

K-Dimensional (K-D) tree

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Course objectives

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- By the end of this module, you will be able to answer the following question:
 - How can we improve the efficiency of the K-NN algorithm?

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How can we improve the efficiency of the K-NN algorithm?

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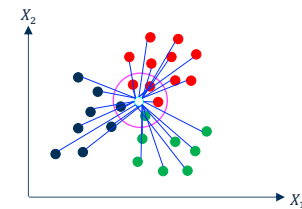


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How can we improve the efficiency of the K-NN algorithm?

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- Discussion
 - It seems that the K-NN algorithm is computationally expensive, especially if the number of data points increases. Can we improve the efficiency of the K-NN algorithm?



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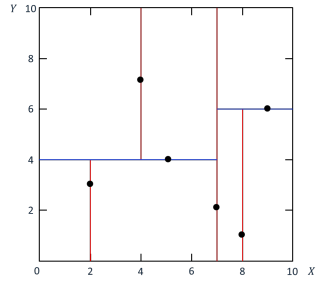
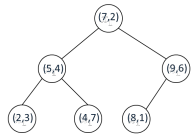


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K-D tree

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- One potential approach is to implement the K-Dimensional (K-D) Tree algorithm
 - The basic idea is to neglect calculating some points that are far from the sample point
 - Time complexity: Brute-Force approach $O(N^2)$ vs. KD-Tree approach $O(N \log N)$

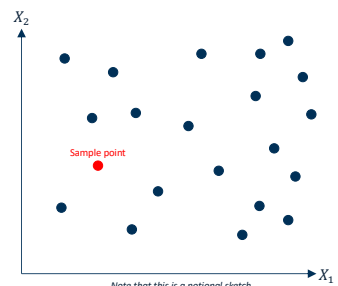
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K-D tree

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- How to build a K-D tree in a two-dimensional space?
 - Imagine that we need to find the closest point from the sample point



Note that this is a notional sketch

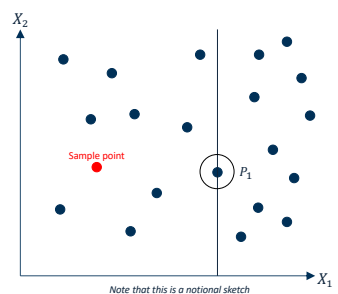
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K-D tree

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- Step 1. Choose a root node and split data points into two groups
 - The median value in X axis is typically selected





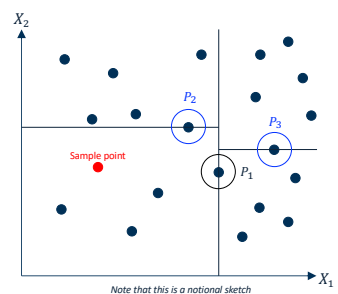
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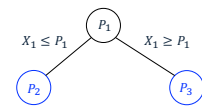
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K-D tree

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- Step 2. Select the median value in Y axis from each half-space
 - Picking other points from both left and right half-spaces to split





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K-D tree

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- Step 3. Continue constructing the K-D tree (i.e., find median, split data, repeat, ...)
- Cut X axis $\rightarrow Y$ axis $\rightarrow X$ axis $\rightarrow \dots$

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K-D tree

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- Step 4. Find the closest point to the sample point
- Note that we can use a sphere in a 3D space

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Course summary

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- Throughout this module, you have learned:
- How can we improve the efficiency of the K-NN algorithm?

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THANK YOU

For more information, please reach out to Prof. Junghyun Kim at
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