# Zip Trees

Robert Tarjan and **Caleb Levy**

Princeton University
& Intertrust Technologies

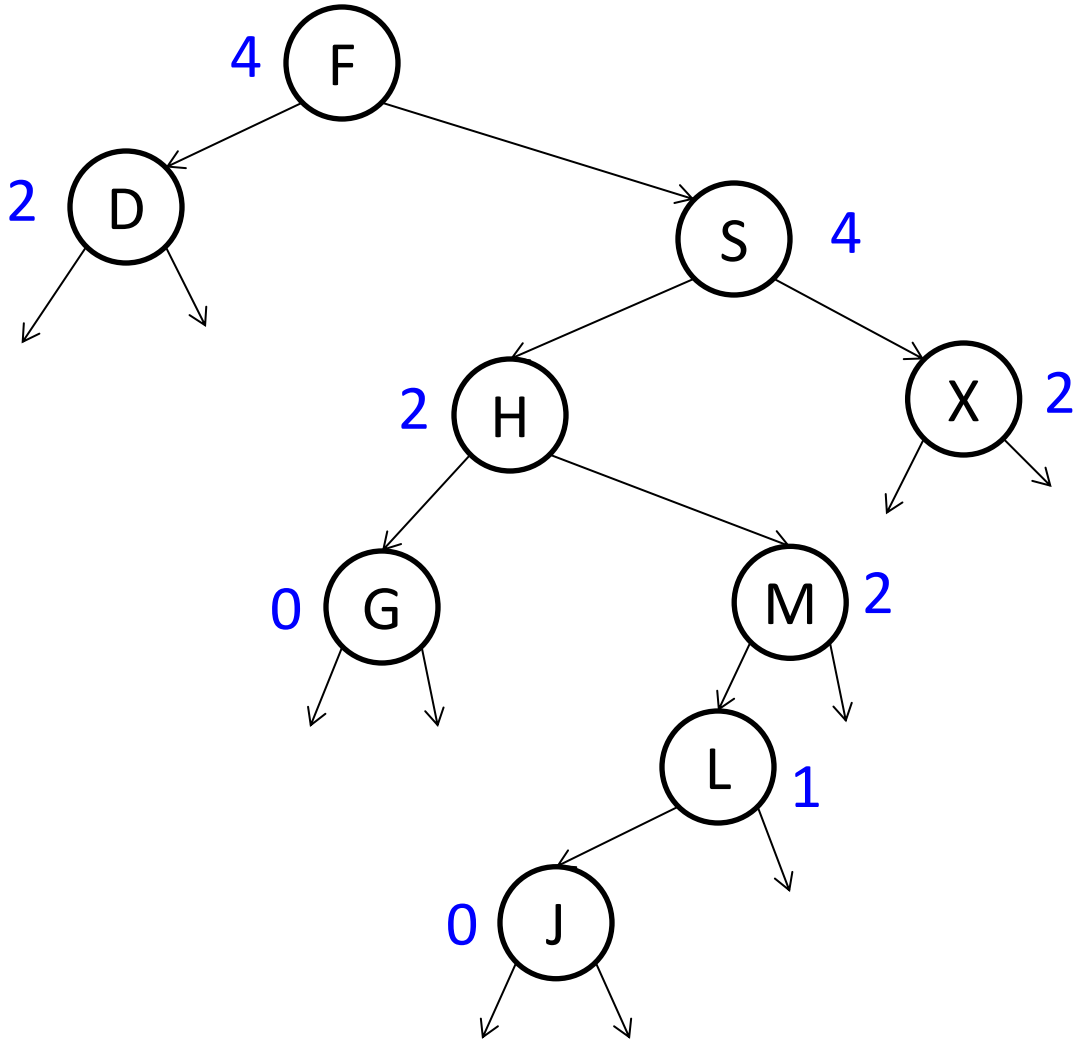
HALG 2018

# Zip Trees

A Binary Search Tree where:

- Keys have random geometrically distributed ranks
  $\boldsymbol{Pr}[\textbf{rank}(x) = k] = 1/2^{k+1}$
- Constructed recursively:
  **root**($T$) is the smallest node of maximum rank
- Variant of Treaps, equivalent to Skip Lists

