Problem 1
The tree before prune:

node 0
Top: 6,4, 0.97
Education Level gain = 0.125
Career gain = 0.125
Years of Experience gain = 0.020
Selected Attribute: Education

node 1
High School 4,1, 0.72
Career gain = 0.171
Years of Experience gain = 0.322
Selected Attribute: Years of Experience
node 3
More than 10
Career gain = 1.0
Selected attribute Career

node 8
Management
Class High

node 9
Service
Class Low

node 4
Less than 3
Class Low

node 5
3 to 10
ClassLow

node 2
College 3,2, 0.97
Career gain = 0.420
Years of Experience gain = 0.171
Selected Attribute: Career

node 6
Management
class High

node 7
Service 1,2, 0,91
Years of Experience gain = 0.918
selected attribute: Years of Experience

node 10
More than 10
Class Low

node 11
Less than 3
Class Low

node 12
3 to 10
Class High

puring the tree

for the 1 iteration:

node num:	sum_of_total_wrong:	wrong_count:
12	0	1
11	0	0
10	0	0
9	0	0
8	0	0
7	1	0

pruning node 7

for the 2 iteration:

node num:	sum_of_total_wrong:	wrong_count:
9	0	0
8	0	0
7	0	0

6	0	1
5	0	0
4	0	0
3	0	0
2	1	2
1	0	1
0	1	1

The final tree

node 0
Top: 6,4, 0.97
Education Level gain = 0.125
Career gain = 0.125
Years of Experience gain = 0.020
Selected Attribute: Education

node 1
High School 4,1, 0.72
Career gain = 0.171
Years of Experience gain = 0.322
Selected Attribute: Years of Experience

node 3
More than 10
Career gain = 1.0
Selected attribute Career

node 8
Management
Class High

node 9
Service
Class Low

node 4
Less than 3
Class Low

node 5
3 to 10

ClassLow

node 2
College 3,2, 0.97
Career gain = 0.420
Years of Experience gain = 0.171
Selected Attribute: Career

node 6
Management
class High

node 7
Service 1,2, 0,91
Years of Experience gain = 0.918
selected attribute: Years of Experience
Class Low

Problem2

The answer of this problem is also stored in "prob2.csv" file in result directory.

6.7,3.1,4.4,1.4,x1,versicolor,versicolor,versicolor,versicolor,versicolor
4.4,3.2,1.3,0.2,x2,setosa,setosa,setosa,setosa,setosa
5.3,3.7,1.5,0.2,x3,setosa,setosa,setosa,setosa,setosa
7.7,2.8,6.7,2.0,x10,virginica,virginica,virginica,virginica,virginica
5.1,3.5,1.4,0.2,x11,setosa,setosa,setosa,setosa,setosa
6.5,3.0,5.2,2.0,x12,setosa,virginica,virginica,virginica,virginica
7.1,3.0,5.9,2.1,x13,virginica,virginica,virginica,virginica,virginica
6.4,2.7,5.3,1.9,x14,virginica,virginica,virginica,virginica,virginica
5.2,2.7,3.9,1.4,x15,versicolor,versicolor,versicolor,versicolor,versicolor
7.0,3.2,4.7,1.4,x16,virginica,versicolor,versicolor,versicolor,versicolor
7.2,3.2,6.0,1.8,x17,virginica,virginica,virginica,virginica,virginica
5.4,3.7,1.5,0.2,x19,setosa,setosa,setosa,setosa,setosa
5.6,3.0,4.5,1.5,x20,versicolor,versicolor,versicolor,versicolor,versicolor
5.9,3.2,4.8,1.8,x21,versicolor,versicolor,versicolor,versicolor,versicolor
5.1,3.4,1.5,0.2,x22,setosa,setosa,setosa,setosa,setosa
6.9,3.1,4.9,1.5,x23,versicolor,versicolor,versicolor,versicolor,versicolor
6.0,2.2,4.0,1.0,x24,versicolor,versicolor,versicolor,versicolor,versicolor
4.7,3.2,1.6,0.2,x25,setosa,setosa,setosa,setosa,setosa
4.6,3.6,1.0,0.2,x27,setosa,setosa,setosa,setosa,setosa
5.6,3.0,4.1,1.3,x31,versicolor,versicolor,versicolor,versicolor,versicolor
5.5,3.5,1.3,0.2,x33,setosa,setosa,setosa,setosa,setosa
5.5,2.4,3.8,1.1,x34,versicolor,versicolor,versicolor,versicolor,versicolor
5.1,3.8,1.6,0.2,x35,setosa,setosa,setosa,setosa,setosa
6.3,3.3,4.7,1.6,x36,versicolor,versicolor,versicolor,versicolor,versicolor
6.6,2.9,4.6,1.3,x100,versicolor,versicolor,versicolor,versicolor,versicolor
7.7,3.0,6.1,2.3,x101,virginica,virginica,virginica,virginica,virginica
6.4,2.9,4.3,1.3,x102,versicolor,versicolor,versicolor,versicolor,versicolor
6.9,3.1,5.1,2.3,x103,virginica,virginica,virginica,virginica,virginica
6.7,3.0,5.0,1.7,x104,setosa,versicolor,versicolor,versicolor,versicolor
4.3,3.0,1.1,0.1,x105,setosa,setosa,setosa,setosa,setosa
7.7,2.6,6.9,2.3,x106,virginica,virginica,virginica,virginica,virginica
6.7,3.3,5.7,2.5,x107,virginica,virginica,virginica,virginica,virginica
6.7,2.5,5.8,1.8,x108,virginica,virginica,virginica,virginica,virginica
1.0,3.1,1.6,0.2,x109,setosa,setosa,setosa,setosa,setosa
5.7,4.4,1.5,0.4,x110,setosa,setosa,setosa,setosa,setosa
6.5,3.0,5.5,1.8,x111,setosa,virginica,virginica,virginica,virginica
6.1,3.0,4.9,1.8,x112,versicolor,versicolor,versicolor,versicolor,versicolor
5.4,3.4,1.7,0.2,x113,setosa,setosa,setosa,setosa,setosa

