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Hidden Markov model example with MATLAB

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1. Fixing a point on the variety:

S=[0.8,0.2; 0.1 0.9]

S =

   0.80000000000000   0.20000000000000
   0.10000000000000   0.90000000000000

T=[0.25 0.25 0.25 0.25; 0.125, 0.375, 0.375, 0.125]

T =

   0.25000000000000   0.25000000000000   0.25000000000000   0.25000000000000
   0.12500000000000   0.37500000000000   0.37500000000000   0.12500000000000


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2. Fixing a sequence sigma:


DNAseq=hmmgenerate(100,S,T,'Statenames',{'exon','intron'},'Symbols',{'A','C','G','T'})

DNAseq =

  Columns 1 through 14

    'G'    'C'    'C'    'C'    'G'    'A'    'C'    'G'    'T'    'C'    'T'    'A'    'C'    'C'

  Columns 15 through 28

    'T'    'C'    'T'    'C'    'C'    'G'    'G'    'C'    'G'    'G'    'G'    'C'    'G'    'G'

  Columns 29 through 42

    'C'    'A'    'T'    'T'    'G'    'A'    'G'    'G'    'C'    'G'    'G'    'C'    'A'    'G'

  Columns 43 through 56

    'C'    'G'    'C'    'T'    'A'    'T'    'C'    'C'    'G'    'G'    'T'    'G'    'G'    'G'

  Columns 57 through 70

    'C'    'C'    'C'    'A'    'A'    'C'    'T'    'C'    'G'    'A'    'C'    'G'    'G'    'G'
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  Columns 71 through 84

    'C'    'G'    'A'    'C'    'T'    'C'    'G'    'C'    'G'    'T'    'A'    'A'    'T'    'G'

  Columns 85 through 98

    'A'    'A'    'G'    'A'    'C'    'A'    'C'    'T'    'T'    'T'    'G'    'G'    'A'    'T'

