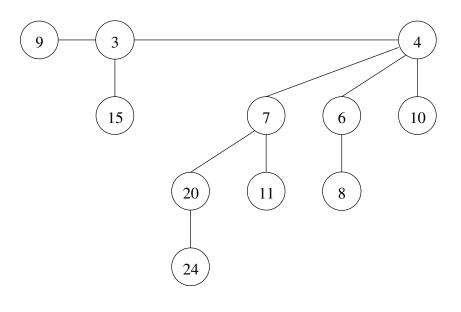# Effiziente Algorithmen und Datenstrukturen I
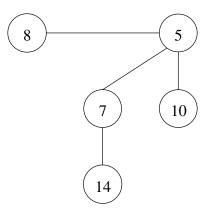
Aufgabe 1 (10 Punkte)

Suppose we label the nodes of a binomial tree B_k in binary as shown in lecture(visit the root, traverse the rightmost subtree, traverse the left subtree). Consider a node x labeled l at depth i. Show that x has i 1's in its binary label l. Also show that the number of children of x is equal to the number of 0's to the right of the rightmost 1 in the binary representation of l (except for the root).

Aufgabe 2 (10 Punkte)

Consider the following Binomial Heaps:

Heap A:

Heap B:

Carry out the following operations sequentially on the heaps and show them after each operation(always carry out each operation on the result of the previous operation):

1. merge(A,B)

2. deleteMin()

Aufgabe 3 (10 Punkte)

We say that $f(n) = \overset{\infty}{\Omega} (g(n))$ if there exists a positive constant c such that $f(n) \geq cg(n) \geq 0$ for infinitely many integers n. Find inputs that cause DELETE-MIN, DECREASE-KEY, and DELETE to run in $\Omega(\log n)$ time for a binomial heap. Explain why the worst-case running times of INSERT, MINIMUM, and MERGE are $\overset{\infty}{\Omega} (\log n)$ but not $\Omega(\log n)$ for a binomial heap.