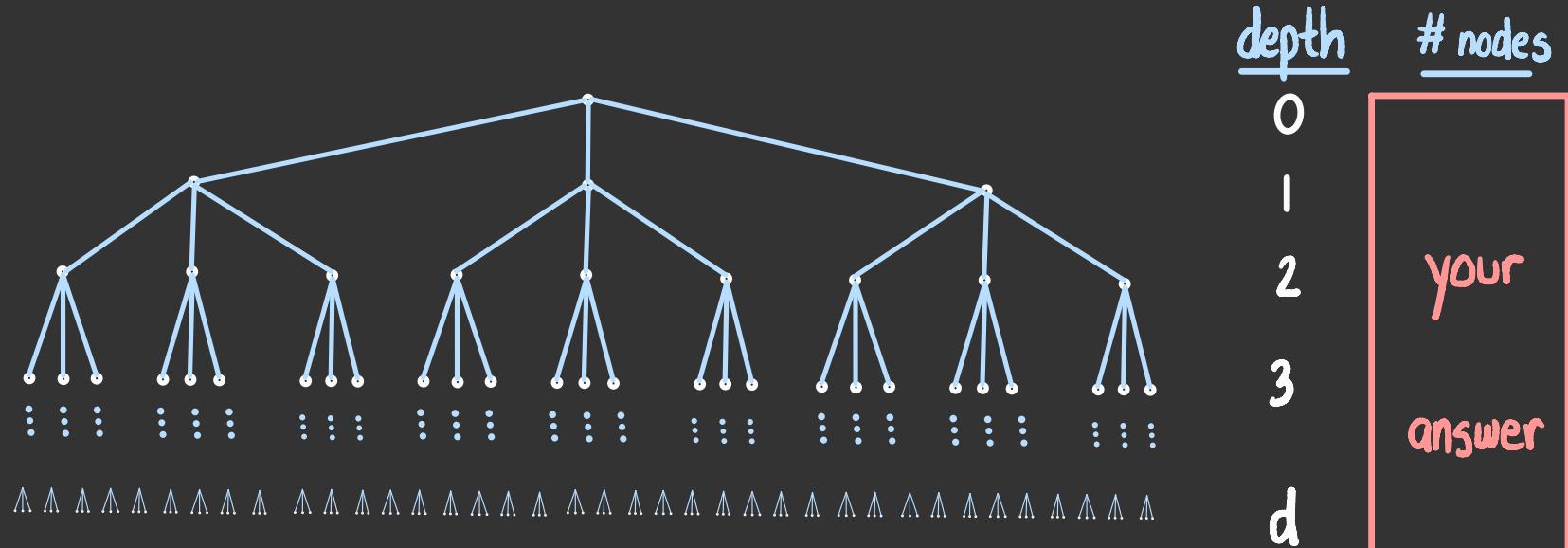


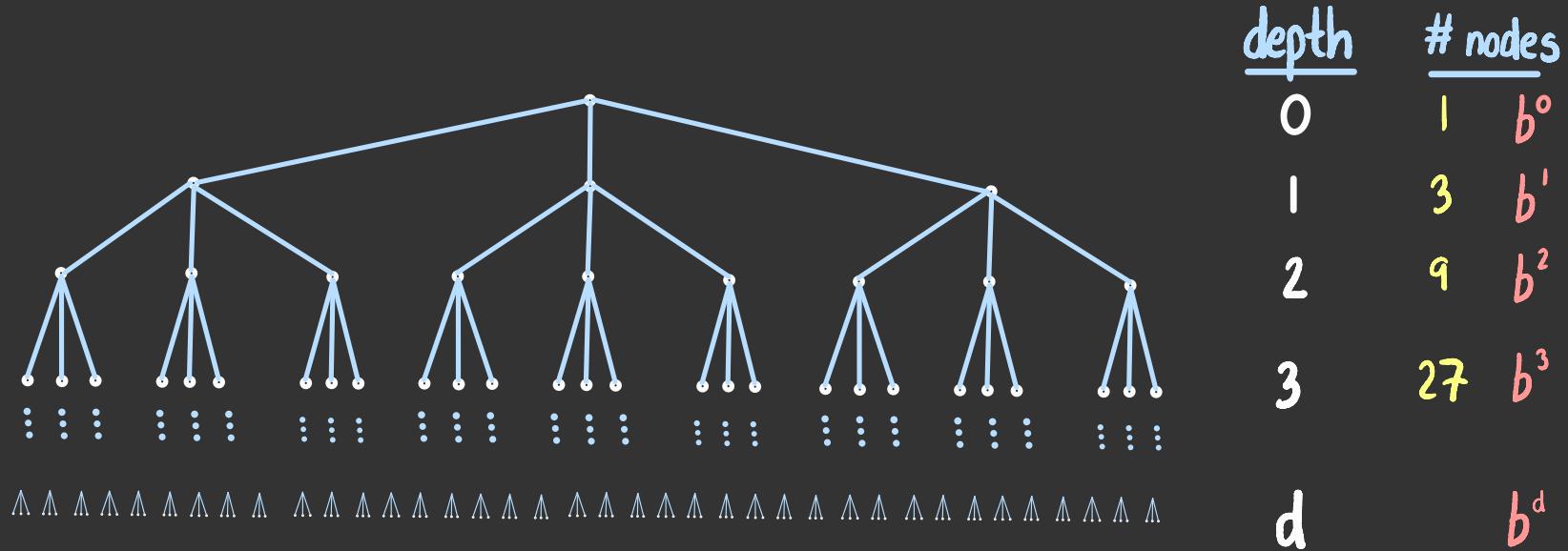
runtime of
bfs and dfs

19 sept
2022

CSCI
373

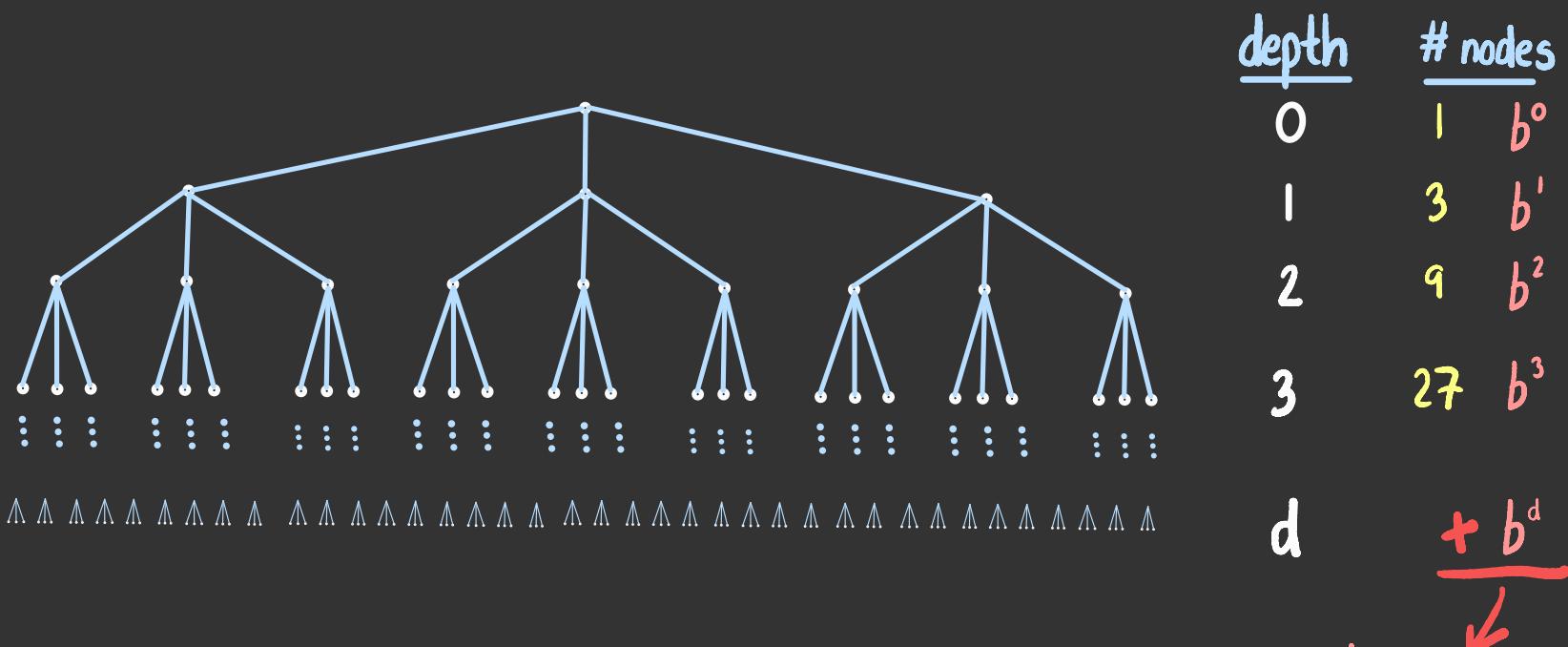


in a full tree with branching factor b ?
 how many nodes are at depth d ?



in a full tree with branching factor b ?
 how many nodes are at depth d ?

$$b^d$$



in a full tree with branching factor b ?
how many nodes are there in total ?

$$\sum_{i=0}^d b^i$$

fun fact: if $b \geq 2$, then

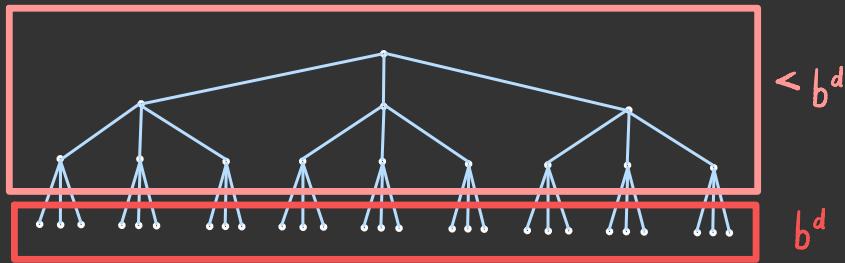
$$\sum_{i=0}^d b^i < 2b^d$$

given that we just observed
there are b^d nodes at depth d
of a full tree, what does
this imply about the number of
internal nodes?

your answer here

fun fact: if $b \geq 2$, then

$$\sum_{i=0}^d b^i < 2b^d$$



trees have more leaves than internal nodes

fun fact: $\sum_{i=0}^{\infty} b^i < b^d$



Fact or Fiction?: Living People
Outnumber the Dead

Booming population growth among the living, according to one rumor, outpaces the dead

By Ciara Curtin on March 1, 2007

Leaves have more leaves than internal nodes

Everybody feels they are right- some are confident, some are open. I'm definitely open to all of these possibilities, but science has it's say(irriducible complexity, creation-i.e. Einsteins clearly stated belief for existence, micro vs macro evolution). Personally that say has led me to be more inclined to the 6000 years theory (and this is ALL THEORY) but I remain open. Thus, if I had to choose today I'd say there are more alive today than ever before. But I'm (hopefully) always open for more info to bring more fact/truth

Jamie, Thorold Canada

No, there are definitely more people alive than dead. That is FACT!

Pippy Van't-Scmit, Kloofenhoffen Namibia

There are more dead people today than living.

