6.034 QUIZ 2 SOLUTIONS
FALL 2000

(Preliminary – without Explanations)

Problem1: M iscellaneous(30p oints)

Thispr oblemi sf irstbe causeot herpr oblemsw ere judgedt ot aket hreet o fourt imesa s long.C irclet he**s ingle**p hraset hat**b est** completest hef ollowingf ragments.A llm ultiple votesw illbe r ejected.

Progressivede epening,a lsoknow na si terativede epening,w orksw ellf or gamesbe cause:

- Alpha-beta allows yout og ot wicea sde epi na givenga met ree.
- Thebr anching factorva riesf roml ayert ol ayer.
- Almostnone of t henode si na g amet reeof a givende ptha rei nt he finall ayer.
- Almosta llt henode si na g amet reeo fa givend eptha rei nt hef inall ayer.
- Allof t hea bove.
- Noneof t hea bove.

Alpha-beta:

- Doublest hes peedo fm inimax.
- Iss lowert hanm inimax.
- Isi ncompatiblew ithm inimax.
- Isi ncompatiblew ithpr ogressivede epening
- Allof t hea bove.
- Noneof t hea bove.

Thet opologicals orting algorithmw asde velopedt o:

- Improver unt imes peed.
- Ensurepr ecedencei sde terminedb yt heup- to-joinpr inciple.
- Dealw ithl oopsi nt hei nheritancet ree.
- Honoror deringp rinciples.
- Allof t hea bove.
- Noneof t hea bove.

Framesh aveb eenus edt o:

- Enables entenceunde rstanding.
- Enables toryunde rstanding.
- Enablem etaphorund erstanding.
- Enablede faultr easoning viai nheritance.
- Allof t hea bove.
- Noneof t hea bove.

Ake yvi rtueof t het ransition-spacer epresentationi st hati t:

- Subsumest hematicr olef ramesa ndpr imitive-actf rames.
- Canbe t ranslatedt or elational-databaser ecords.
- Enablest hede scriptionof s tates.
- Facilitatest heund erstandingof m etaphors.
- Allof t hea bove.
- Noneof t hea bove.

Ake yvi rtueof t het hematic-rolef rame representationi st hati t:

- Expressesa lla ctionsi nt ermsof a f ewpr imitivea cts.
- Enablesde scriptiona tt hes toryl evel.
- Focusesonv ariable-valuec hanges.
- Capturesc ausalr elations.
- Allof t hea bove.
- Noneof t hea bove.

Ake yvi rtueof s emantic-transition-tree grammars ist hatt hey:

- Reducet henum berof w ordst hatne edt obe und erstood.
- Simplify grammarc onstructionb ys ubstitutingr ecursionf ore xplicitl oops.
- Exploitt her etea lgorithm.
- Exploitt ransition-spacer epresentation.
- Allof t hea bove.
- Noneof t hea bove.

Naturall anguageda tabasei nterfacesw orkbe causepr ocessednounphr asesm ostof ten become:

- Relationalj oinope rations.
- Relationals electionope rations.
- Relationalpr ojectionope rations.
- Relationals ortingope rations.
- Allof t hea bove.
- Noneof t hea bove.

Thepur poseof crossoveri ng enetica lgorithmsi st o:

- Increasedi versity.
- Modelna turalm utation.
- Changes electionpr obabilities.
- Reducet henum berof genotypes.
- Allof t hea bove.
- Noneof t hea bove.

Inn euraln ets:

- Biologicalne uralne tsa rem odeleda ccurately.
- Sigmoidt hresholdsw ere introducedt oa voidove rfitting.
- Overfittingo ccursi ft herea ret oo-fewt rainingc ycles.
- Thec omputationr equiredb yba ckpropagationpe rt raining cyclei spr oportional ton ^{2},w hereni st henum berof node s.
- Allof t hea bove.
- Noneof t hea bove.

Problem2: N earestN eighbor,D ecisionT reesa ndS upportV ectors(30 points)

Congress has decidedt oa ske achvot er a few key questions soa s topr edict how each will vote.T his will,of course,s ave everyone the troublesome andt ime-consuming practice of actually having toe xamine the ballots tof igure out the electionr esult.

