + ... + b^{d-1}$

- Soon in your module “Mathematics in Computer Science” you’ll learn to proof by induction

  \[
  1 + b + b^2 + ... + b^{d-1} < b^d \text{ or } b^0 + b + b^2 + ... + b^{d-1} < b^d
  \]

  You can proof it informally by letting the depth $d = 1, 2, ...$ in the equation and see if it’s true ($b = 2$)

  \[
  d = 1, \text{ LHS} = 2^0 = 1; \text{ RHS} = 2^1 = 2 \\
  d = 2, \text{ LHS} = 2^0 + 2^1 = 3; \text{ RHS} = 2^2 = 4 \\
  d = 3, ...
  \]

- Therefore the upper bound of space/time complexity for BFS is $b^d$

- You won’t be asked to proof the time/space complexity in your exam. What you do need to know is the complexity of BFS is exponential $b^d$