# A Zip Tree



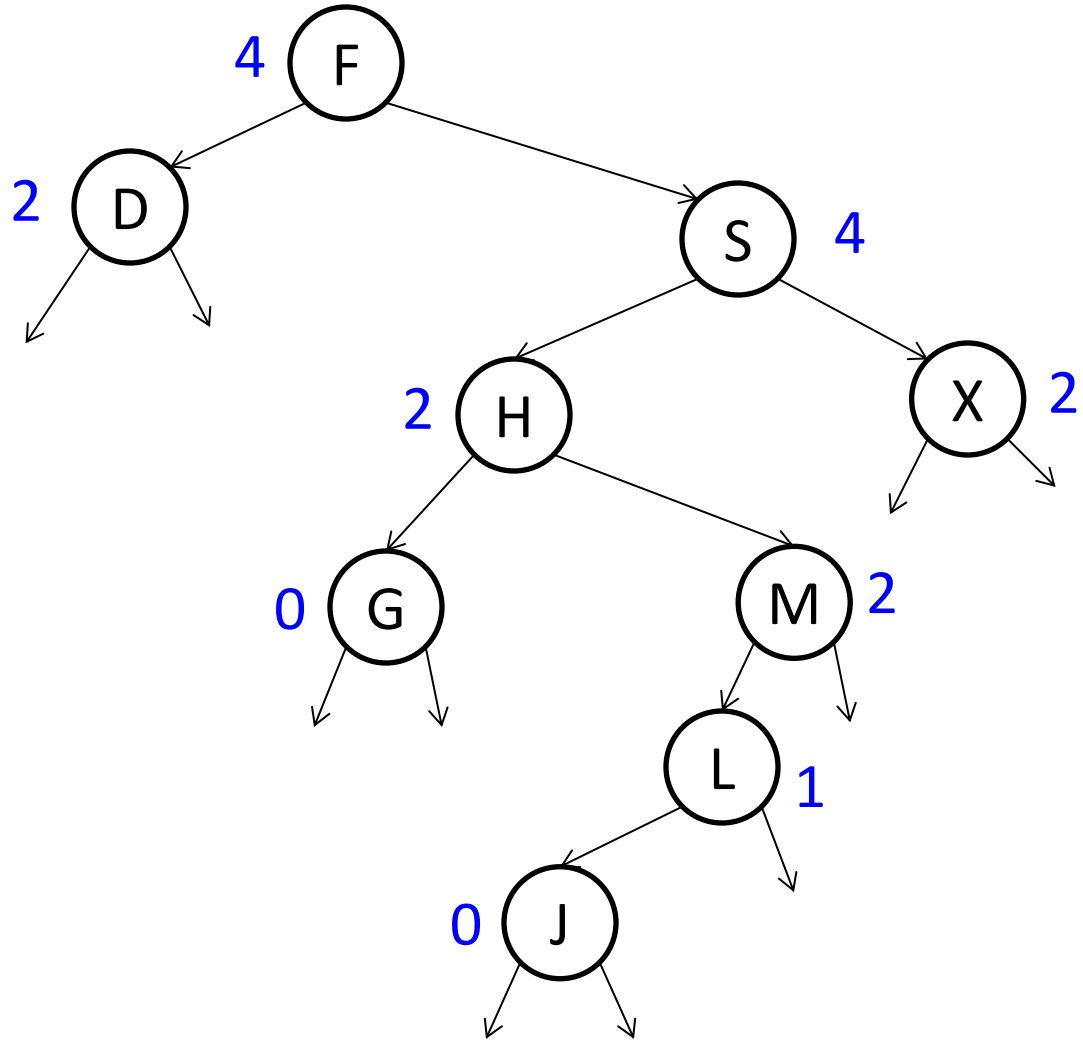
# INSERTION

# Insertion by Unzipping

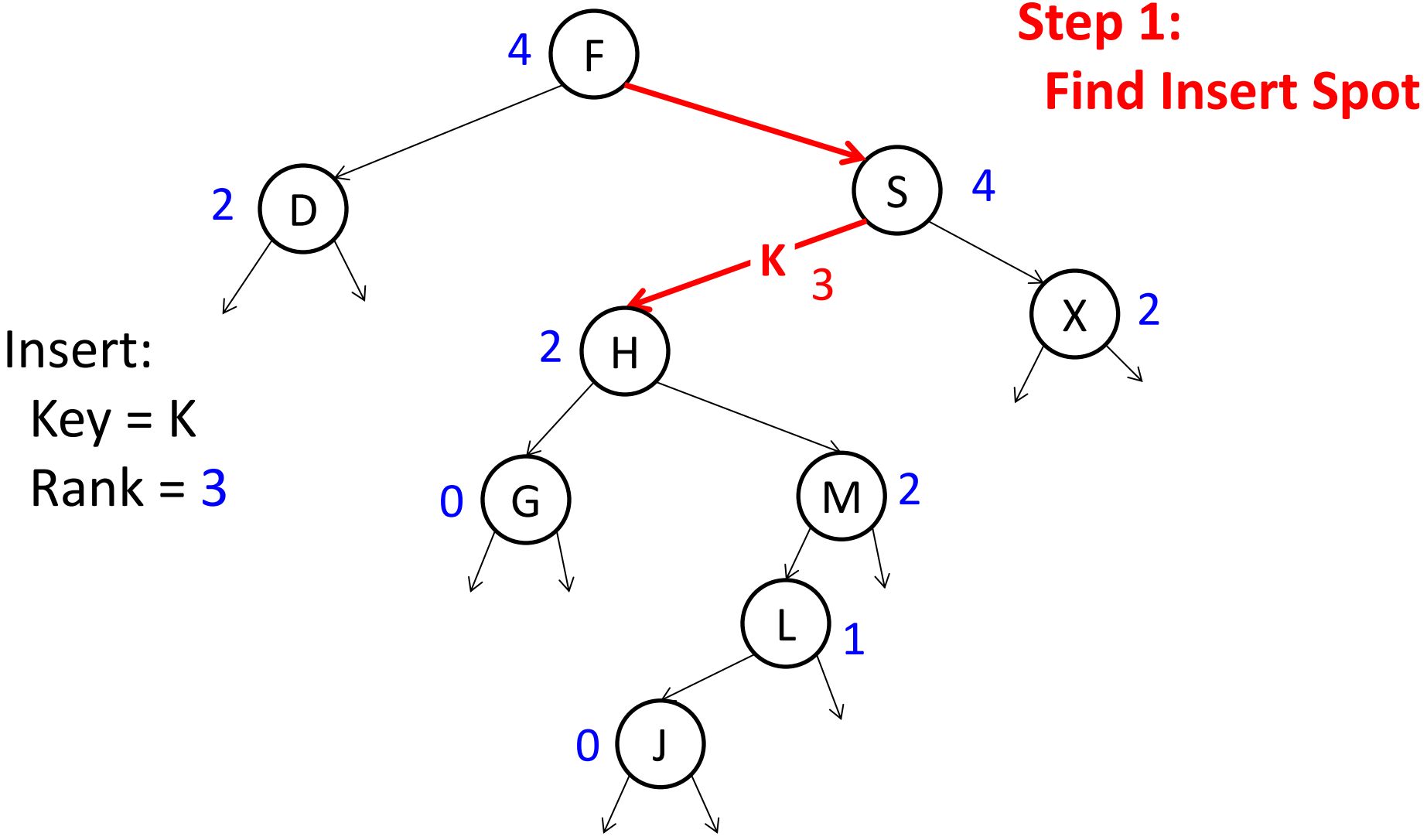
