K-D Tree

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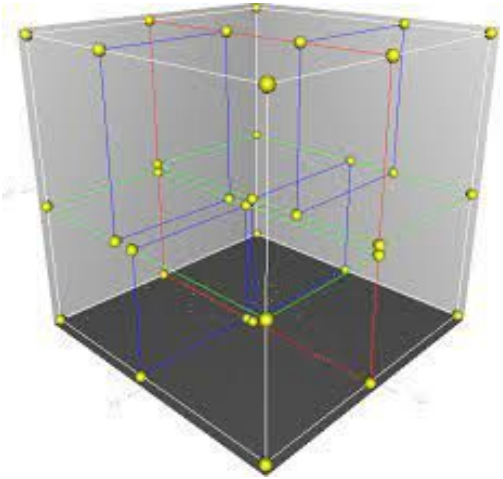
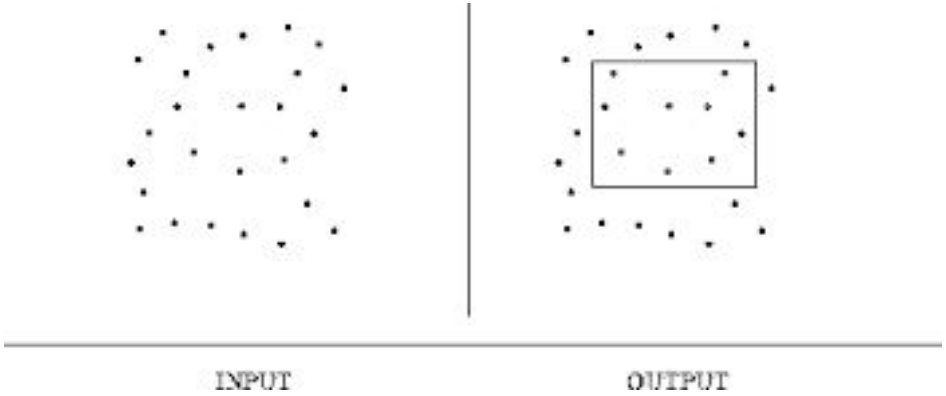
What is a K-D Tree?



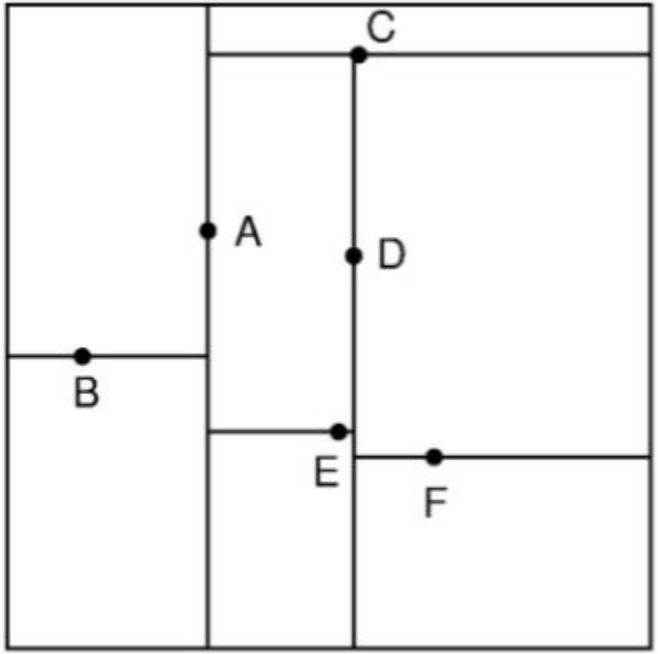
- K is the number of D (dimensions) in the tree, hence K-D tree.
- A 1-D tree is essentially a Binary Search Tree (BST)
- Extra implementation when becoming multidimensional
- On average, O(logn) search times.
- Recommended k < 10 and minimum N of data to be >= 2^k