  Columns 99 through 100

    'T'    'G'
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3. Evaluating the sigma coordinate of the point (answer in logpseq):

```
[PSTATES,logpseq]=hmmdecode(DNAseq,S,T,'Symbols',{'A','C','G','T'})

PSTATES =

  Columns 1 through 5

   0.60269417895039   0.39545352949766   0.29488836174298   0.26053316770887   0.27856407170065
   0.39730582104961   0.60454647050234   0.70511163825702   0.73946683229113   0.72143592829935

  Columns 6 through 10

   0.35623636603883   0.32096815699868   0.34996540284456   0.45489604297638   0.45112973926224
   0.64376363396117   0.67903184300132   0.65003459715544   0.54510395702363   0.54887026073776

  Columns 11 through 15

   0.53432855985292   0.51984806975245   0.40096518427134   0.36782470824217   0.40709154535795
   0.46567144014708   0.48015193024755   0.59903481572866   0.63217529175784   0.59290845464205

  Columns 16 through 20

   0.33710609259936   0.33617816108945   0.21616194703670   0.15201458312126   0.11792439195811
   0.66289390740064   0.66382183891055   0.78383805296330   0.84798541687874   0.88207560804189

  Columns 21 through 25

   0.10017412996019   0.09162142979974   0.08882484784079   0.09065909277127   0.09786222981322
   0.89982587003981   0.90837857020026   0.91117515215921   0.90934090722873   0.90213777018678

  Columns 26 through 30

   0.11333266410970   0.14329540374668   0.19980688443524   0.30560624959528   0.50326514854121
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   0.88666733589030   0.85670459625332   0.80019311556476   0.69439375040472   0.49673485145879

  Columns 31 through 35

   0.57589005090898   0.55719966136935   0.43851629906462   0.41036520455833   0.26185456395850
   0.42410994909102   0.44280033863065   0.56148370093538   0.58963479544167   0.73814543604150

  Columns 36 through 40

   0.18461164956697   0.14755538392618   0.13577503157590   0.14453040311807   0.17734449329225
   0.81538835043303   0.85244461607382   0.86422496842410   0.85546959688193   0.82265550670775

  Columns 41 through 45

   0.24742106695425   0.20205194562013   0.19663959662293   0.22900619381851   0.31217543941179
   0.75257893304575   0.79794805437987   0.80336040337707   0.77099380618149   0.68782456058821

  Columns 46 through 50

   0.47961305365337   0.52795684350717   0.47965213997672   0.31227175928006   0.22915878536248
   0.52038694634663   0.47204315649283   0.52034786002327   0.68772824071994   0.77084121463752

  Columns 51 through 55

   0.19687014062384   0.20241348944309   0.24801936979752   0.17818891613869   0.14577936197373
   0.80312985937616   0.79758651055691   0.75198063020247   0.82181108386131   0.85422063802626

  Columns 56 through 60

   0.13774972003153   0.15086901534009   0.19041620244025   0.27230431614135   0.42948357362311
   0.86225027996847   0.84913098465991   0.80958379755975   0.72769568385865   0.57051642637689

  Columns 61 through 65

   0.46575414263798   0.39795593022857   0.40851150403450   0.30705849521450   0.27404712374403
   0.53424585736202   0.60204406977143   0.59148849596550   0.69294150478550   0.72595287625597

  Columns 66 through 70

   0.29619424253139   0.20150177781691   0.15405690611393   0.13476871476101   0.13587600295185
   0.70380575746861   0.79849822218309   0.84594309388607   0.86523128523899   0.86412399704815

  Columns 71 through 75

   0.15782432236325   0.20944525866311   0.31151009336259   0.29627346964088   0.34094915399206
   0.84217567763675   0.79055474133689   0.68848990663741   0.70372653035912   0.65905084600794

  Columns 76 through 80
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```
   0.27240670477681   0.26117394975167   0.30273104225174   0.41379976473540   0.63907205553536
   0.72759329522319   0.73882605024833   0.69726895774826   0.58620023526460   0.36092794446464

  Columns 81 through 85

   0.74644219703297   0.78576061206641   0.77528227904407   0.71014225763415   0.75156624891788
   0.25355780296703   0.21423938793359   0.22471772095593   0.28985774236585   0.24843375108212

  Columns 86 through 90

   0.73503903600748   0.65288727005171   0.67590397916883   0.62509384745648   0.67642138425783
   0.26496096399252   0.34711272994829   0.32409602083117   0.37490615254352   0.32357861574217

  Columns 91 through 95

   0.65399384655019   0.73685545344791   0.75434445224422   0.71458073523743   0.59910257667437
   0.34600615344981   0.26314454655209   0.24565554775578   0.28541926476257   0.40089742332563

  Columns 96 through 100

   0.58946171777194   0.68177886054322   0.69697068436274   0.64209053600384   0.49165834658560
   0.41053828222806   0.31822113945678   0.30302931563726   0.35790946399616   0.50834165341440


logpseq =

    -1.341061974974420e+02

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4. Tropical evaluation of the coordinate sigma of the point:

STATES=hmmviterbi(DNAseq,S,T,'Statenames',{'exon','intron'},'Symbols',{'A','C','G','T'})

STATES =

  Columns 1 through 8

    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'

  Columns 9 through 16

    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'

  Columns 17 through 24

    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'

  Columns 25 through 32
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    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'
  Columns 33 through 40
    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'
  Columns 41 through 48
    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'
  Columns 49 through 56
    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'
