


















































## Board with wooden pegs & rubber bands

Below you are given different networks in edge list format. Some of these are well known real networks, while others are synthetic networks generated with different graph models or constructed by hand. Your task is to reveal the structure of these networks without using a computer or any other electronic device.

You should use a board with numbered wooden pegs and rubber bands of different color. These should serve as network nodes and links, respectively. To simulate a force-directed layout of the network, rubber bands will take care of the attractive forces between the linked nodes. You should, however, simulate the repulsive forces between the nodes on your own.















































































### I. Network with heterogeneous structure

Try to reveal the structure of the following synthetic network.

|   |   |   |   |   |
|---|---|---|---|---|
|  1 – 10  |  1 – 20  |  1 – 25  |  2 – 9   |  2 – 20  |
|  2 – 33  |  3 – 18  |  3 – 29  |  4 – 5   |  4 – 8   |
|  4 – 13  |  4 – 15  |  4 – 25  |  6 – 7   |  6 – 32  |
|  6 – 34  |  7 – 10  |  7 – 32  |  7 – 34  |  8 – 16  |
|  8 – 17  |  8 – 27  |  8 – 31  |  9 – 24  |  9 – 28  |
|  10 – 25 |  10 – 34 |  11 – 12 |  11 – 33 |  12 – 14 |
|  12 – 19 |  12 – 30 |  14 – 19 |  14 – 21 |  14 – 30 |
|  16 – 23 |  17 – 23 |  18 – 28 |  19 – 30 |  19 – 33 |
|  20 – 24 |  22 – 30 |  23 – 26 |  23 – 27 |  23 – 31 |
|  24 – 29 |  26 – 30 |  28 – 29 |  32 – 34 |   |

### II. Real network and two synthetic networks

Try to recognize the following well known real network.

|   |   |   |   |   |
|---|---|---|---|---|
|  1 – 2     |  1 – 3     |  1 – 4     |  1 – 5     |  1 – 6     |
|  1 – 7     |  1 – 8     |  1 – 9     |  1 – 11    |  1 – 12    |
|  1 – 13    |  1 – 14    |  1 – 18    |  1 – 20    |  1 – 22    |
|  1 – 32    |  2 – 3     |  2 – 4     |  2 – 8     |  2 – 14    |
|  2 – 18    |  2 – 20    |  2 – 22    |  2 – 31    |  3 – 4     |
|  3 – 8     |  3 – 9     |  3 – 10    |  3 – 14    |  3 – 28    |
|  3 – 29    |  3 – 33    |  4 – 8     |  4 – 13    |  4 – 14    |
|  5 – 7     |  5 – 11    |  6 – 7     |  6 – 11    |  6 – 17    |
|  7 – 17    |  9 – 31    |  9 – 33    |  9 – 34    |  10 – 34   |
|  14 – 34   |  15 – 33   |  15 – 34   |  16 – 33   |  16 – 34   |
|  19 – 33  |  19 – 34  |  20 – 34  |  21 – 33  |  21 – 34  |
|  23 – 33 |  23 – 34 |  24 – 26 |  24 – 28 |  24 – 30 |
|  24 – 33 |  24 – 34 |  25 – 26 |  25 – 28 |  25 – 32 |
|  26 – 32 |  27 – 30 |  27 – 34 |  28 – 34 |  29 – 32 |
|  29 – 34 |  30 – 33 |  30 – 34 |  31 – 33 |  31 – 34 |
|  32 – 33 |  32 – 34 |  33 – 34 |   |   |

Try to figure out which graph models were used to generate the following two networks.