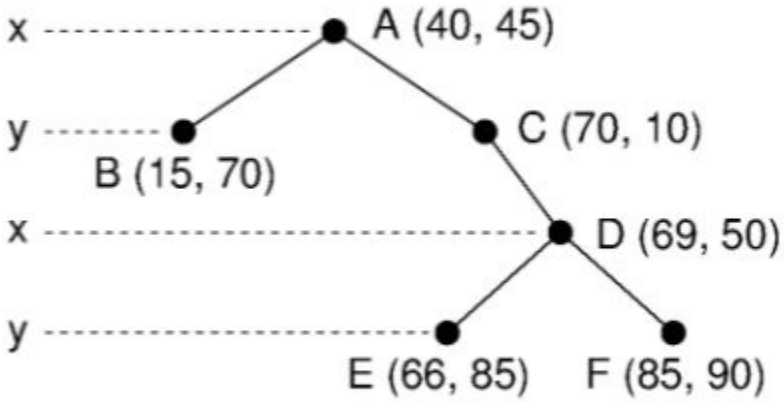
Uses for K-D Trees

- Nearest Neighbor
- Multi-dimensional searches
- Range searches
- Creating a point cloud

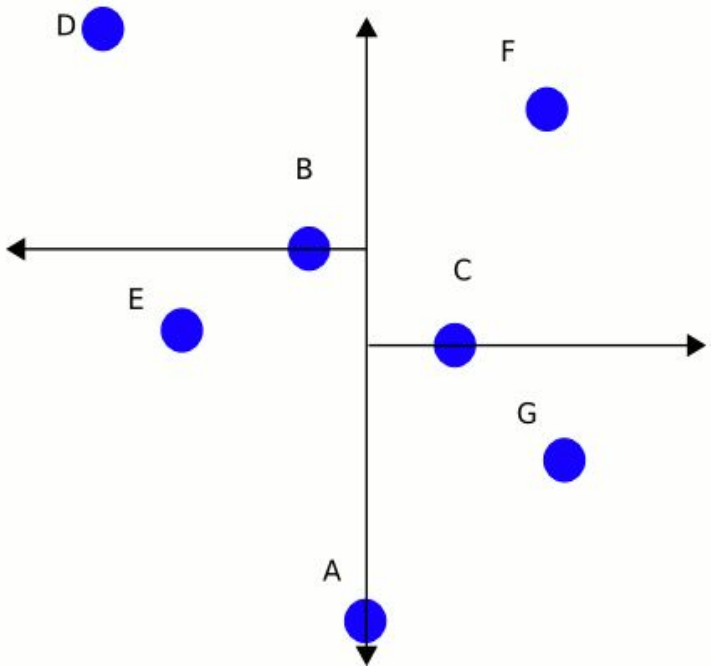


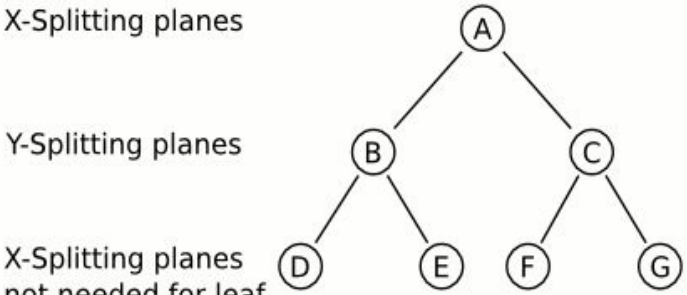
Spatial Representation of 2 Dimensions





K-D and Exclusion of Search Spaces