6.5,3.2,5.1,2.0,x114,virginica,virginica,virginica,virginica,virginica
5.2,3.4,1.4,0.2,x115,setosa,setosa,setosa,setosa,setosa
5.7,3.0,4.2,1.2,x116,versicolor,versicolor,versicolor,versicolor,versicolor
5.5,2.3,4.0,1.3,x117,versicolor,versicolor,versicolor,versicolor,versicolor
5.0,3.4,1.6,0.4,x118,setosa,setosa,setosa,setosa,setosa
5.8,2.7,5.1,1.9,x119,virginica,virginica,virginica,virginica,virginica
6.1,2.8,4.0,1.3,x120,versicolor,versicolor,versicolor,versicolor,versicolor
5.7,2.5,5.0,2.0,x121,virginica,virginica,virginica,virginica,virginica
6.3,2.9,5.6,1.8,x122,versicolor,virginica,virginica,virginica,virginica
4.9,3.1,1.5,0.1,x123,setosa,setosa,setosa,setosa,setosa
6.8,3.2,5.9,2.3,x124,virginica,virginica,virginica,virginica,virginica
6.9,3.2,5.7,2.3,x125,virginica,virginica,virginica,virginica,virginica
6.7,3.1,4.7,1.5,x126,versicolor,versicolor,versicolor,versicolor,versicolor
5.7,2.8,4.1,1.3,x127,versicolor,versicolor,versicolor,versicolor,versicolor
5.0,3.5,1.6,0.6,x128,setosa,setosa,setosa,setosa,setosa
5.4,3.9,1.7,0.4,x129,setosa,setosa,setosa,setosa,setosa
5.2,3.5,1.5,0.2,x130,setosa,setosa,setosa,setosa,setosa
6.1,2.8,4.7,1.2,x131,versicolor,versicolor,versicolor,versicolor,versicolor
5.7,2.9,4.2,1.3,x132,versicolor,versicolor,versicolor,versicolor,versicolor
5.8,2.7,3.9,1.2,x133,versicolor,versicolor,versicolor,versicolor,versicolor
5.0,3.3,1.4,0.2,x134,setosa,setosa,setosa,setosa,setosa
6.8,2.8,4.8,1.4,x135,versicolor,versicolor,versicolor,versicolor,versicolor
6.3,2.8,5.1,1.5,x136,versicolor,versicolor,versicolor,versicolor,versicolor
6.2,2.2,4.5,1.5,x137,virginica,versicolor,versicolor,versicolor,versicolor
6.0,3.0,4.8,1.8,x138,versicolor,versicolor,versicolor,versicolor,versicolor
5.1,3.5,1.4,0.3,x139,setosa,setosa,setosa,setosa,setosa
5.7,3.8,1.7,0.3,x140,setosa,setosa,setosa,setosa,setosa
6.1,3.0,4.6,1.4,x141,versicolor,versicolor,versicolor,versicolor,versicolor
5.8,4.0,1.2,0.2,x142,setosa,setosa,setosa,setosa,setosa
7.2,3.6,6.1,2.5,x143,virginica,virginica,virginica,virginica,virginica
6.1,2.6,5.6,1.4,x144,versicolor,versicolor,versicolor,versicolor,versicolor
5.5,2.5,4.0,1.3,x145,versicolor,versicolor,versicolor,versicolor,versicolor
7.3,2.9,6.3,1.8,x146,virginica,virginica,virginica,virginica,virginica
4.8,3.0,1.4,0.1,x147,setosa,setosa,setosa,setosa,setosa
7.6,3.0,6.6,2.1,x148,virginica,virginica,virginica,virginica,virginica
6.5,3.0,5.8,2.2,x149,virginica,virginica,virginica,virginica,virginica
5.1,3.3,1.7,0.5,x150,setosa,setosa,setosa,setosa,setosa