|                                  |                                  |                                  |                                  |                                  |
|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| <input type="checkbox"/> 1 – 21  | <input type="checkbox"/> 1 – 24  | <input type="checkbox"/> 1 – 7   | <input type="checkbox"/> 1 – 23  | <input type="checkbox"/> 1 – 9   |
| <input type="checkbox"/> 1 – 10  | <input type="checkbox"/> 1 – 28  | <input type="checkbox"/> 1 – 13  | <input type="checkbox"/> 1 – 29  | <input type="checkbox"/> 1 – 15  |
| <input type="checkbox"/> 1 – 16  | <input type="checkbox"/> 1 – 2   | <input type="checkbox"/> 1 – 3   | <input type="checkbox"/> 1 – 4   | <input type="checkbox"/> 1 – 5   |
| <input type="checkbox"/> 1 – 6   | <input type="checkbox"/> 2 – 21  | <input type="checkbox"/> 2 – 25  | <input type="checkbox"/> 2 – 12  | <input type="checkbox"/> 2 – 32  |
| <input type="checkbox"/> 2 – 31  | <input type="checkbox"/> 2 – 3   | <input type="checkbox"/> 2 – 4   | <input type="checkbox"/> 2 – 5   | <input type="checkbox"/> 2 – 6   |
| <input type="checkbox"/> 3 – 18  | <input type="checkbox"/> 3 – 20  | <input type="checkbox"/> 3 – 7   | <input type="checkbox"/> 3 – 27  | <input type="checkbox"/> 3 – 12  |
| <input type="checkbox"/> 3 – 13  | <input type="checkbox"/> 3 – 31  | <input type="checkbox"/> 3 – 4   | <input type="checkbox"/> 3 – 5   | <input type="checkbox"/> 3 – 6   |
| <input type="checkbox"/> 4 – 33  | <input type="checkbox"/> 4 – 22  | <input type="checkbox"/> 4 – 14  | <input type="checkbox"/> 4 – 5   | <input type="checkbox"/> 4 – 6   |
| <input type="checkbox"/> 5 – 17  | <input type="checkbox"/> 5 – 22  | <input type="checkbox"/> 5 – 21  | <input type="checkbox"/> 5 – 8   | <input type="checkbox"/> 5 – 10  |
| <input type="checkbox"/> 5 – 27  | <input type="checkbox"/> 5 – 29  | <input type="checkbox"/> 5 – 6   | <input type="checkbox"/> 6 – 7   | <input type="checkbox"/> 6 – 8   |
| <input type="checkbox"/> 6 – 9   | <input type="checkbox"/> 6 – 11  | <input type="checkbox"/> 6 – 15  | <input type="checkbox"/> 6 – 16  | <input type="checkbox"/> 6 – 26  |
| <input type="checkbox"/> 6 – 25  | <input type="checkbox"/> 6 – 28  | <input type="checkbox"/> 6 – 32  | <input type="checkbox"/> 7 – 19  | <input type="checkbox"/> 7 – 8   |
| <input type="checkbox"/> 7 – 26  | <input type="checkbox"/> 7 – 9   | <input type="checkbox"/> 7 – 14  | <input type="checkbox"/> 7 – 15  | <input type="checkbox"/> 8 – 24  |
| <input type="checkbox"/> 8 – 27  | <input type="checkbox"/> 8 – 30  | <input type="checkbox"/> 8 – 31  | <input type="checkbox"/> 9 – 18  | <input type="checkbox"/> 9 – 20  |
| <input type="checkbox"/> 9 – 19  | <input type="checkbox"/> 9 – 10  | <input type="checkbox"/> 9 – 11  | <input type="checkbox"/> 9 – 12  | <input type="checkbox"/> 9 – 30  |
| <input type="checkbox"/> 9 – 14  | <input type="checkbox"/> 10 – 11 | <input type="checkbox"/> 10 – 13 | <input type="checkbox"/> 12 – 33 | <input type="checkbox"/> 12 – 20 |
| <input type="checkbox"/> 12 – 19 | <input type="checkbox"/> 13 – 22 | <input type="checkbox"/> 13 – 24 | <input type="checkbox"/> 14 – 18 | <input type="checkbox"/> 15 – 17 |
| <input type="checkbox"/> 15 – 23 | <input type="checkbox"/> 15 – 29 | <input type="checkbox"/> 15 – 16 | <input type="checkbox"/> 16 – 17 | <input type="checkbox"/> 19 – 26 |
| <input type="checkbox"/> 19 – 32 | <input type="checkbox"/> 21 – 34 | <input type="checkbox"/> 21 – 25 | <input type="checkbox"/> 21 – 28 | <input type="checkbox"/> 21 – 30 |
| <input type="checkbox"/> 22 – 33 | <input type="checkbox"/> 22 – 23 | <input type="checkbox"/> 30 – 34 | <input type="checkbox"/> 33 – 34 |                                  |

