

Module 5

Misc-Group Testing

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Group Testing

- For pandemic like COVID-19, there may not be sufficient number of test kits needed to individually test people in a larger population set and identify infected people.
- With “Group Testing,” the idea is to collect samples from multiple people and test the entire group with one test kit.
 - If the result turns out to be negative, then all the people whose samples were put together are considered to test negative for the virus.
 - If the result turns out to be positive, then one or more people within the test group are considered to have been infected and we need to narrow down our testing to the infected people.
 - We can use the binary search approach to narrow down the search space and individually identify the infected people.
- We will build a binary search tree whose nodes represent the number of people being tested using a test kit.
- The total number of test kits needed for a person/group cleared at a particular level of the binary search tree is one plus the level number for the corresponding node.

Evaluation of the Binary Search-based Test Pooling Strategy

- **Efficiency**

- = $1 - (\# \text{ test kits needed}) / (\text{group size})$

- One test kit needed for each node in the binary search tree

- The approach is not effective for efficiency < 0

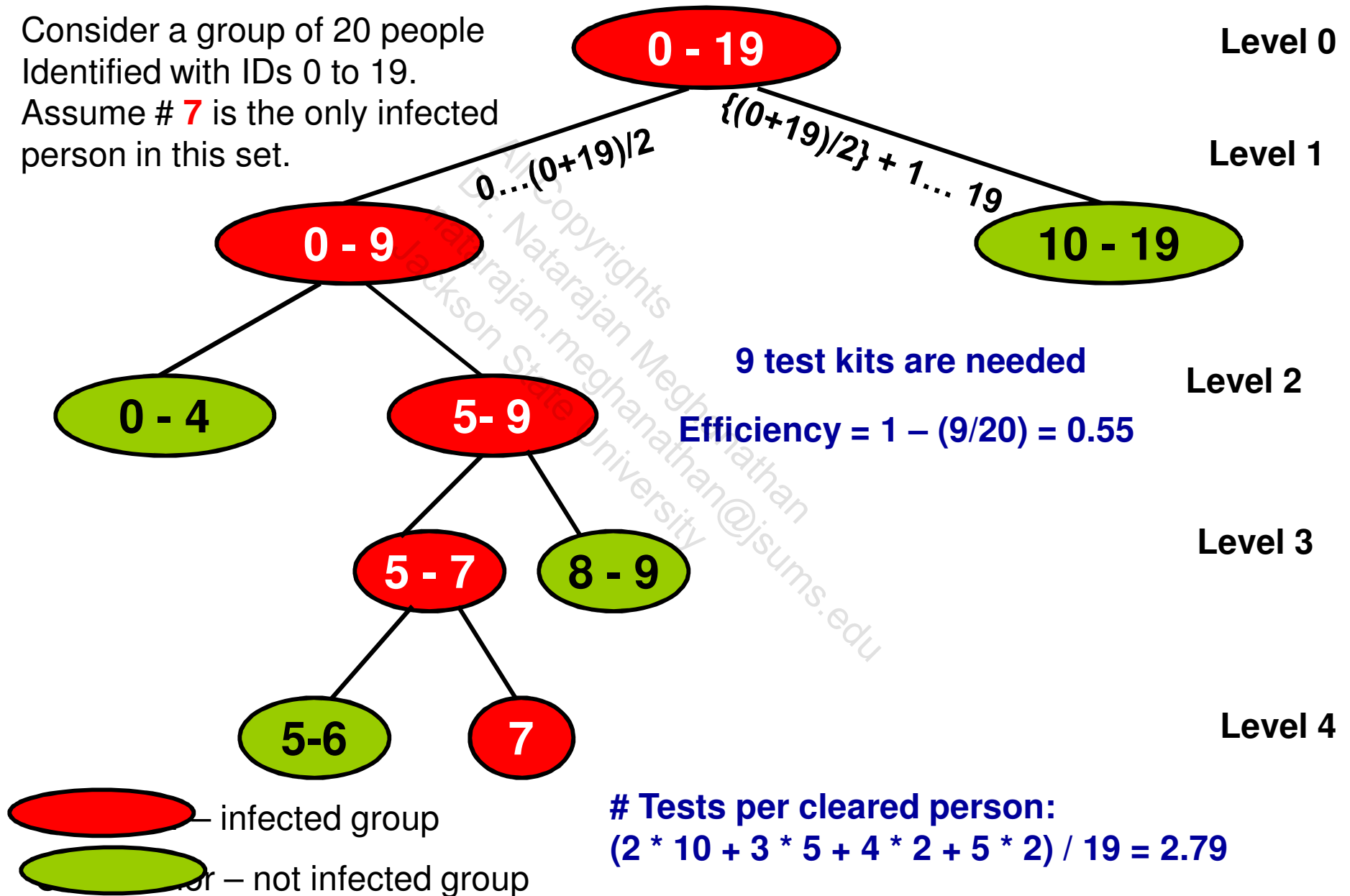
- **# Tests per cleared person**

- = Weighted average

- = (Sum of the products of the number of people cleared as a group/individual and the number of test kits needed) / (group size)

