The Havel Hakimi Algorithm

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The Havel Hakimi algorithm gives a systematic approach to answer the question of determining whether it is possible to construct a simple graph from a given degree sequence.

Take as input a degree sequence S and determine if that sequence is graphical
That is, can we produce a graph with that degree sequence?

Assume the degree sequence is S

$S = d_1, d_2, d_3, \cdots, d_n$

$d_i \geq d_{i+1}$

1. If any $d_i \geq n$ then fail
2. If there is an odd number of odd degrees then fail
3. If there is a $d_i < 0$ then fail
4. If all $d_i = 0$ then report success
5. Reorder S into non-increasing order
6. Let $k = d_1$
7. Remove d_1 from S.
8. Subtract 1 from the first k terms remaining of the new sequence
9. Go to step 3 above

Example 1:

S = 4, 3, 3, 3, 1

Where n = 5 (no. of vertices)

Step 1. Degree of all vertices is less than or equal to n (no.of vertices)

Step 2. Odd number vertices are four.

Step 3. There is no degree less than zero.

Step 4. Remove '4' from the sequence and subtract 1 from the remaining new sequence and arrange again in non-increasing order to get

S = 2,2,2,0

Step 5. Again remove '2 ' from the sequence and subtracting 1 from the remaining new sequence and arrange in non-increasing order we get

S= 1,1,0

Repeating the above step

S= 0,0

Step 6. Since all the deg remaining in the sequence is zero, the given sequence is graphical.

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I have always wished for my computer to be as easy to use as my telephone; my wish has come true because I can no longer figure out how to use my telephone.

— Bjarne Stroustrup

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Example 2:

Consider the degree sequence: S = 7, 5, 5, 4, 4, 4, 4, 3

Where n = 8 (no. of vertices)

Step 1. Degree of all vertices is less than or equal to n (no.of vertices)

Step 2. Odd number vertices are four.

Step 3. There is no degree less than zero.

Step 4. Remove '7' from the sequence and subtract 1 from the remaining new sequence and arrange again in non-increasing order to get

S = 4, 4, 3, 3, 3, 3, 2

Step 5. Now remove the first '4 ' from the sequence and subtract 1 from the remaining new sequence to get:

S = 3, 2, 2, 2, 3, 2

rearrange in non-increasing order to get:

S = 3, 3, 2, 2, 2, 2

Repeating the above step we get following degree sequences:

S = 2, 2, 2, 1, 1

S = 1, 1, 1, 1

S = 1, 1, 0

S = 0, 0

Step 6. Since all the deg remaining in the sequence is zero, the given sequence is graphical (or in other words, it is possible to construct a simple graph from the given degree sequence).

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