They decide tos tart withj ust twoque stions:

a) Ona scale of –1(strongly disagree) to +1(strongly agree) how do youf eel about privatizing social security?

b) Ona scale of –1t o+ 1,h ow do you feel about registering handguns?

The training sample is shownbe low,w ith15i ndividuals plotteda ccordingt ohow they feel about these twoi ssues,w itha darks quare (for Gore) anda light diamond(for Bush) indicating how they votedf or president. T here is alsoa questionm ark" ?" ont he plot, indicating one of the infamous undecidedvot ers about whichs om uchha s beens aid during this election.W e'll call him Mr.U ndecided.
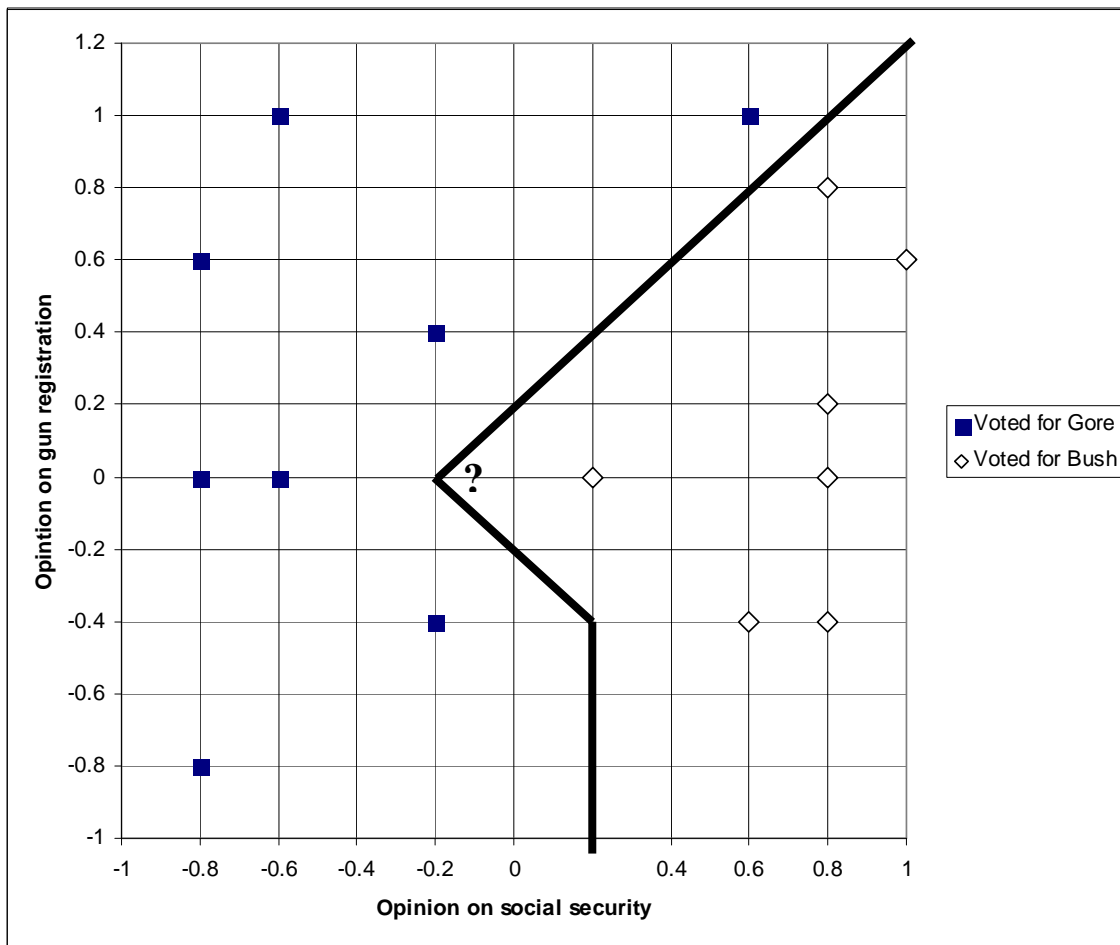
PartA : NearestN eighbor(10p oints)

1) Whatw ouldne arestne ighborpr edicta boutt hevo teof M r.U ndecided,a ssumingt he
   useof t hes tandardE uclideandi stance ast hem etric?(Youra nswers houldbe e ither
   Goreor Bush.)