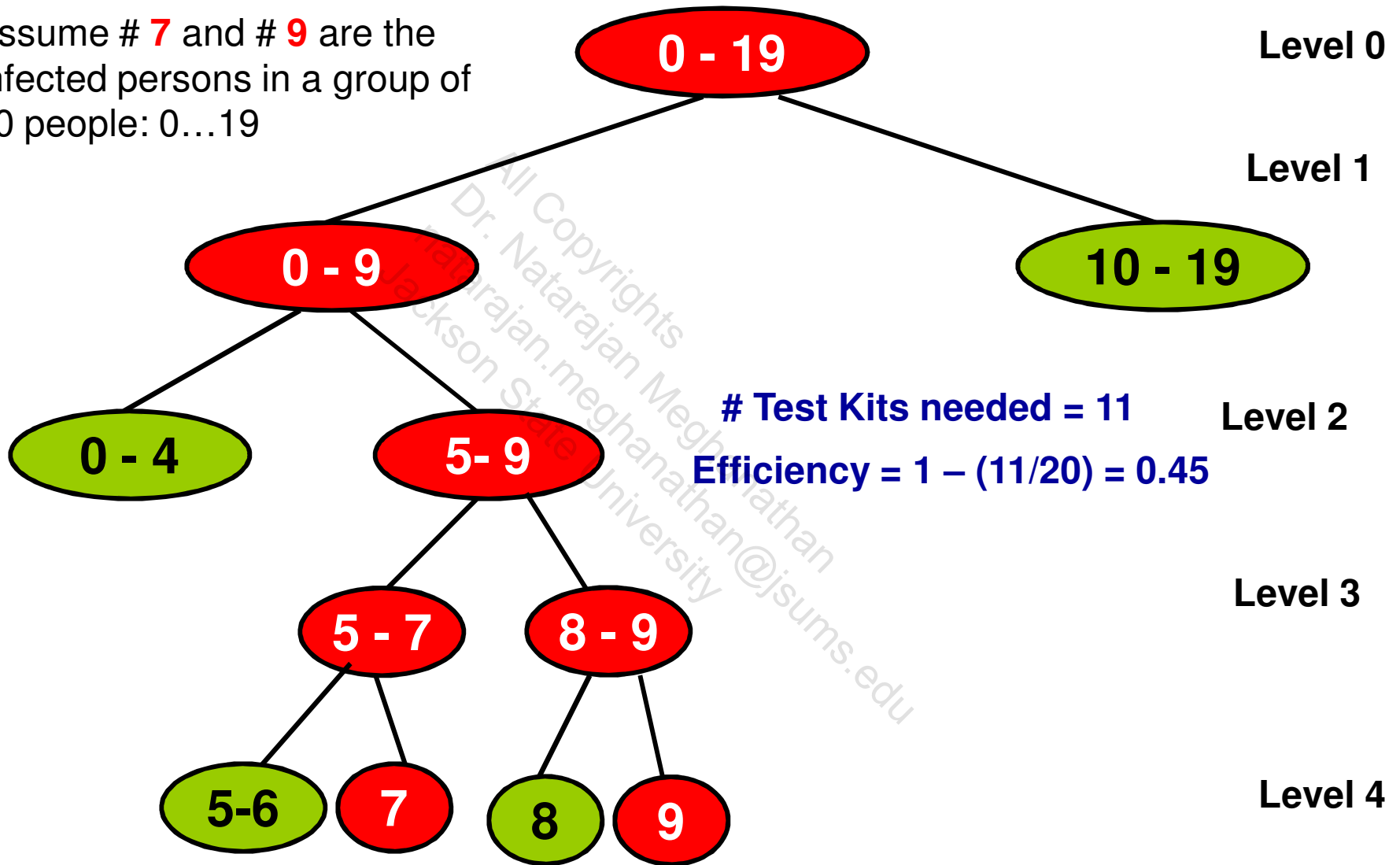
0 1 2 3 4 5 6 **7** 8 9 10 11 12 13 14 15 16 17 18 19

Consider a group of 20 people
Identified with IDs 0 to 19.
Assume # **7** is the only infected
person in this set.