**Insert:**

**Key = K**

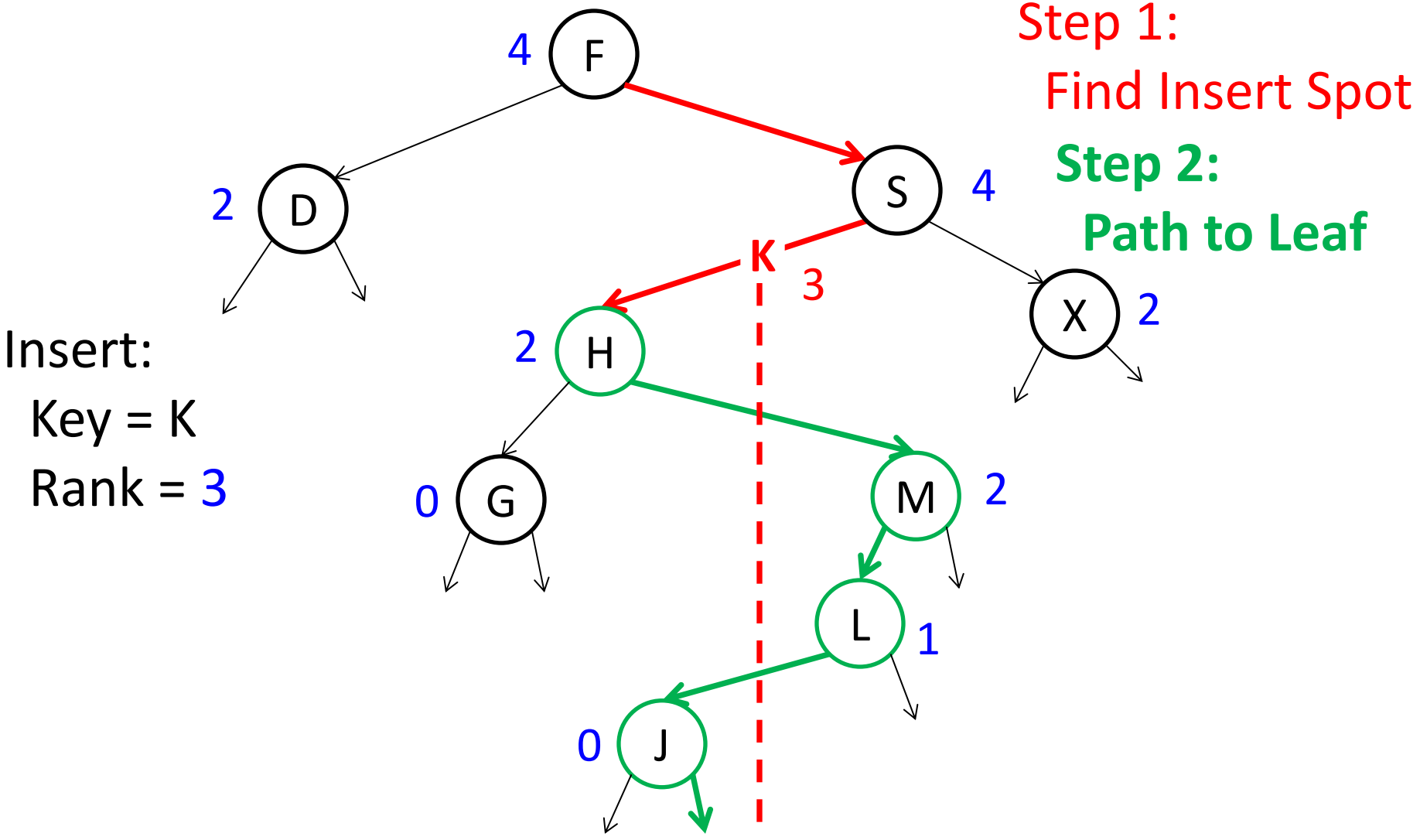
**Rank = 3**



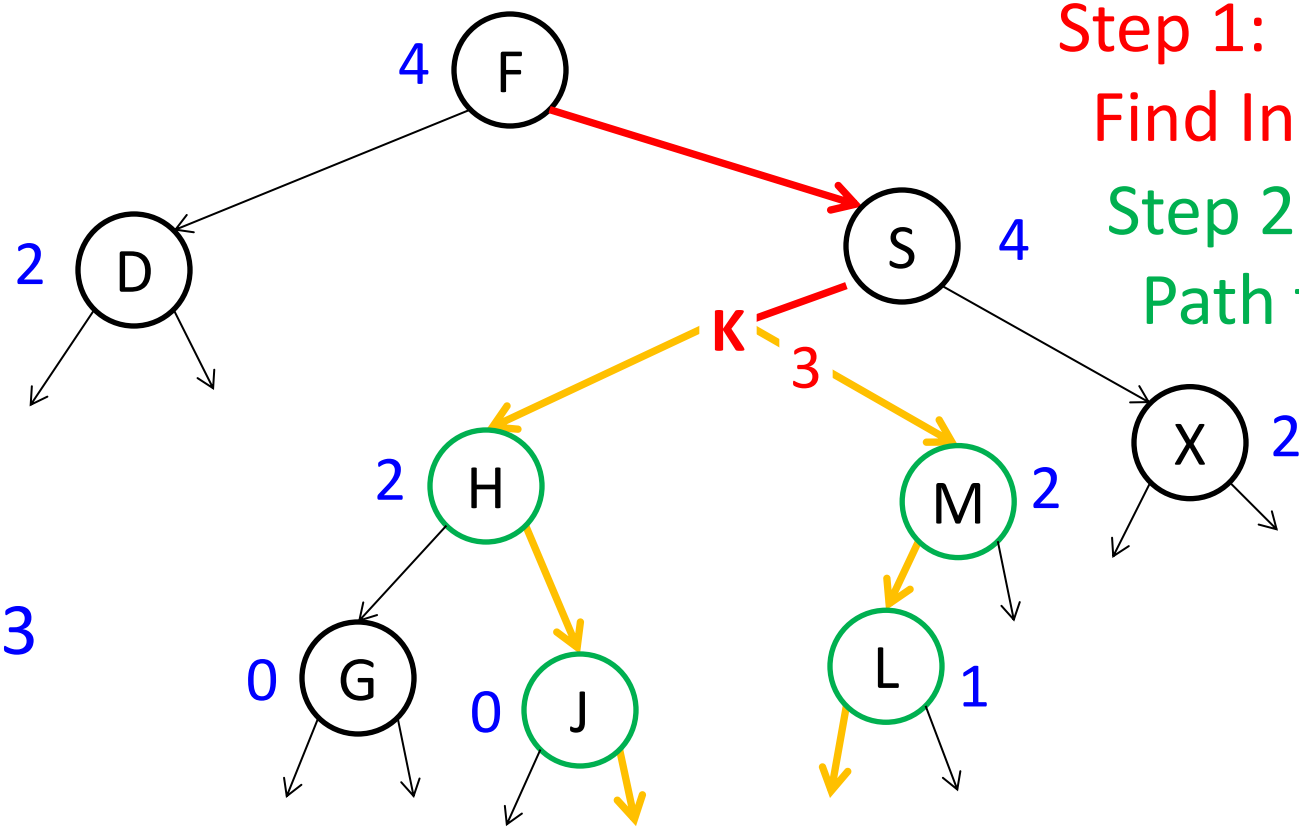