2) Ont hepl ota bove,**c arefully**dr awt he**p recise**bo undaryl inest hatne arest neighbor
   wouldi ndicatea ss eparatingt heG orepa rtof t hes amples pace fromt he Bushpa rt.

3) Whatw ould3- nearestn eighborp redict aboutt hevot eof M r.U ndecided(usingt he sameE uclideanm etric)?

4) Itt urnsout t herew ason eot herque stiont hatvot ersha dbe ena sked:" How do you feela boutl oweringt hep ayo fC ongressmen/women?"T heque stionw asnot i ncluded int hepubl iclyr eleasedd atabe cause,(accordingt ot hepol iticiansw hoc ontrolledt he release),t heda taw illnot be us efuli nm akinga de cision.W hendi ggingi n, youf ind outt hatt hea ctualpr oblemw ast hata llt hea nswersw eres tronglyc lusteredn neart he +1e ndof t hes cale.Y ou arebr oughti na s ac onsultanta nds uggestt hat:

a) Thepol iticiansa re correct;t heda taw illnot be us eful.

b) Theda tac ans tillbe us eful, youj ustne edt o**d ivide**a llt heva luesb yt hem eanof theva lue.

c) Theda tac ans tillbe us eful, youj ustne edt o**s ubtract**f rome achv aluet he mean ofa llt heva lues,t hen **multiply**a llt heva luesb yt hes tandardd eviationof t he values

d) Theda tac ans tillbe us eful, youj ustne edt o**d ivide**b yt hes tandardd eviation.

e) Theda tac ans tillbe us eful,but none of t hec hoicesof fereda bove are correct.

B: Identification Trees (8p oints)

(Wer epeatt hes ameda tahe ref or yourc onvenience.)
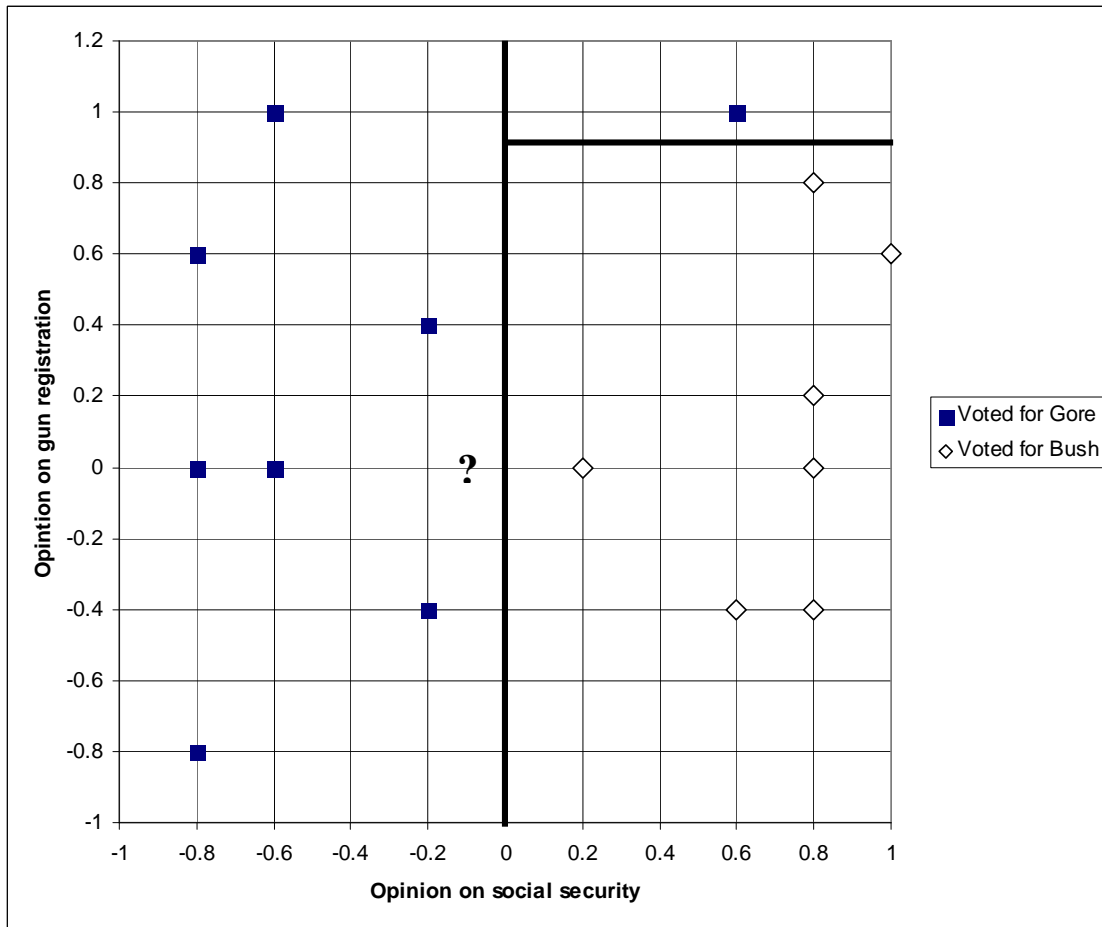
Thingss eemt obe g oing alongw ell,w hens uddenly,R alphN ader appearso nt hes cene ands uggestst hatne arestne ighbori sw reckingt he environmentb y wasting precioust ime ands pace. Hes uggestsu sing IDt reesi nstead.