0 1 2 3 4 5 6 **7** 8 **9** 10 11 12 13 14 15 16 17 18 19

Assume # **7** and # **9** are the
Infected persons in a group of
20 people: 0...19



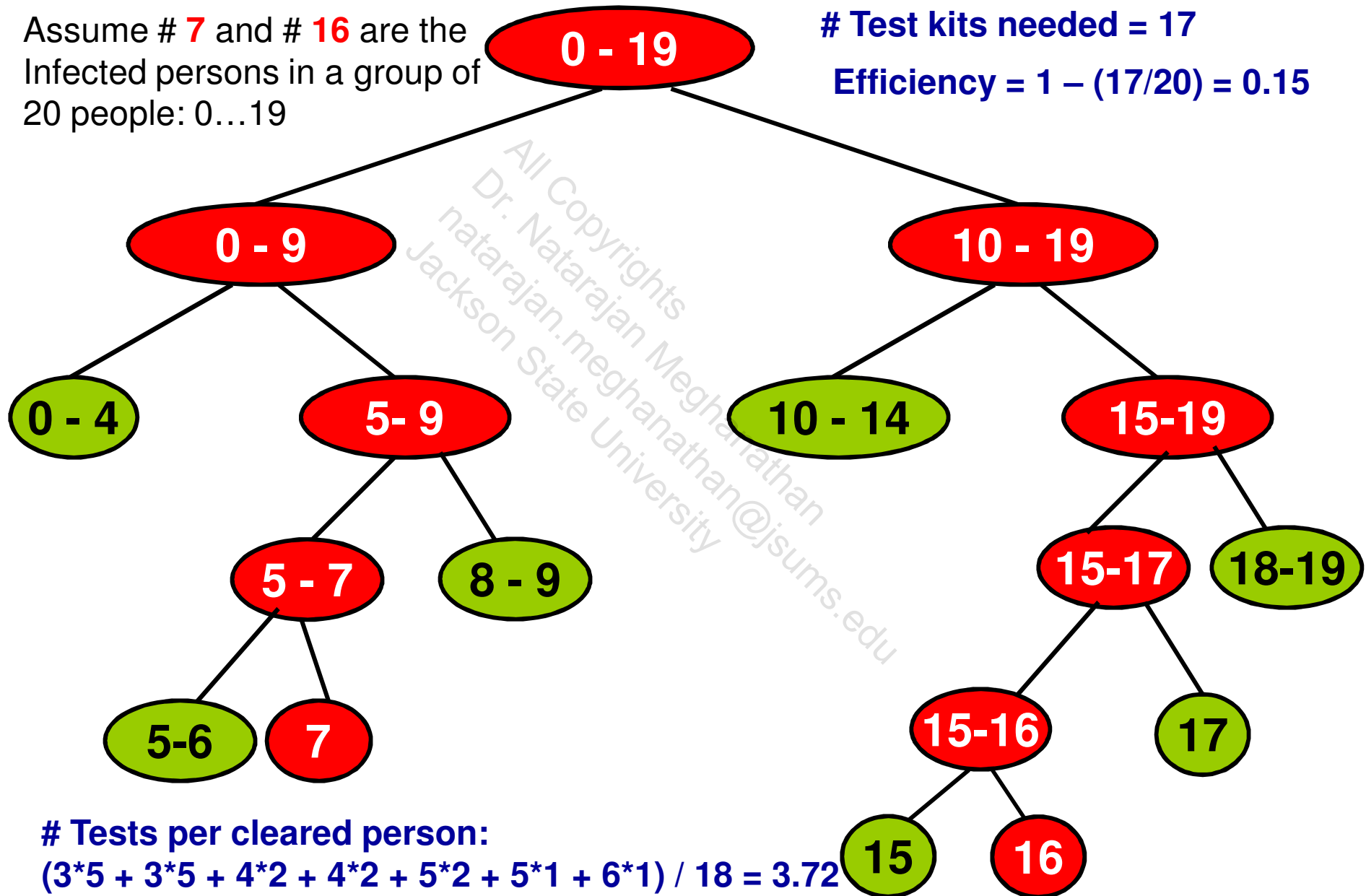
Tests per cleared person:
 $(2 * 10 + 3 * 5 + 5 * 2 + 5 * 1) / 18 = 2.78$

0 1 2 3 4 5 6 **7** 8 9 10 11 12 13 14 15 **16** 17 18 19

Assume # **7** and # **16** are the
Infected persons in a group of
20 people: 0...19

