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Analysis of K-Nearest Neighbor project

Algorithm 1: Forward Selection
Algorithm 2: Backwards Elimination
Algorithm 3: Exhaustive Search

Algorithm 3 (My own algorithm) is proven to produce better results
than both Forward Selection and Backwards Elimination.
The reason for this is because since both those algorithms use a biase to
guide a search towards a possible optimal selection, it's not guaranteed
to find the optimal solution. Exhaustive search is guaranteed
to find the optimal solution since all possible nodes and their children
are pushed onto the queue for processing. The drawback of this algorithm is
that it extremely costly. The time to complete the program's runtime
increases nearly exponentially as datasets become larger. To give an example,
I have posted the completion times for all three searches on both the
small and medium data sets.

============BEGIN SMALL TEST============

Forward Selection

real    0m43.893s
user    0m42.623s
sys     0m0.252s

Backwards Elimination

real    0m53.650s
user    0m53.155s
sys     0m0.004s

Brute Force

real    2m12.418s
user    2m11.332s
sys     0m0.532s


============END SMALL TEST===============

============BEGIN MEDIUM TEST=============

Forward Selection

real    3m3.177s
user    3m1.939s
sys     0m0.108s

Backwards Elimination

real    5m49.626s
user    5m48.386s
sys     0m0.488s

Brute Force

real    149m14.069s
user    148m45.458s
sys     0m4.912s

============END MEDIUM TEST=============

We can see that a brute force seach takes substantially longer
to finish even for a data set with 10 features over that of 5.
Having the additional branching factor makes it extremely
difficult to search every possible node. K-Nearest Neighbor
is in itself a relatively to implement algorithm, but it is naive
in nature. By using an exhaustive search, we can guarantee an optimal
solution but the cost is so high it simply isn't practical. Generally,
Forward Selection and Backwards Elimination will produce relatively optimal
solutions at an efficient cost.

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I have attached traces of the following:
1) All 3 searches run on a Small data set
2) Exhaustive Search run on a Medium data set
3) Forward Selection run on a Large data set

I will also attach graphs of the data involving the accuracies
correlating to features usedand analyze that as well.

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==================BEGIN ALGORITHM 1=================

Type the number of the algorithm you want to run.

   1) Forward Selection
   2) Backward Elimination
   3) Hans' Special Algorithm

1
Using Forward Selection

68.5 % using features: {  1  }

Accuracy has increased to: 68.5 %

83.9 % using features: {  2  }

Accuracy has increased to: 83.9 %

68.2 % using features: {  3  }
73.3 % using features: {  4  }
66.8 % using features: {  5  }
83.5 % using features: {  1  2  }
86.4 % using features: {  2  3  }

Accuracy has increased to: 86.4 %

96.5 % using features: {  2  4  }

Accuracy has increased to: 96.5 %

83.6 % using features: {  2  5  }
91.6 % using features: {  1  2  4  }
95.4 % using features: {  2  3  4  }
94.0 % using features: {  2  4  5  }
Accuracy has decreased for all options, exiting
Highest accuracy was  96.5 % using features: {  2   4   }


==================BEGIN ALGORITHM 2=================

Type the number of the algorithm you want to run.

   1) Forward Selection
   2) Backward Elimination
   3) Hans' Special Algorithm

2
Using Backwards Elimination

87.8 % using features: {  1  2  3  4  5  }
92.3 % using features: {  2  3  4  5  }

Accuracy has increased to: 92.3 %

73.6 % using features: {  1  3  4  5  }
89.8 % using features: {  1  2  4  5  }
80.0 % using features: {  1  2  3  5  }
91.7 % using features: {  1  2  3  4  }
73.2 % using features: {  3  4  5  }
94.0 % using features: {  2  4  5  }