# Insertion by Unzipping



# Insertion by Unzipping



# Insertion by Unzipping




Step 1:
Find Insert Spot

Step 2:
Path to Leaf

Step 3:
Unzip

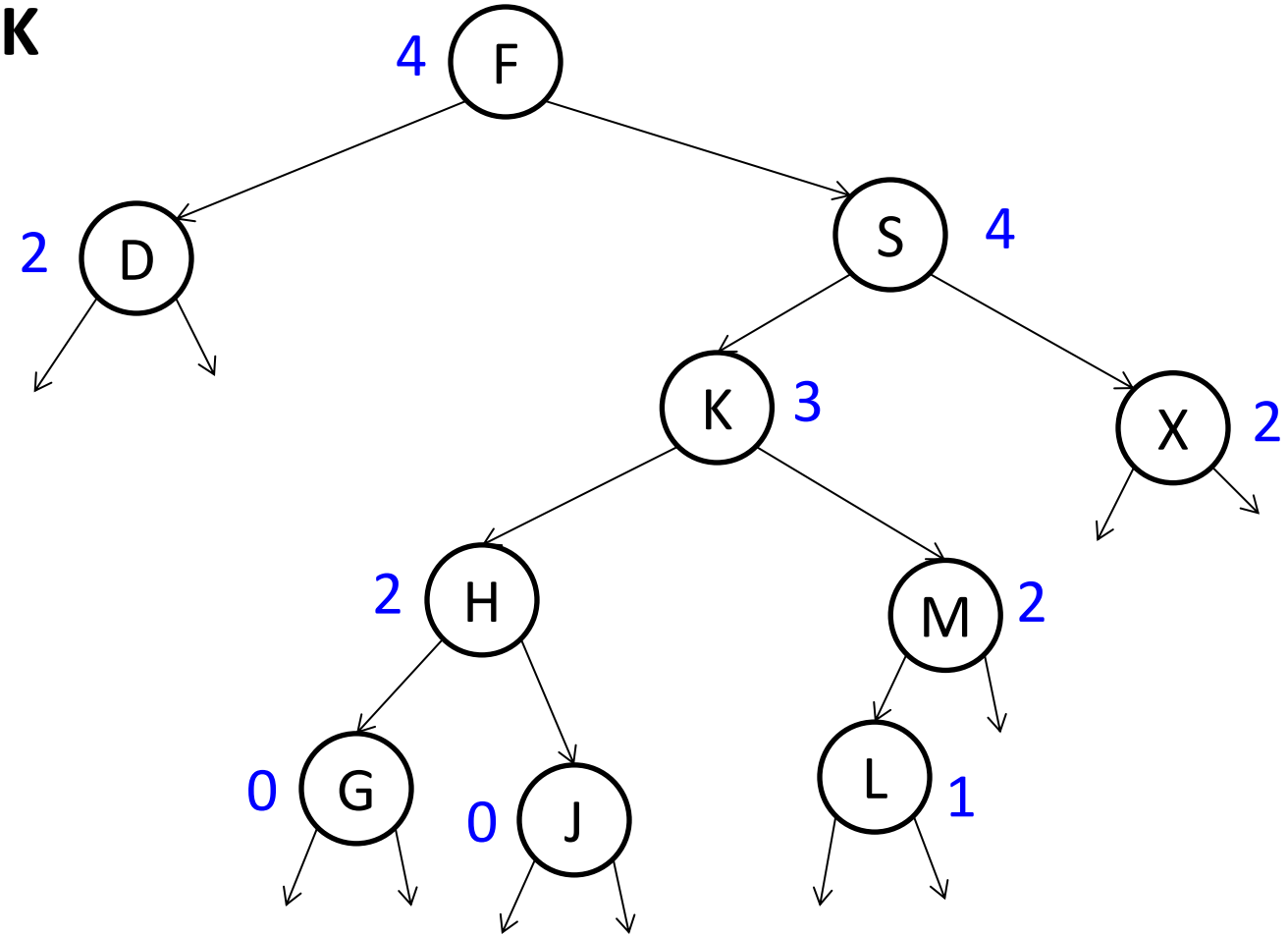
Insert:
Key = K
Rank = 3