Test kits needed = 17

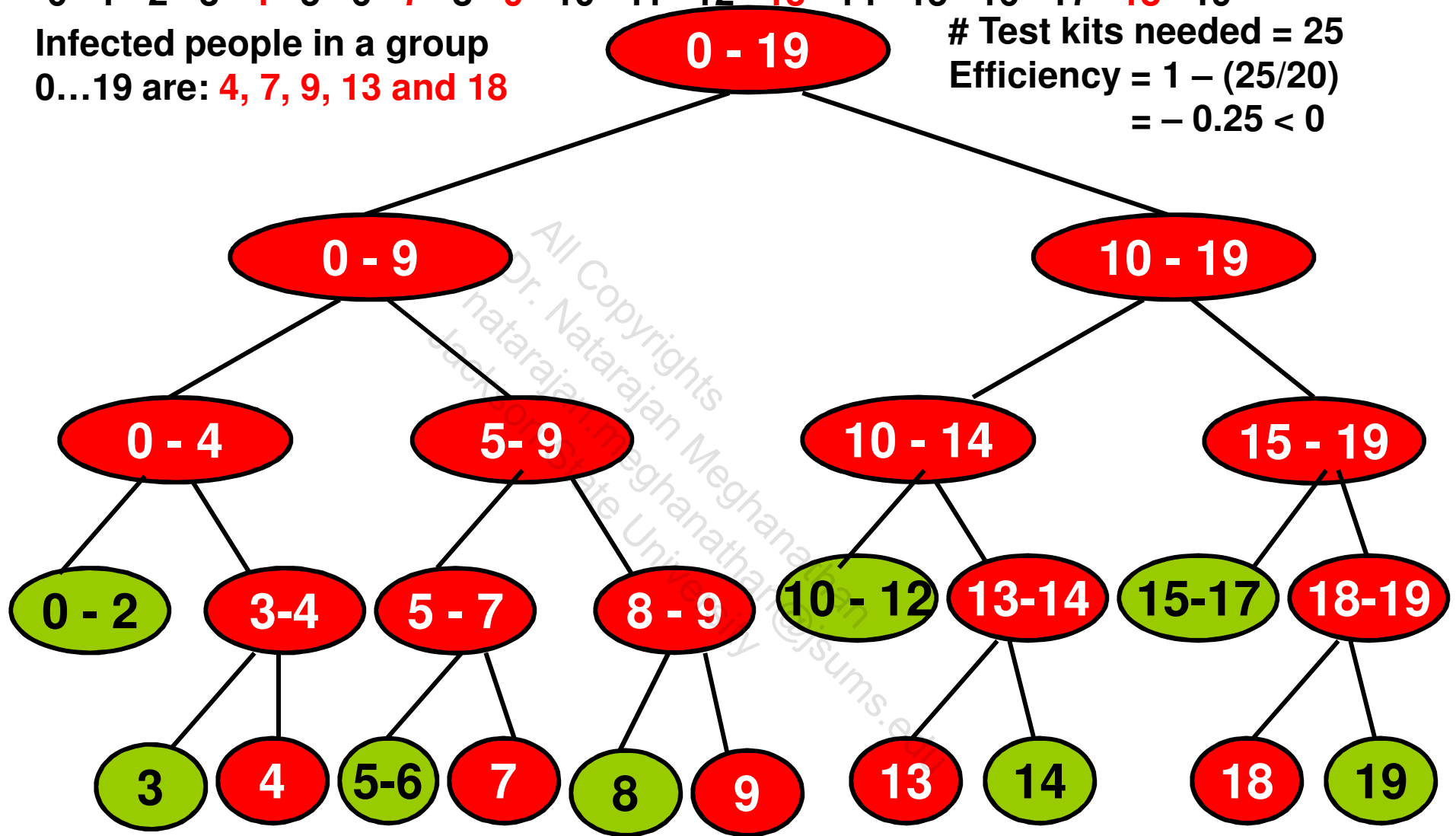
Efficiency = $1 - (17/20) = 0.15$



Tests per cleared person:

$$(3 \cdot 5 + 3 \cdot 5 + 4 \cdot 2 + 4 \cdot 2 + 5 \cdot 2 + 5 \cdot 1 + 6 \cdot 1) / 18 = 3.72$$

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
 Infected people in a group
 0...19 are: 4, 7, 9, 13 and 18
 # Test kits needed = 25
 Efficiency = $1 - (25/20) = -0.25 < 0$



Tests per cleared person:
 $\{4 \cdot (3+3+3) + 5 \cdot (1+2+1+1+1)\} / 15$
 $= 4.4$

Group Testing: Binary Search

- As we notice from the examples, the binary search-based group testing is efficient if the number of infected people within a group is lower.
 - Roughly at most 10% of infected people
- As the number of infected people within a group gets larger, the binary search approach becomes inefficient (efficiency < 0).
- The fewer and more clustered (close to each other) are the infected people, the lower the value for the # tests needed per cleared person.