Accuracy has increased to: 94.0 %

82.8 % using features: {  2  3  5  }
95.4 % using features: {  2  3  4  }

Accuracy has increased to: 95.4 %

73.8 % using features: {  3  4  }
96.5 % using features: {  2  4  }

Accuracy has increased to: 96.5 %
```



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86.4 % using features: {  2  3  }
73.3 % using features: {  4  }
83.9 % using features: {  2  }
Accuracy has decreased for all options, exiting
Highest accuracy was  96.5 % using features: {  2   4   }


==================BEGIN ALGORITHM 3=================

Type the number of the algorithm you want to run.

   1) Forward Selection
   2) Backward Elimination
   3) Hans' Special Algorithm

3
Using Special Algorithm

68.5 % using features: {  1  }

Accuracy has increased to: 68.5 %

83.9 % using features: {  2  }

Accuracy has increased to: 83.9 %

68.2 % using features: {  3  }
73.3 % using features: {  4  }
66.8 % using features: {  5  }
83.5 % using features: {  1  2  }
86.4 % using features: {  2  3  }

Accuracy has increased to: 86.4 %

96.5 % using features: {  2  4  }

Accuracy has increased to: 96.5 %

83.6 % using features: {  2  5  }
91.6 % using features: {  1  2  4  }
95.4 % using features: {  2  3  4  }
94.0 % using features: {  2  4  5  }
91.7 % using features: {  1  2  3  4  }
92.3 % using features: {  2  3  4  5  }
89.8 % using features: {  1  2  4  5  }
87.8 % using features: {  1  2  3  4  5  }
83.2 % using features: {  1  2  3  }
82.8 % using features: {  2  3  5  }
82.1 % using features: {  1  2  5  }
80.0 % using features: {  1  2  3  5  }
71.0 % using features: {  1  4  }
73.8 % using features: {  3  4  }
72.6 % using features: {  4  5  }
72.3 % using features: {  1  3  4  }
73.2 % using features: {  3  4  5  }
73.6 % using features: {  1  3  4  5  }
71.4 % using features: {  1  4  5  }
68.9 % using features: {  1  3  }
67.3 % using features: {  1  5  }
69.7 % using features: {  1  3  5  }
70.0 % using features: {  3  5  }
1
Special Algorithm finished running.
Higest accuracy was  96.5 % using features: {  2   5   }

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```
Type the number of the algorithm you want to run.

   1) Forward Selection
   2) Backward Elimination
   3) Hans' Special Algorithm

3
Using Special Algorithm

64.7 % using features: {  1  }

Accuracy has increased to: 64.7 %

66.4 % using features: {  2  }

Accuracy has increased to: 66.4 %

65.7 % using features: {  3  }
68.5 % using features: {  4  }

Accuracy has increased to: 68.5 %

65.1 % using features: {  5  }
67.3 % using features: {  6  }
70.0 % using features: {  7  }

Accuracy has increased to: 70.0 %

83.2 % using features: {  8  }

Accuracy has increased to: 83.2 %

69.4 % using features: {  9  }
69.1 % using features: {  10  }
80.9 % using features: {  1  8  }
82.8 % using features: {  2  8  }
82.0 % using features: {  3  8  }
80.6 % using features: {  4  8  }
82.8 % using features: {  5  8  }
82.6 % using features: {  6  8  }
82.7 % using features: {  7  8  }
97.5 % using features: {  8  9  }

Accuracy has increased to: 97.5 %

83.9 % using features: {  8  10  }
93.8 % using features: {  1  8  9  }
93.7 % using features: {  2  8  9  }
93.8 % using features: {  3  8  9  }
93.6 % using features: {  4  8  9  }

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.
.

66.7 % using features: {  1  3  4  5  6  7  }
67.9 % using features: {  1  3  4  5  6  10  }
65.8 % using features: {  2  3  4  5  7  9  10  }
67.8 % using features: {  2  4  5  6  7  9  10  }
65.4 % using features: {  1  2  3  4  5  10  }