1) Youde cidet ot rya s yourf irstt estopinion on social security < 0. Buta s youknow , youne edt ode terminet he averagedi sorderof t hes etspr oducedb y thist estt os eew hetheri t'sa ny good.W hati st hea veragedi sorder?(Youra nswer can includet hel log_2ope rator, youne ednot s implify youre xpression.)

2) Youde cidet hati tl ooksg ood,s o youde cidet oc ompletet hede cisiont ree. D rawt he IDt ree ands pecifya llt ests.
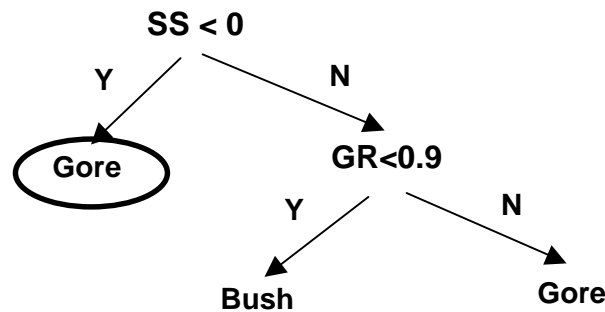
3) Whatdoe s yourt reepr edicta bouthow M r.U ndecidedw illvot ef orpr esident?C ircle thec orrespondingnod eo n your IDt ree.

PartC : More VoterQ uestions(4p oints)

Mr.G ore,h avingi nventedt he Internet, claimst oknow a t hingo rt woa boutt echnology. Hes ayst hatw e're askingw ayt oof ewqu estionsof t hevot ers,a ndi ndicatest hatt og et a decentpr edictivea bility wes houlda skt hema tl east100que stions.Y ouc omeupw ith 100que stions,a ndw hiley ouw orkedha rda ti t, youdon' tt hinka ll100que stionsa re goingt o give youpr edictivei nformationa boutt hevot er.N evertheless, you forgea head andt ryus ingbot hne arestne ighbors andi dentificationt rees.Y ouri nitiale xperiments indicate(circlet hem ostl ikelyr esult):

a) Botht echniquesw orkw ella ndw orka boute quallyw ell.

b) Nearestne ighborsw orks muchbe ttert hani dentificationt rees.

c) Identificationt reesw ork muchbe ttert hanne arest neighbors.

d) Neitherw orks well.

Part D: Support Vector Machines (8p oints)

Allof t hisi sa boutt oe ndw hen younot icea s mall butvoc alde monstration goingonout int hes treet,w ithpe ople carryings ignst hats ay

> Support
> VectorM achines

You're abi tc onfused anda ska c olleague," What'sa ve ctorm achine?"H ee xplainst hat you'vepa rsedt hisa bi ti ncorrectly,i t's calleda s upportve ctorm achine.T hisbr ingsi ta ll backt o you,a nd youi ndicate yourund erstanding bya nsweringt he followingque stion. (At hirdc opyof t hes ameda tai ss hownbe low for yourc onvenience.)