Source: https://commons.wikimedia.org/wiki/File:KDTree-animation.gif

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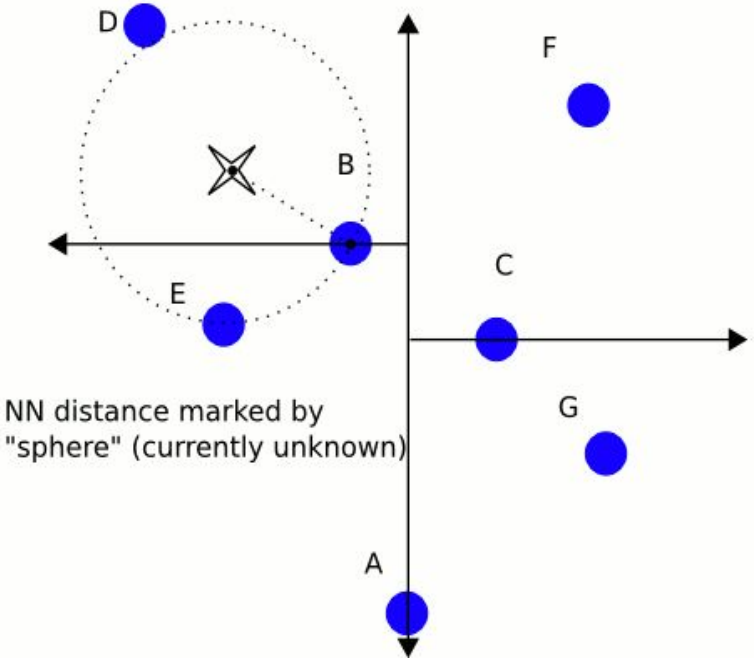

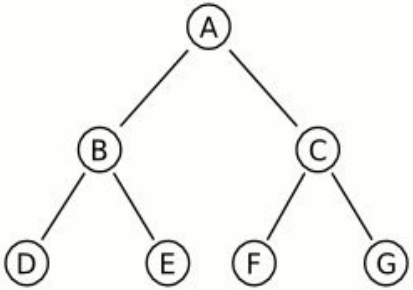

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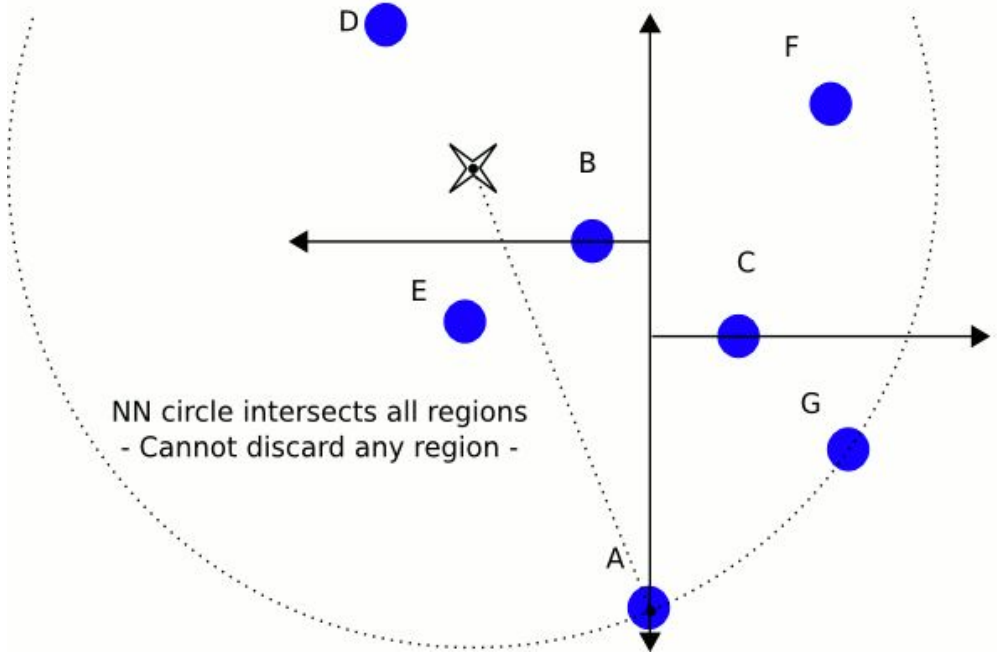
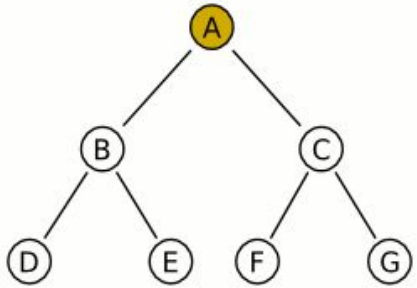
K-D and Exclusion of Search Spaces