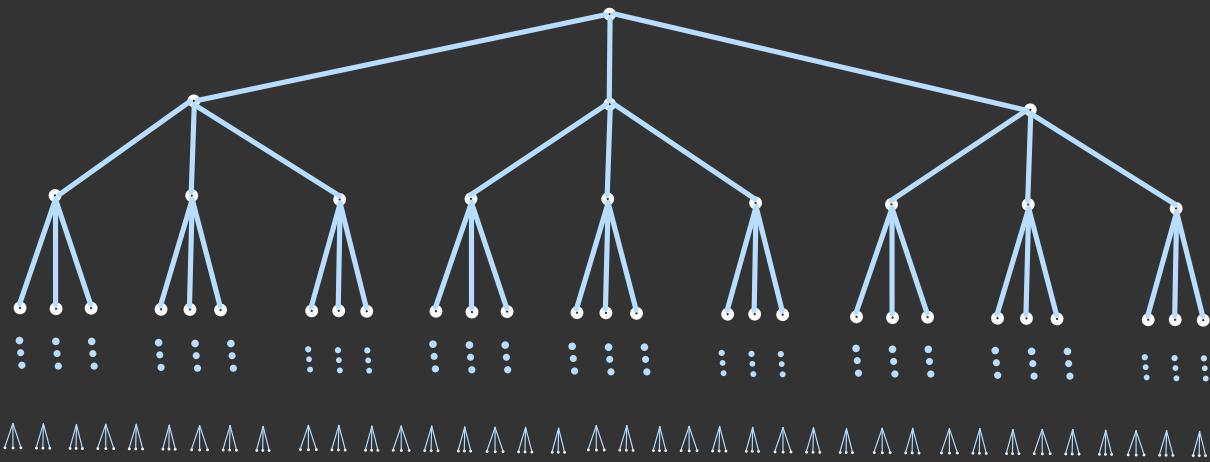
Abdulai Ibrahim, Tamale Ghana

6000 years? Really? I thought it was just some backward bible belt Americans who did not believe in evolution. Flat earth next maybe eh?

Barry Ley, Dubai UAE

Did some actually state the earth at 6000 years old? Why aren't they dead from stupidity? Ugh. Whatever the number is, there are a lot more brain dead people than alive.

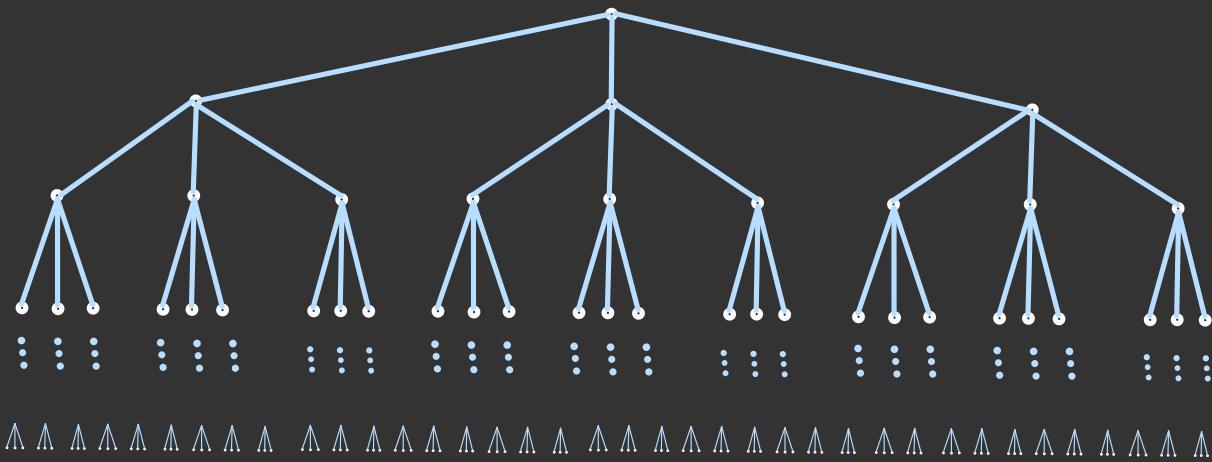
Tom, New York United States



in a full tree with branching factor b ?
how many nodes are there in total?

