Task 1: Non-dominated sorting and hypervolume (20%)

- Describe how the following population will be sorted when using the non-dominated sorting algorithm as in NSGA II. What will be the layers of equal rank. What are the crowding distances* in the first ranked layer?
  - Rank 1 is y2 y1 y11 y9 y12
  - Rank 2 is y6 y7 y3 y8
  - Rank 4 is y5
  - Rank 5 is y4
  - Crowding distance:
  - y2 infinity, y1:5+2=7, y11=5
  - y9 5+2=7 y12: infinity
- What is the hypervolume indicator of this population when the reference point is (9,9)
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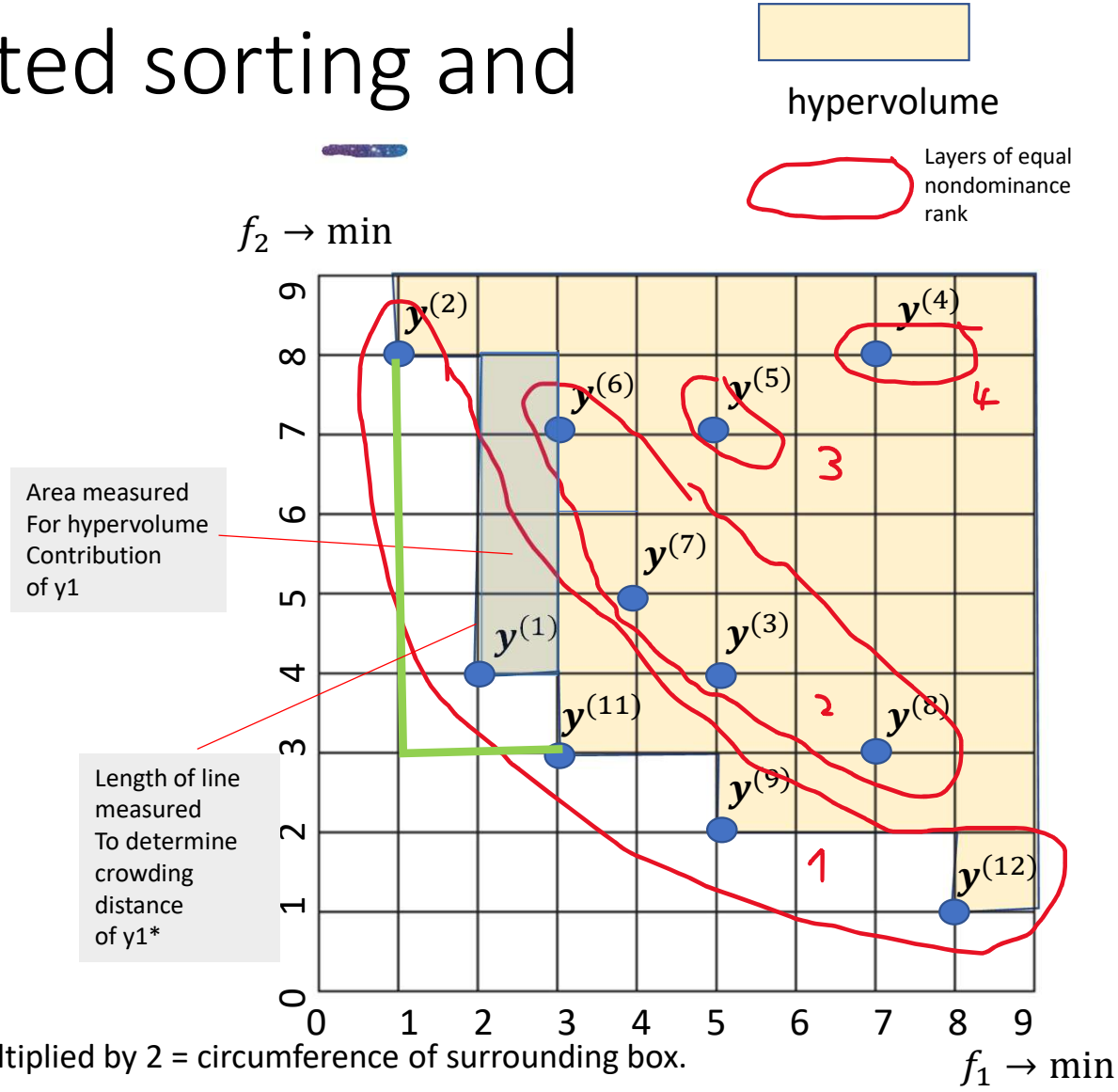
- What are the hypervolume contributions of the points in the best ranked layer (only consider points in that layer).
  - y2: 1 y1: 4 y11: 2 y9: 3: y12: 1



*Remark: in some literature the crowding distance is multiplied by 2 = circumference of surrounding box. It is also correct.