Youde cide experimentw itha r adial-basis-functionke rnel,

$$K(\mathbf{x}_1, \mathbf{x}_2) = e^{\frac{-\|\mathbf{x}_1 - \mathbf{x}_2\|^2}{2\sigma^2}}$$

Youre xperiments ucceeds,w itha s mallnum berof s amplese merginga ss upportve ctors, anda lls amplesc orrectly providingva lueso fl esst hanor e qualt o- 1o r greatert hanor equalt o+ 1.

1. Sketcht hede cisionboun daryi nt hedi agrambe low.
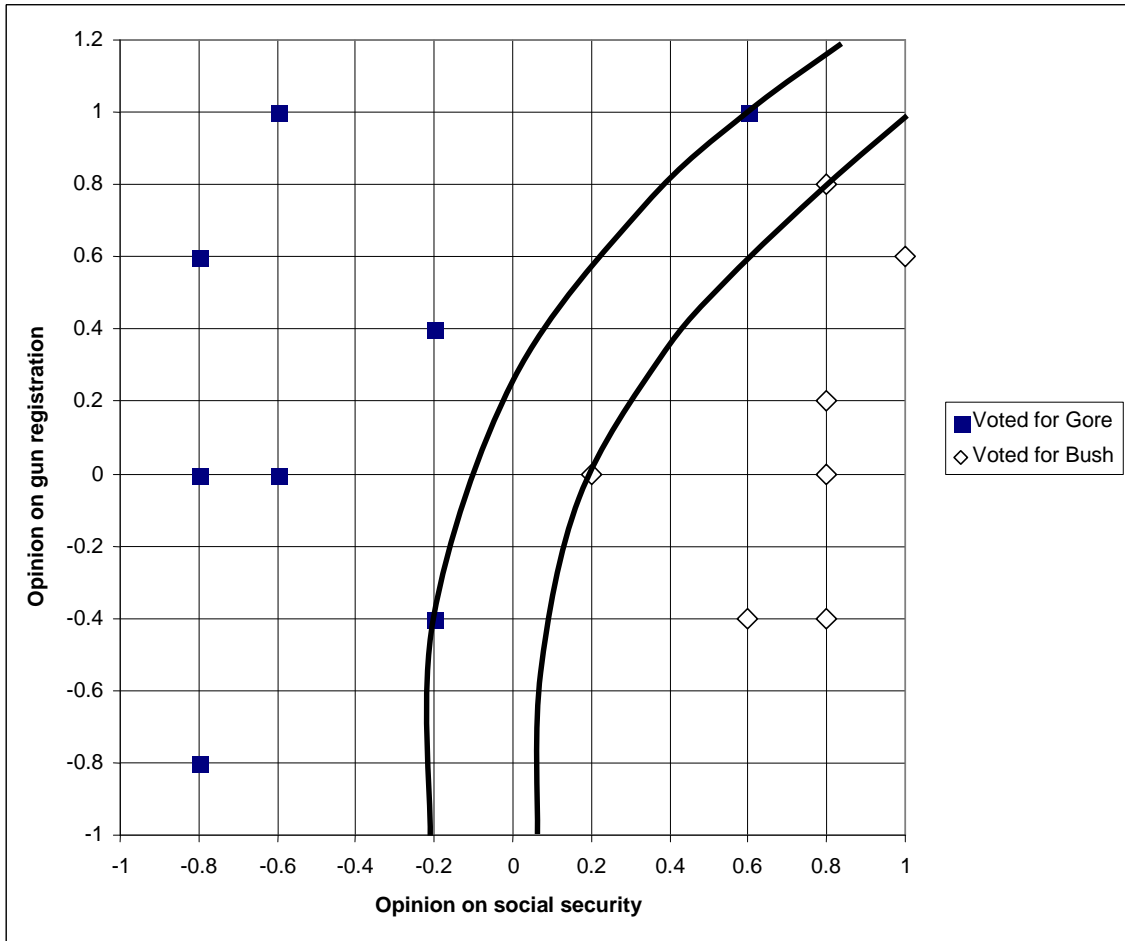
2. Check *all*t hes tatementst hata rec orrect:

Therei sa s igmav alues ucht hata llt heG ore/Bushs amplesw illbe come supportve ctors.