$$\sum_{i=0}^d b^i < 2b^d = O(\boxed{?})$$

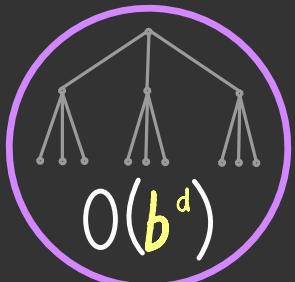
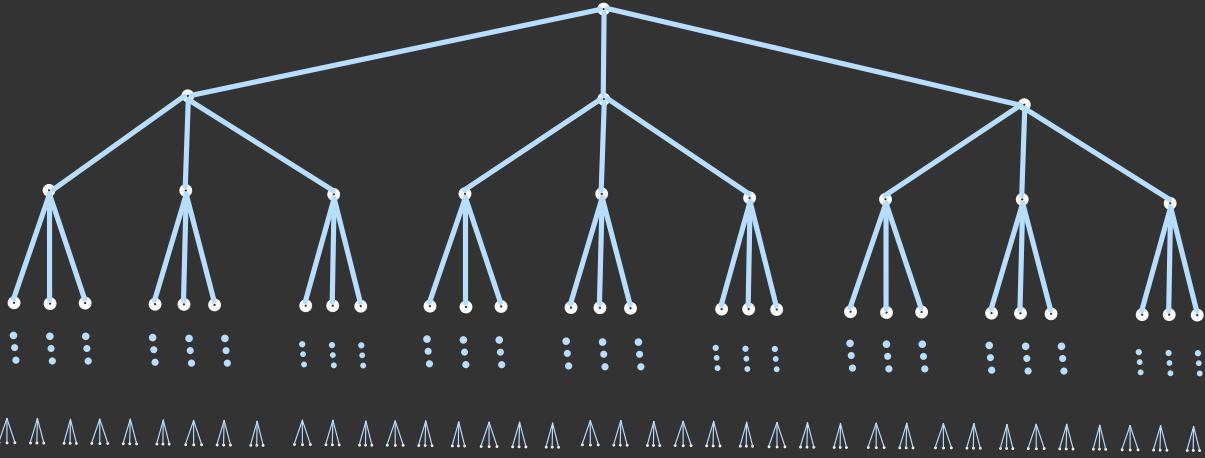
if $b \geq 2$



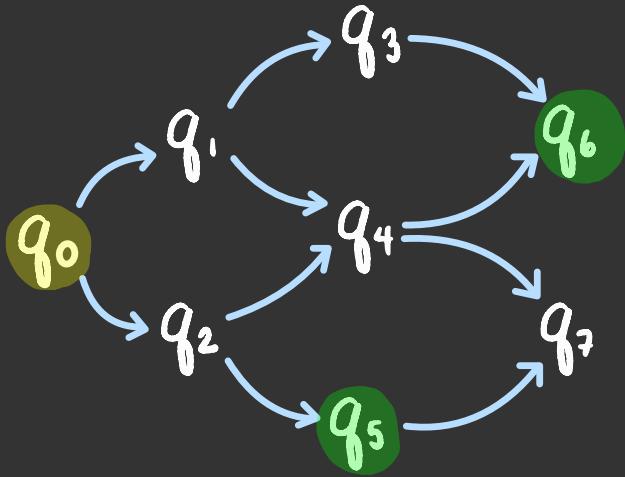
in a full tree with branching factor b ?
how many nodes are there in total?

$$\sum_{i=0}^d b^i < 2b^d = O(b^d)$$

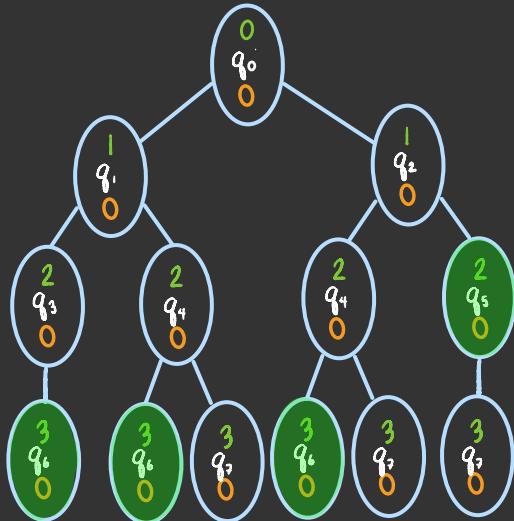
if $b \geq 2$



: a full tree with branching factor b and depth d has $O(b^d)$ nodes



state machine



search tree

d

solution depth

the length of the shortest search path that leads to a final state

m

maximum depth

the length of the longest search path

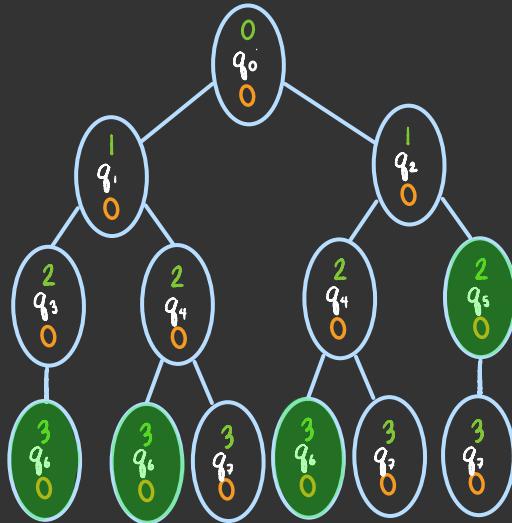
b

branching factor

the maximum number of successors of a search node

what is the worst-case

running time of
bfs?