65.9 % using features: {  1  3  4  5  7  10  }
66.1 % using features: {  2  3  4  5  6  7  9  }
67.1 % using features: {  1  3  4  6  10  }
68.0 % using features: {  1  3  5  6  10  }
65.7 % using features: {  1  3  6  7  10  }
65.4 % using features: {  1  3  5  6  7  10  }
68.6 % using features: {  2  3  6  10  }
64.8 % using features: {  2  4  6  10  }
66.6 % using features: {  2  5  6  10  }
65.4 % using features: {  2  6  7  10  }
66.3 % using features: {  2  3  4  6  10  }
67.0 % using features: {  2  3  5  6  10  }
65.5 % using features: {  1  2  3  4  5  6  10  }
```



```
65.1 % using features: {  1  3  4  5  6  7  10  }
65.4 % using features: {  3  4  6  10  }
66.9 % using features: {  3  5  6  10  }
66.1 % using features: {  2  3  4  5  6  7  9  10  }
66.7 % using features: {  1  3  4  10  }
66.0 % using features: {  2  3  4  10  }
64.9 % using features: {  3  4  7  10  }
67.2 % using features: {  2  3  4  5  6  }
64.2 % using features: {  3  4  5  6  7  }
67.1 % using features: {  3  4  5  6  10  }
65.7 % using features: {  1  2  7  10  }
67.4 % using features: {  2  3  7  10  }
65.7 % using features: {  2  4  7  10  }
67.1 % using features: {  2  5  7  10  }
67.3 % using features: {  1  2  4  6  7  10  }
65.4 % using features: {  1  2  3  4  5  7  }
65.1 % using features: {  1  2  3  4  6  10  }
68.3 % using features: {  3  5  10  }
67.0 % using features: {  1  3  5  10  }
67.3 % using features: {  2  3  5  10  }
68.7 % using features: {  3  5  7  10  }
66.9 % using features: {  1  3  5  7  10  }
66.3 % using features: {  2  3  5  7  10  }
64.9 % using features: {  3  4  5  7  10  }
66.8 % using features: {  3  5  6  7  10  }
65.6 % using features: {  1  2  3  7  }
65.0 % using features: {  2  3  4  7  }
66.2 % using features: {  2  3  5  7  }
65.1 % using features: {  1  2  3  7  10  }
64.5 % using features: {  2  3  4  7  10  }
63.5 % using features: {  4  5  6  10  }
65.6 % using features: {  5  6  7  10  }
67.6 % using features: {  1  6  7  }
65.6 % using features: {  2  6  7  }
64.7 % using features: {  4  6  7  }
64.8 % using features: {  5  6  7  }
66.6 % using features: {  1  2  6  7  }
66.8 % using features: {  1  4  6  7  }
66.6 % using features: {  1  5  6  7  }
67.4 % using features: {  1  6  }
66.9 % using features: {  2  6  }
64.4 % using features: {  3  6  }
64.8 % using features: {  5  6  }
68.8 % using features: {  1  2  6  }
68.4 % using features: {  1  3  6  }
65.3 % using features: {  1  4  6  }
66.0 % using features: {  1  5  6  }
67.4 % using features: {  1  2  3  6  }
70.4 % using features: {  1  2  4  6  }
65.5 % using features: {  1  2  5  6  }
64.9 % using features: {  1  2  3  4  6  }
67.1 % using features: {  1  2  4  5  6  }
69.4 % using features: {  1  2  4  6  7  }
66.2 % using features: {  1  2  4  5  6  7  }
66.8 % using features: {  1  3  4  6  }
70.7 % using features: {  1  3  5  6  }
65.3 % using features: {  1  2  3  5  6  }
66.3 % using features: {  1  3  5  6  7  }
66.0 % using features: {  1  2  3  5  10  }
66.4 % using features: {  2  3  4  5  10  }
65.6 % using features: {  1  2  3  4  6  7  10  }
66.4 % using features: {  1  2  4  5  6  7  10  }
64.5 % using features: {  3  4  6  7  10  }
70.0 % using features: {  1  4  5  6  10  }
65.3 % using features: {  1  5  6  7  10  }
65.7 % using features: {  1  4  5  6  7  10  }
66.0 % using features: {  1  4  6  7  10  }
64.9 % using features: {  2  3  4  5  6  7  }
65.2 % using features: {  2  3  4  5  6  10  }
64.7 % using features: {  1  2  3  4  5  6  7  }
65.4 % using features: {  3  4  5  6  7  10  }
64.9 % using features: {  1  3  7  10  }