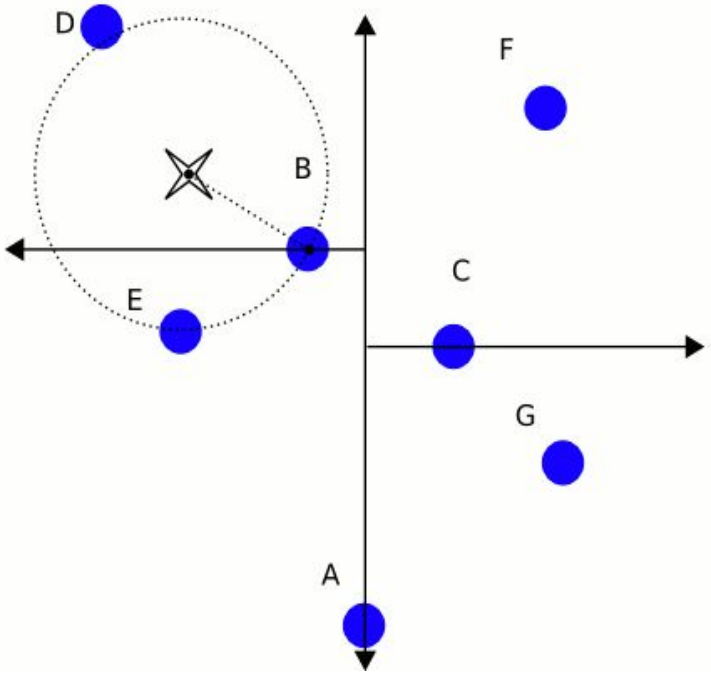


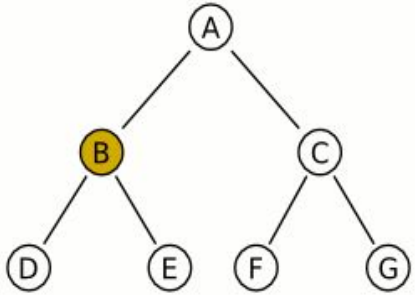


Start at A, then proceed in depth-first search (maintain a stack of parent-nodes if using a singly-linked tree). Set best estimate to A's distance Then examine left child node

Source: https://commons.wikimedia.org/wiki/File:KDTree-animation.gif

K-D and Exclusion of Search Spaces





Calculate B's distance and
compare against best estimate
- It is smaller distance, so update
best estimate. Examine children (left then right)

Source: https://commons.wikimedia.org/wiki/File:KDTree-animation.gif

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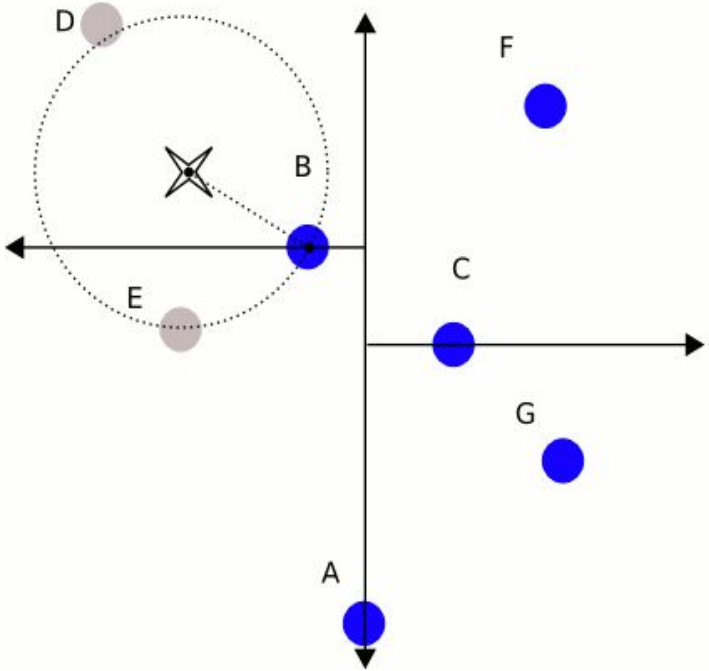