search tree

d

solution depth

the length of the shortest search path that leads to a final state

m

maximum depth

the length of the longest search path

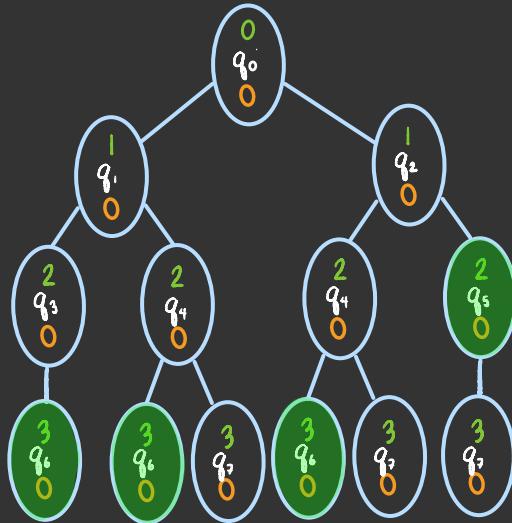
b

branching factor

the maximum number of successors of a search node

recall this property
of bfs:

if $j < k$, then every node
at search depth j is
visited before any node
at search depth k



search tree

d

solution depth

the length of the shortest
search path that leads to a
final state

m

maximum depth

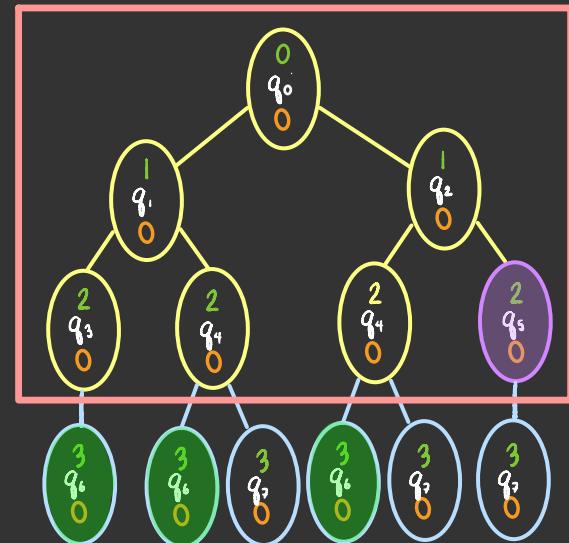
the length of the longest
search path

b

branching factor

the maximum number of successors
of a search node

so the worst-case scenario
is that bfs visits all
search nodes at solution
depth d or lower