65.9 % using features: {  1  3  4  6  7  10  }
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 65.6 % using features: {  1  2  5  7  10  }
 65.8 % using features: {  2  4  5  7  10  }
 64.9 % using features: {  2  5  6  7  10  }
 67.1 % using features: {  1  2  3  10  }
 67.1 % using features: {  1  2  4  10  }
 67.0 % using features: {  1  2  5  10  }
 65.7 % using features: {  1  2  3  4  10  }
 66.0 % using features: {  1  2  4  5  10  }
 66.3 % using features: {  1  2  4  7  10  }
 64.4 % using features: {  2  3  5  6  7  10  }
 64.7 % using features: {  1  3  4  6  7  }
 67.4 % using features: {  1  5  7  }
 65.9 % using features: {  2  5  7  }
 65.2 % using features: {  4  5  7  }
 69.4 % using features: {  5  7  10  }
 67.1 % using features: {  1  5  7  10  }
 65.2 % using features: {  4  5  7  10  }
 66.7 % using features: {  1  2  5  7  }
 65.9 % using features: {  1  3  5  7  }
 67.5 % using features: {  1  4  5  7  }
 66.9 % using features: {  1  2  4  5  7  }
 65.5 % using features: {  1  4  5  6  7  }
 65.1 % using features: {  1  4  5  7  10  }
 67.8 % using features: {  1  4  5  10  }
 66.2 % using features: {  1  2  4  5  7  10  }
 68.0 % using features: {  4  5  10  }
 66.6 % using features: {  4  7  10  }
 67.1 % using features: {  2  4  5  10  }
 64.9 % using features: {  2  4  5  6  10  }
 65.7 % using features: {  2  3  6  }
 65.6 % using features: {  2  4  6  }
 64.8 % using features: {  2  5  6  }
 63.9 % using features: {  2  3  4  6  7  10  }
 62.9 % using features: {  1  2  3  5  7  10  }
 64.7 % using features: {  2  3  4  6  }
 67.6 % using features: {  1  3  4  7  10  }
 65.3 % using features: {  1  2  3  4  7  10  }
 66.0 % using features: {  1  2  3  5  7  }
 67.2 % using features: {  1  2  5  6  7  }
 67.8 % using features: {  1  2  4  }
 64.7 % using features: {  2  4  5  }
 63.2 % using features: {  2  4  7  }
 67.9 % using features: {  1  2  3  4  }
 67.1 % using features: {  1  2  4  5  }
 67.2 % using features: {  1  2  4  7  }
 64.8 % using features: {  1  2  3  4  7  }
 65.0 % using features: {  1  3  4  7  }
 66.3 % using features: {  1  4  7  10  }
 64.6 % using features: {  4  6  7  10  }
 63.4 % using features: {  2  3  4  5  7  10  }
 65.5 % using features: {  1  2  3  4  5  6  7  10  }
 66.9 % using features: {  1  2  }
 67.5 % using features: {  2  3  }
 64.1 % using features: {  2  5  }
 69.4 % using features: {  1  2  3  }
 66.8 % using features: {  2  3  5  }
 65.8 % using features: {  1  2  3  5  }
 66.8 % using features: {  1  2  5  }
 69.8 % using features: {  1  2  7  }
 67.4 % using features: {  2  3  5  6  }
 64.3 % using features: {  1  2  3  5  6  7  10  }
 64.7 % using features: {  1  2  3  4  5  7  10  }
 65.8 % using features: {  1  4  5  }
 64.3 % using features: {  4  5  6  }
 65.2 % using features: {  2  3  4  5  7  }
 66.2 % using features: {  1  4  7  }
 66.8 % using features: {  1  4  5  6  }
 68.1 % using features: {  2  4  5  7  }
 66.7 % using features: {  2  5  6  7  }
 63.7 % using features: {  2  4  5  6  7  }
 62.6 % using features: {  2  4  5  6  7  10  }
 64.2 % using features: {  1  3  }
 68.9 % using features: {  3  5  }
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 67.4 % using features: {  1  3  5  }
 68.6 % using features: {  3  5  6  }
 64.7 % using features: {  2  4  6  7  10  }
 64.6 % using features: {  4  5  6  7  10  }
 62.6 % using features: {  2  4  6  7  }
 65.3 % using features: {  2  4  5  6  }
 62.9 % using features: {  2  3  4  5  6  7  10  }
 63.8 % using features: {  4  5  6  7  }
 66.3 % using features: {  1  5  }
1