Problem 3
==========
poly-kernel
exponent = 1
result:
=== Confusion Matrix ===
a b <-- classified as
356 73 | a = car
56 361 | b = noncar
correct 717
incorect 129

==========
poly-kernel
exponent = 2
result:
=== Confusion Matrix ===
a b <-- classified as
408 21 | a = car
15 402 | b = noncar
correct 810
incorrect 36

==========
poly-kernel
exponent = 4
result:
=== Confusion Matrix ===
a b <-- classified as
401 28 | a = car
27 390 | b = noncar
correct 791
incorrect 55

==========
rbf kernel
gamma = 0.01
result:
=== Confusion Matrix ===
a b <-- classified as
267 162 | a = car

70 347 | b = noncar
correct 614
incorrect 232

==========
rbf kernel
gamma = 1
result:
=== Confusion Matrix ===
a b <-- classified as
373 56 | a = car
26 391 | b = noncar
correct 764
incorrect 82

From the result, poly kernel, when exponent equals 2, the number of correct instances is greater than the number of correct instances when exponent equals to 1 and 4. For rbf kernel when gamma equals to 1 the number of correct instances is greater than the number of correct instances when gamma equals to 0.01
The kernel function map the original data set to a high dimension data set. If the higher dimension data set could be separated, the SVM would achieve a better result. So for the poly kernel, when exponent equals to 2 the mapped data is more separable than the mapped data when exponent equals to 1 and 4. For the same reason, when gamma eqs to 1 the mapped data is more separable than the mapped data when gamma eqs to 0.01

Problem 4

Let support $\Phi(x) = \Phi(x_1, x_2) = x_1 + e^{x2}$, then K $(x, z) = K(x_1, x_2, z_1, z_2) =\Phi(x) *\Phi(z)$. From the definition of kernel we can see that K $(x, x) =\Phi(x)^2$. So that K $(x, z) = x_1 * z_1 + x_1 * e^{z2} + z_1 * e^{x2} + e^{x2} + z_2$ is kernel.

Problem 5

Because a0 = -0.8, a1 = 1, a2 = 6.4, a3 = -1.9, so [1,1,1] and [1,1,0] are support vectors.

Because $\mathbf{w} = \sum_{\mathbf{x}_i \in SV} \alpha_i y_i \mathbf{x}_i$, so that w = [5,4, -1, -1]^T, and according to $y_i(\mathbf{w}^T\mathbf{x}_i + b) = 1$, so b = -4.4.

To classify [1, 0.8, 1], we apply the formula w^T * x + b, which equals to -0.8. So we can conclude that even the tuple [1, 0.8, 1] lies between the support vectors, it still closer to the negative class. [1, 0.8, 1] is labeled with class -1.