|                                  |                                  |                                  |                                  |                                  |
|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| <input type="checkbox"/> 1 – 4   | <input type="checkbox"/> 1 – 8   | <input type="checkbox"/> 1 – 14  | <input type="checkbox"/> 1 – 15  | <input type="checkbox"/> 1 – 16  |
| <input type="checkbox"/> 1 – 22  | <input type="checkbox"/> 1 – 26  | <input type="checkbox"/> 2 – 11  | <input type="checkbox"/> 2 – 23  | <input type="checkbox"/> 3 – 4   |
| <input type="checkbox"/> 3 – 11  | <input type="checkbox"/> 3 – 13  | <input type="checkbox"/> 3 – 18  | <input type="checkbox"/> 3 – 17  | <input type="checkbox"/> 4 – 21  |
| <input type="checkbox"/> 4 – 25  | <input type="checkbox"/> 4 – 28  | <input type="checkbox"/> 4 – 32  | <input type="checkbox"/> 5 – 8   | <input type="checkbox"/> 5 – 9   |
| <input type="checkbox"/> 5 – 18  | <input type="checkbox"/> 5 – 17  | <input type="checkbox"/> 6 – 14  | <input type="checkbox"/> 6 – 17  | <input type="checkbox"/> 7 – 13  |
| <input type="checkbox"/> 7 – 29  | <input type="checkbox"/> 8 – 17  | <input type="checkbox"/> 8 – 31  | <input type="checkbox"/> 8 – 34  | <input type="checkbox"/> 9 – 16  |
| <input type="checkbox"/> 9 – 21  | <input type="checkbox"/> 9 – 25  | <input type="checkbox"/> 9 – 32  | <input type="checkbox"/> 10 – 19 | <input type="checkbox"/> 10 – 25 |
| <input type="checkbox"/> 10 – 32 | <input type="checkbox"/> 10 – 34 | <input type="checkbox"/> 11 – 16 | <input type="checkbox"/> 11 – 24 | <input type="checkbox"/> 12 – 17 |
| <input type="checkbox"/> 12 – 21 | <input type="checkbox"/> 12 – 27 | <input type="checkbox"/> 12 – 30 | <input type="checkbox"/> 13 – 26 | <input type="checkbox"/> 13 – 28 |
| <input type="checkbox"/> 13 – 34 | <input type="checkbox"/> 14 – 17 | <input type="checkbox"/> 14 – 26 | <input type="checkbox"/> 14 – 30 | <input type="checkbox"/> 15 – 18 |
| <input type="checkbox"/> 15 – 20 | <input type="checkbox"/> 16 – 22 | <input type="checkbox"/> 16 – 32 | <input type="checkbox"/> 17 – 26 | <input type="checkbox"/> 17 – 25 |
| <input type="checkbox"/> 19 – 24 | <input type="checkbox"/> 20 – 22 | <input type="checkbox"/> 20 – 23 | <input type="checkbox"/> 20 – 27 | <input type="checkbox"/> 20 – 30 |
| <input type="checkbox"/> 21 – 32 | <input type="checkbox"/> 21 – 34 | <input type="checkbox"/> 22 – 25 | <input type="checkbox"/> 23 – 29 | <input type="checkbox"/> 23 – 34 |
| <input type="checkbox"/> 24 – 30 | <input type="checkbox"/> 24 – 34 | <input type="checkbox"/> 25 – 29 | <input type="checkbox"/> 28 – 29 | <input type="checkbox"/> 28 – 34 |
| <input type="checkbox"/> 32 – 33 |                                  |                                  |                                  |                                  |