Therei sa s igmav alues ucht hatt heG ore/Bushs amplesw illnot be separable.
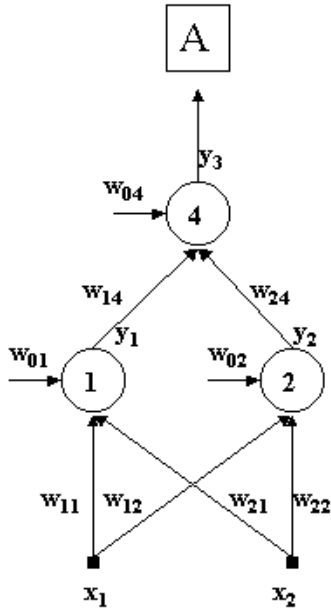
Therei sa s igmav alues ucht hatove rfittingw illoc cur.

Ift her adial-basis-functionke rneli sr eplacedb y a dotpr oductke rnel,$\mathbf{x}_1 \cdot \mathbf{x}_2$,t heG ore/Bushs amplesw illbe s eparable.

Problem3: N euralN ets(40p oints)

PartA (24p oints):

Consider the following neural network. **Allt hreeof t heu nitsar ep erceptronu nits,n ot sigmoidu nits; thati s,al lt heou tputsar e0or 1.** Assume all inputs tot hreshold implementing weights,s ucha s w_{01} andw $_{02}$ are -1.
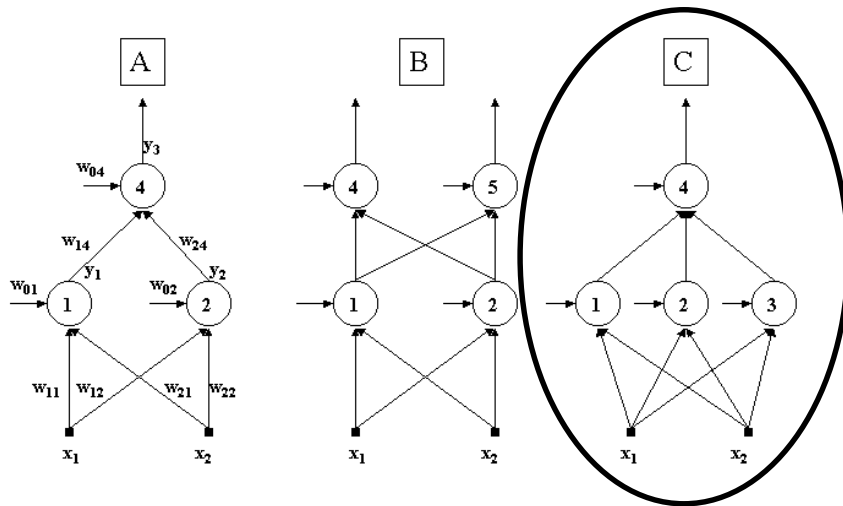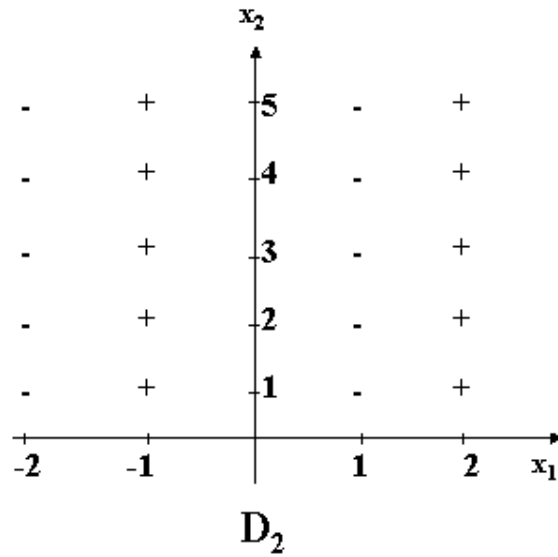

A.1(10p oints)

Give values for the missing weights of net A sot hat it correctly classifies the Data inD $_1$ below. The output for eachi nstance shouldbe 0f or instances labeled–a nd1f or instances labeled +.