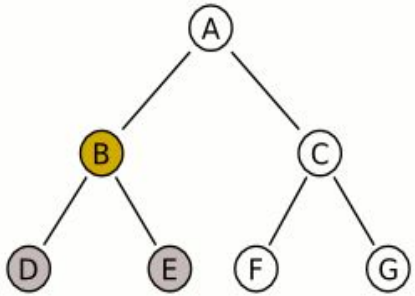

D & E Discarded as B
(already visited) is closer.
B is the best estimate for B's sub-branch
Proceed back to parent node

Source: https://commons.wikimedia.org/wiki/File:KDTree-animation.gif

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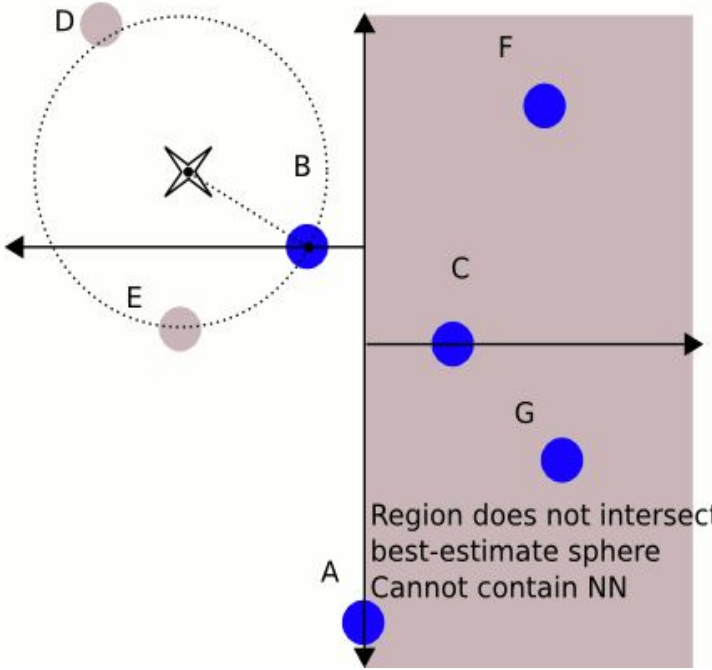

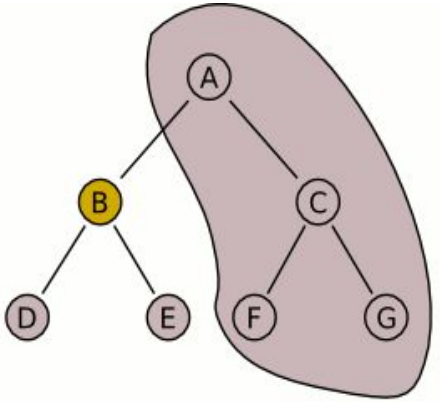

A's children have all been searched,
B is the best estimate for entire tree

Source: https://commons.wikimedia.org/wiki/File:KDTree-animation.gif

References

- https://www.google.com/imgres?imgurl=https%3A%2F%2Fwww.researchgate.net%2Fprofile%2FGottfried-Mandlburger%2Fpublication%2F313756154%2Ffigure%2Ffig1%2FAS%3A472464959512576%401489655832933%2Fk-d-trees-are-an-extension-of-binary-search-trees.png&imgrefurl=https%3A%2F%2Fwww.researchgate.net%2Ffigure%2Fk-d-trees-are-an-extension-of-binary-search-trees_fig1_313756154&tbnid=KZdjhFRxxgXZZM&vet=12ahUKEwi0rerLnNX0AhUPF1kFHdXDBdIQMygBegUIARCuAQ..i&docid=eE3SDadVJx4rCM&w=762&h=278&itg=1&q=kd%20tree%20vs%20binary%20tree&ved=2ahUKEwi0rerLnNX0AhUPF1kFHdXDBdIQMygBegUIARCuAQ
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