search tree

d

solution depth

the length of the shortest
search path that leads to a
final state

m

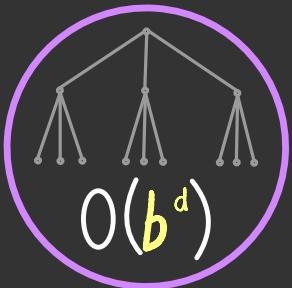
maximum depth

the length of the longest
search path

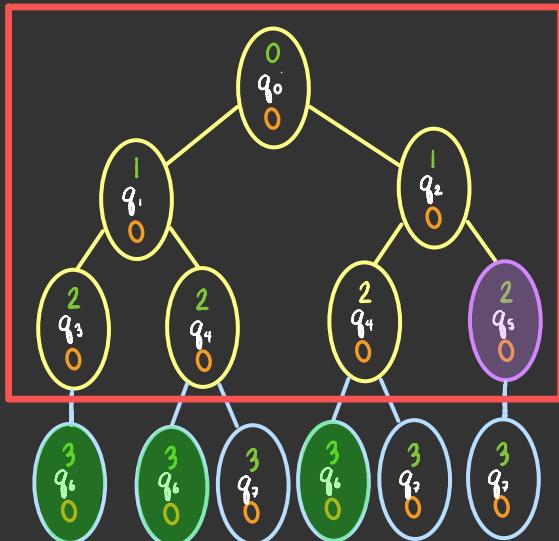
b

branching factor

the maximum number of successors
of a search node



so in the worst case, bfs visits $O(b^d)$ nodes



search tree

d

solution depth

the length of the shortest search path that leads to a final state

m

maximum depth

the length of the longest search path

b

branching factor

the maximum number of successors of a search node

what is the worst-case

running time of

dfs?

your answer
here

d

solution depth

the length of the shortest search path that leads to a final state

m

maximum depth

the length of the longest search path

b

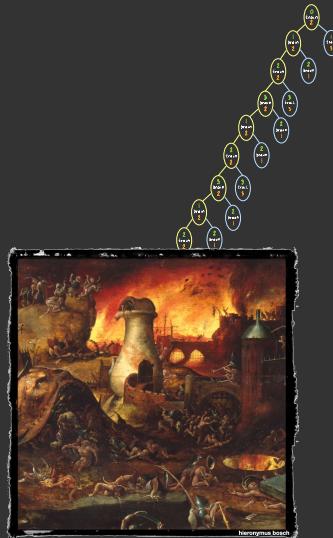
branching factor

the maximum number of successors of a search node

what is the worst-case

running time of

dfs?



infinite

or

$O(\text{😭})$

or

$O(\text{🚽})$

d

solution depth

the length of the shortest search path that leads to a final state

m

maximum depth

the length of the longest search path

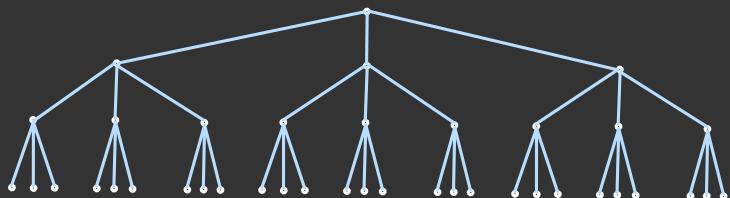
b

branching factor

the maximum number of successors of a search node

what is the worst-case
running time of
dfs?

but what if we know
that the search tree
has finite depth?



d

solution depth

the length of the shortest
search path that leads to a
final state

m

maximum depth

the length of the longest
search path

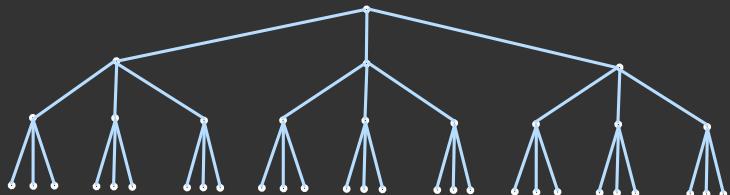
b

branching factor

the maximum number of successors
of a search node

what is the worst-case
running time of
dfs?

but what if we know
that the search tree
has finite depth?



there might not be a solution,
or it be in the last place we look

d

solution depth

the length of the shortest
search path that leads to a
final state

m

maximum depth

the length of the longest
search path

b

branching factor

the maximum number of successors
of a search node

what is the worst-case
running time of
dfs?

so in the worst-case
we need to visit all
nodes in a tree of
depth **m** and branching
factor **b**, which is
 $O(\boxed{?})$

d

solution depth

the length of the shortest
search path that leads to a
final state

m

maximum depth

the length of the longest
search path

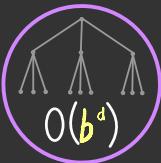
b

branching factor

the maximum number of successors
of a search node

what is the worst-case
running time of
dfs?

so in the worst-case
we need to visit all
nodes in a tree of
depth **m** and branching
factor **b**, which is
 $O(b^m)$



d

solution depth

the length of the shortest
search path that leads to a
final state

m

maximum depth

the length of the longest
search path

b

branching factor

the maximum number of successors
of a search node