# DELETION

# Deletion by Zipping

**Delete:**

**Key = K**

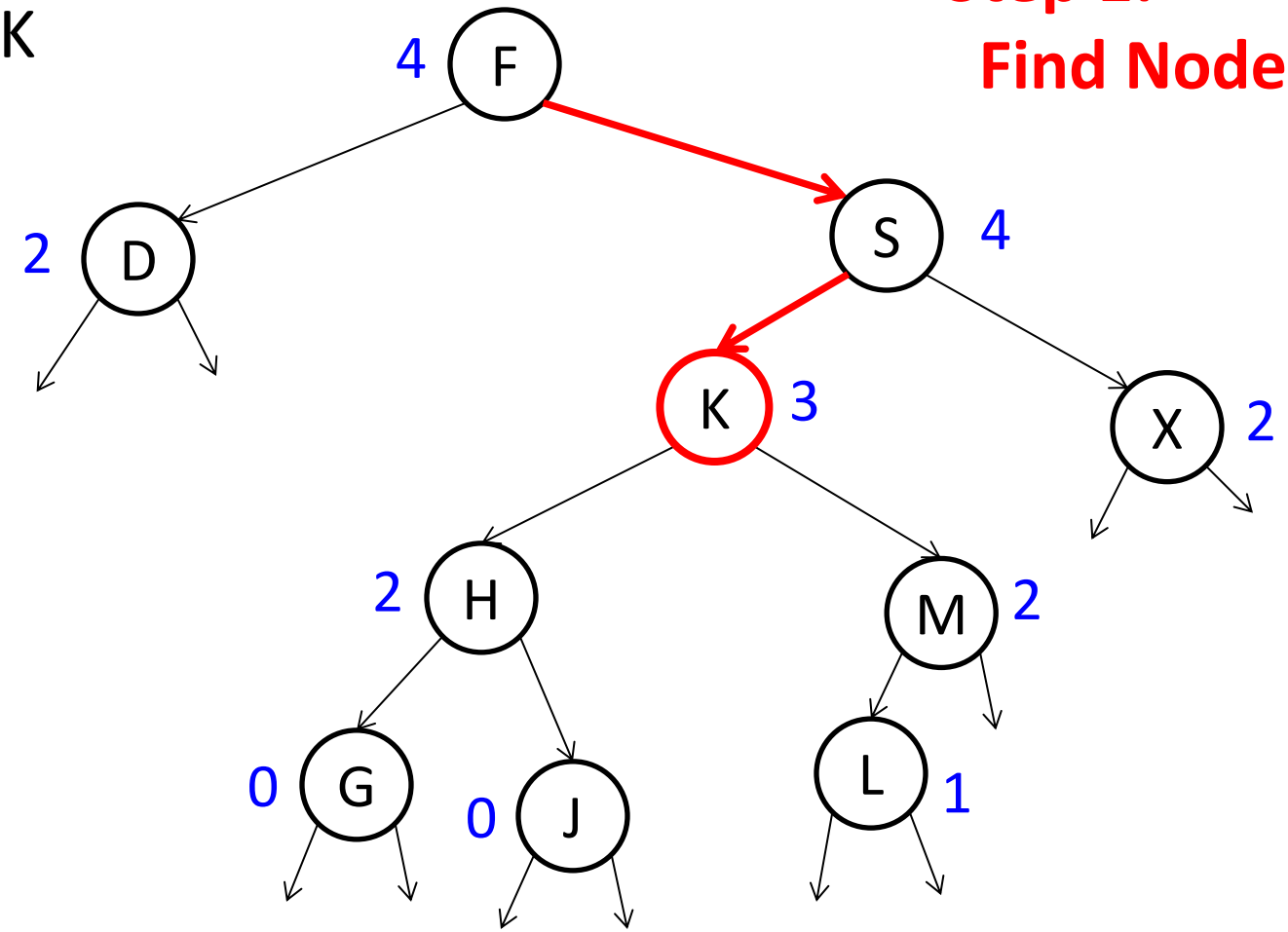


# Deletion by Zipping

Delete:

Key = K

**Step 1:**
**Find Node**



# Deletion by Zipping

Delete:

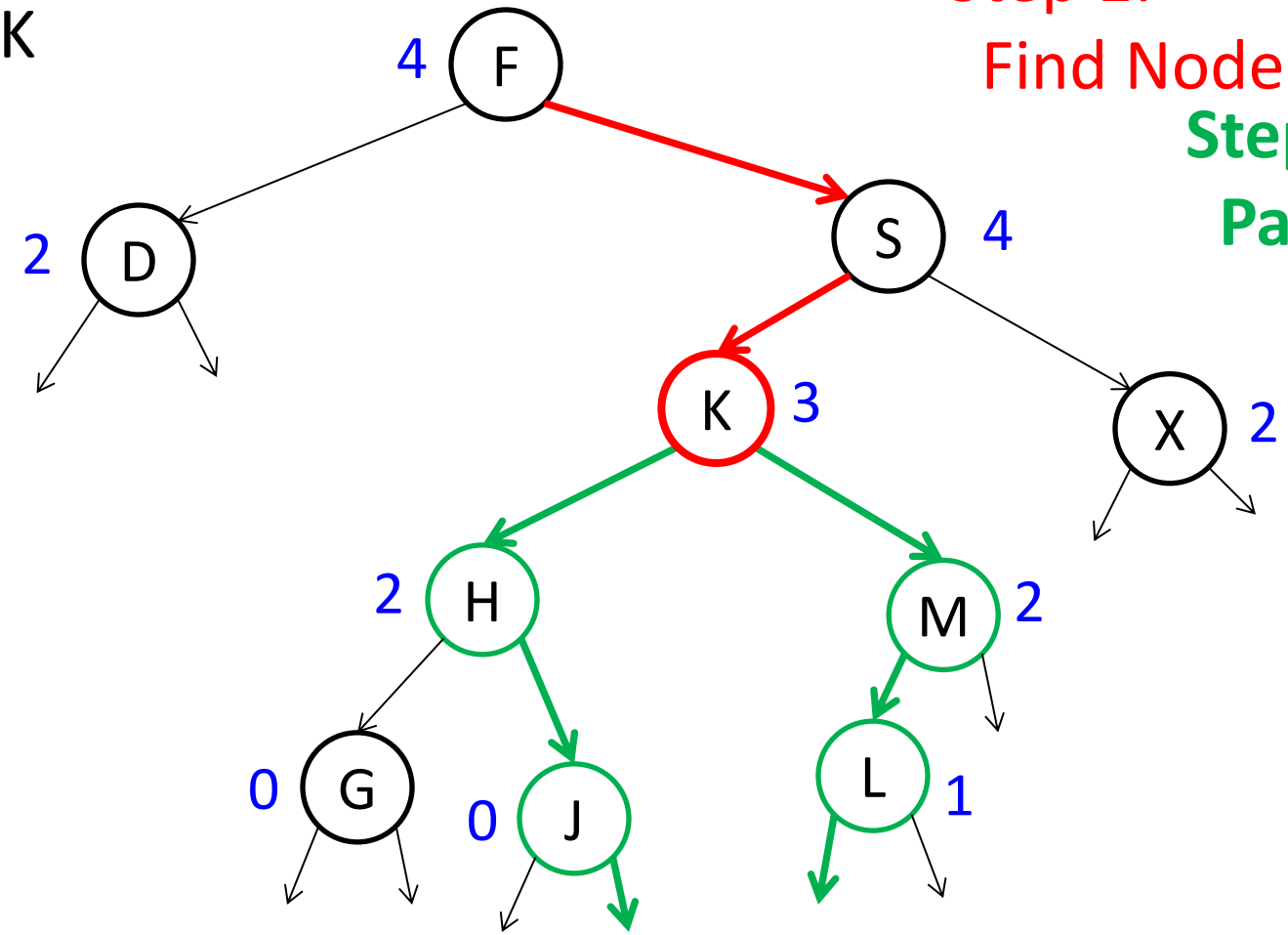
Key = K

Step 1:

Find Node

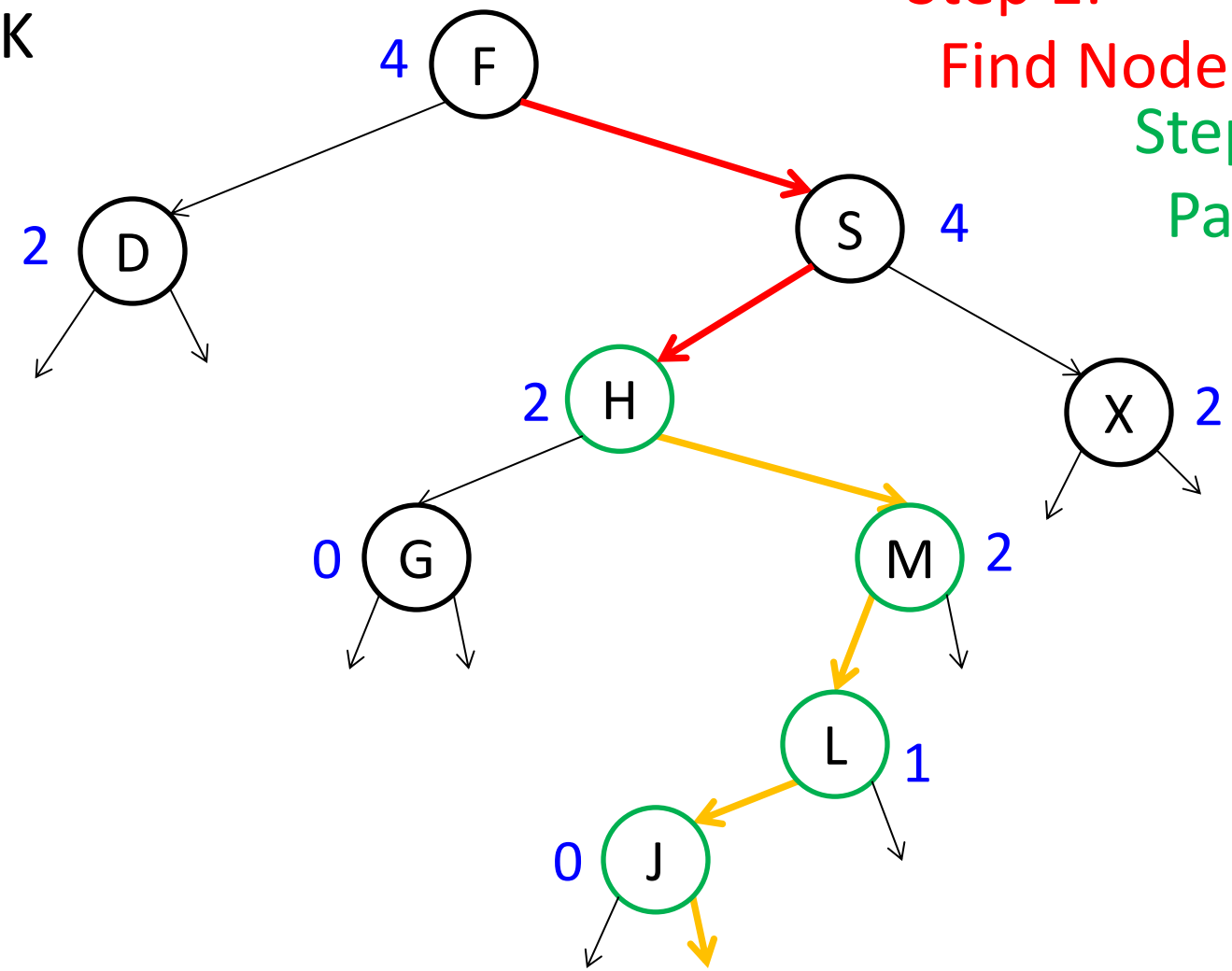
**Step 2:**

**Paths to Leaf**



# Deletion by Zipping

Delete:
Key = K




Step 1:
Find Node

Step 2:
Paths to Leaf

Step 3:
Zip

# Properties of Zip Trees

- Tree depth is O(log *n*) W.H.P.
- A unique tree for each set of ***keys*** and ***ranks***
- O(1) pointer changes per Insert/Delete
- Insert & Delete purely top-down, no rotations
- W.H.P. need only O(log log *n*) bits/rank

# Current work

Develop, analyze, and implement efficient non-blocking concurrent *zip* trees

# Related Work

C. Aragon and R. Seidel, “Randomized search trees,” *Algorithmica*, (1996).

C. Martinez and S. Roura, “Randomized binary search trees,” *ACM,* (1998).

W. Pugh, “Skip lists: a probabilistic alternative to balanced trees,” *Comm. ACM*, (1990).

R. Sprugnoli, “Randomly balanced binary trees,” *CALCOLO*, (1980).

C. Stephenson, “A method for constructing binary search trees by making insertions at the root,” *IJCIS*, (1980).

*Thanks!*