W_{01}=	-1.5
W_{11}=	-1
W_{21}=	0
W_{02}=	-1.5
W_{12}=	1
W_{22}=	0
W_{04}=	1.5
W_{14}=	1
W_{24}=	1

A.2(8p oints)

Usingt hew eightsyou c omputedi nA .1:

1. Carefully draw the decisionbounda ries for units 1 and2of A ont he diagram
   below. Be sure tol abel eachbounda ry witha 1or 2.

$$D_1$$

2. O nt he diagram below,d raw ina ll combinations of outputs for units 1a nd2.
   Label eachc ombination witht he class(es) associatedw itht hat combination(+ or
   –or both),g ivent he data set D_1.

A.3(8p oints)

Considert hef ollowingd atas et,w hichi ss omewhatdi fferentf romD $_1$:

CircleA LLof t hen eta rchitectures,i fa ny,t hat canc orrectly classifyt hisda tas et.
Assume thatal lt hear chitecturesu seon lyp erceptronu nits.

Part B (16p oints)
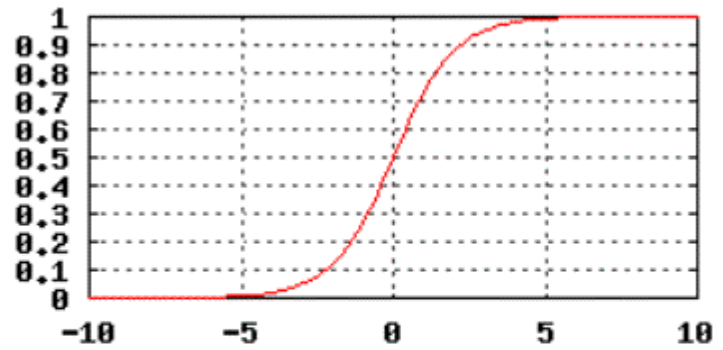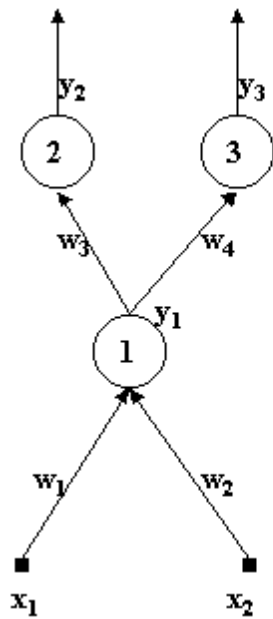
Sigmoid Values

S(-5)= 0	S(-4)=0.02	S(-3)=0.04	S(-2)=0.12	S(-1)=0.27	S(0)=0.5
S(5)=1	S(4)=0.98	S(3)=0.96	S(2)=0.88	S(1)=0.73	

B.1(6poi nts)

Assumingt hate achuni tha sa f ixedt hresholdof 0 .0,c ompute(approximately), givent hat thei nputsa rebot hs ett o2a ndt hew eightsa rew $_1$=2,w $_2$=- 2,w $_3$=4,a ndw $_4$=0.

- $y_1 = 1/2$

- $y_2 = 0.88$

- $y_3 = 1/2$

B.2 (8p oints)

Youa re confrontedw itht wos ituations,a nd youa ret ode termine whethert hew eights willg oupor dow n. Inb oths ituations, you aret o uset hene tworko fpa rt B.1,w hichus es sigmoidne urons.

Ins **ituation1**, youa ret oa ssumet hatt hede sired outputsf ori nputs

$x_1 = 2,$
$x_2 = 2$

are

$y_2 = 0,$
$y_3 = 1,$

thatt hel earningr atei s1,a ndt hatt hew eightsa re asi nB .1.

Ins **ituation2**, youa ret oa ssumet hatt hede sired outputs,f ort hes amei nputs,a re

$y_2 = 1,$
$y_3 = 0,$

Filli nt hec ellsof t het ablebe loww ith**u p**a nd**d own,**a sa ppropriate**.**

	Situation1	Situation2
w_1	↓	↑
w_2	↓	↑
w_3	↓	↑
w_4	↑	↓