Special Algorithm finished running.
Higest accuracy was  97.5 % using features: {  8   10   }
```

```
Type the number of the algorithm you want to run.

   1) Forward Selection
   2) Backward Elimination
   3) Hans' Special Algorithm

1
Using Forward Selection

70.7 % using features: {  1  }

Accuracy has increased to: 70.7 %

71.1 % using features: {  2  }

Accuracy has increased to: 71.1 %

72.7 % using features: {  3  }

Accuracy has increased to: 72.7 %

70.7 % using features: {  4  }
76.0 % using features: {  5  }

Accuracy has increased to: 76.0 %

72.1 % using features: {  6  }
71.6 % using features: {  7  }
69.2 % using features: {  8  }
72.6 % using features: {  9  }
71.7 % using features: {  10  }
70.2 % using features: {  11  }

.
.
.

Accuracy has increased to: 96.7 %

85.2 % using features: {  6  32  }
87.1 % using features: {  7  32  }
85.2 % using features: {  8  32  }
84.3 % using features: {  9  32  }
84.3 % using features: {  10  32  }
85.7 % using features: {  11  32  }
86.3 % using features: {  12  32  }
85.6 % using features: {  13  32  }
85.3 % using features: {  14  32  }
83.9 % using features: {  15  32  }
85.3 % using features: {  16  32  }
84.5 % using features: {  17  32  }
83.3 % using features: {  18  32  }
84.5 % using features: {  19  32  }
84.4 % using features: {  20  32  }
84.9 % using features: {  21  32  }
84.4 % using features: {  22  32  }
85.2 % using features: {  23  32  }
83.3 % using features: {  24  32  }
82.2 % using features: {  25  32  }
85.0 % using features: {  26  32  }
83.5 % using features: {  27  32  }
86.2 % using features: {  28  32  }
85.0 % using features: {  29  32  }
85.6 % using features: {  30  32  }
83.7 % using features: {  31  32  }
86.0 % using features: {  32  33  }
85.9 % using features: {  32  34  }
84.2 % using features: {  32  35  }
84.9 % using features: {  32  36  }
82.6 % using features: {  32  37  }
84.7 % using features: {  32  38  }
86.9 % using features: {  32  39  }
84.8 % using features: {  32  40  }
```



```
94.2 % using features: {  1  5  32  }
93.4 % using features: {  2  5  32  }
93.7 % using features: {  3  5  32  }
93.7 % using features: {  4  5  32  }
94.1 % using features: {  5  6  32  }
96.0 % using features: {  5  7  32  }
95.0 % using features: {  5  8  32  }
93.9 % using features: {  5  9  32  }
94.4 % using features: {  5  10  32  }
94.3 % using features: {  5  11  32  }
93.4 % using features: {  5  12  32  }
93.8 % using features: {  5  13  32  }
93.0 % using features: {  5  14  32  }
94.1 % using features: {  5  15  32  }
94.2 % using features: {  5  16  32  }
94.0 % using features: {  5  17  32  }
92.7 % using features: {  5  18  32  }
93.8 % using features: {  5  19  32  }
94.6 % using features: {  5  20  32  }
92.4 % using features: {  5  21  32  }
93.8 % using features: {  5  22  32  }
94.4 % using features: {  5  23  32  }
94.8 % using features: {  5  24  32  }
94.8 % using features: {  5  25  32  }
94.9 % using features: {  5  26  32  }
95.5 % using features: {  5  27  32  }
94.2 % using features: {  5  28  32  }
95.7 % using features: {  5  29  32  }
93.1 % using features: {  5  30  32  }
94.2 % using features: {  5  31  32  }
95.0 % using features: {  5  32  33  }
94.9 % using features: {  5  32  34  }
93.5 % using features: {  5  32  35  }
93.8 % using features: {  5  32  36  }
94.9 % using features: {  5  32  37  }
93.6 % using features: {  5  32  38  }
94.2 % using features: {  5  32  39  }
93.5 % using features: {  5  32  40  }
Accuracy has decreased for all options, exiting
Highest accuracy was  96.7 % using features: {  5   32   }
```