  Columns 57 through 64
    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'
  Columns 65 through 72
    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'
  Columns 73 through 80
    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'intron'    'exon'
  Columns 81 through 89
    'exon'    'exon'    'exon'    'exon'    'exon'    'exon'    'exon'    'exon'    'exon'
  Columns 90 through 98
    'exon'    'exon'    'exon'    'exon'    'exon'    'exon'    'exon'    'exon'    'exon'
  Columns 99 through 100
    'exon'    'exon'
************************************
6. Mechanics of the calculation: the forward and backward variables.
[PSTATES,logpseq,FORWARD,BACKWARD,SCALE]=hmmdecode(DNAseq,S,T,'Symbols',{'A','C','G','T'})
PSTATES =
  Columns 1 through 5
```

```
   0.60269417895039   0.39545352949766   0.29488836174298   0.26053316770887   0.27856407170065
   0.39730582104961   0.60454647050234   0.70511163825702   0.73946683229113   0.72143592829935

  Columns 6 through 10

   0.35623636603883   0.32096815699868   0.34996540284456   0.45489604297638   0.45112973926224
   0.64376363396117   0.67903184300132   0.65003459715544   0.54510395702363   0.54887026073776

  Columns 11 through 15

   0.53432855985292   0.51984806975245   0.40096518427134   0.36782470824217   0.40709154535795
   0.46567144014708   0.48015193024755   0.59903481572866   0.63217529175784   0.59290845464205

  Columns 16 through 20

   0.33710609259936   0.33617816108945   0.21616194703670   0.15201458312126   0.11792439195811
   0.66289390740064   0.66382183891055   0.78383805296330   0.84798541687874   0.88207560804189

  Columns 21 through 25

   0.10017412996019   0.09162142979974   0.08882484784079   0.09065909277127   0.09786222981322
   0.89982587003981   0.90837857020026   0.91117515215921   0.90934090722873   0.90213777018678

  Columns 26 through 30

   0.11333266410970   0.14329540374668   0.19980688443524   0.30560624959528   0.50326514854121
   0.88666733589030   0.85670459625332   0.80019311556476   0.69439375040472   0.49673485145879

  Columns 31 through 35

   0.57589005090898   0.55719966136935   0.43851629906462   0.41036520455833   0.26185456395850
   0.42410994909102   0.44280033863065   0.56148370093538   0.58963479544167   0.73814543604150

  Columns 36 through 40

   0.18461164956697   0.14755538392618   0.13577503157590   0.14453040311807   0.17734449329225
   0.81538835043303   0.85244461607382   0.86422496842410   0.85546959688193   0.82265550670775

  Columns 41 through 45

   0.24742106695425   0.20205194562013   0.19663959662293   0.22900619381851   0.31217543941179
   0.75257893304575   0.79794805437987   0.80336040337707   0.77099380618149   0.68782456058821

  Columns 46 through 50

   0.47961305365337   0.52795684350717   0.47965213997672   0.31227175928006   0.22915878536248
   0.52038694634663   0.47204315649283   0.52034786002327   0.68772824071994   0.77084121463752

  Columns 51 through 55
```

```
   0.19687014062384   0.20241348944309   0.24801936979752   0.17818891613869   0.14577936197373
   0.80312985937616   0.79758651055691   0.75198063020247   0.82181108386131   0.85422063802626

  Columns 56 through 60

   0.13774972003153   0.15086901534009   0.19041620244025   0.27230431614135   0.42948357362311
   0.86225027996847   0.84913098465991   0.80958379755975   0.72769568385865   0.57051642637689

  Columns 61 through 65

   0.46575414263798   0.39795593022857   0.40851150403450   0.30705849521450   0.27404712374403
   0.53424585736202   0.60204406977143   0.59148849596550   0.69294150478550   0.72595287625597

  Columns 66 through 70

   0.29619424253139   0.20150177781691   0.15405690611393   0.13476871476101   0.13587600295185
   0.70380575746861   0.79849822218309   0.84594309388607   0.86523128523899   0.86412399704815

  Columns 71 through 75

   0.15782432236325   0.20944525866311   0.31151009336259   0.29627346964088   0.34094915399206
   0.84217567763675   0.79055474133689   0.68848990663741   0.70372653035912   0.65905084600794

  Columns 76 through 80

   0.27240670477681   0.26117394975167   0.30273104225174   0.41379976473540   0.63907205553536
   0.72759329522319   0.73882605024833   0.69726895774826   0.58620023526460   0.36092794446464

  Columns 81 through 85

   0.74644219703297   0.78576061206641   0.77528227904407   0.71014225763415   0.75156624891788
   0.25355780296703   0.21423938793359   0.22471772095593   0.28985774236585   0.24843375108212

  Columns 86 through 90

   0.73503903600748   0.65288727005171   0.67590397916883   0.62509384745648   0.67642138425783
   0.26496096399252   0.34711272994829   0.32409602083117   0.37490615254352   0.32357861574217

  Columns 91 through 95

   0.65399384655019   0.73685545344791   0.75434445224422   0.71458073523743   0.59910257667437
   0.34600615344981   0.26314454655209   0.24565554775578   0.28541926476257   0.40089742332563

  Columns 96 through 100

   0.58946171777194   0.68177886054322   0.69697068436274   0.64209053600384   0.49165834658560
   0.41053828222806   0.31822113945678   0.30302931563726   0.35790946399616   0.50834165341440
```

```
logpseq =

    -1.341061974974420e+02


FORWARD =

  Columns 1 through 5

   1.00000000000000   0.72727272727273   0.50950570342205   0.35909702496636   0.26532029102485
                   0   0.27272727272727   0.49049429657795   0.64090297503364   0.73467970897515

  Columns 6 through 10

   0.21053439308468   0.39663174036656   0.28801731089915   0.22354986071493   0.40825783420085
   0.78946560691532   0.60336825963344   0.71198268910085   0.77645013928507   0.59174216579915

  Columns 11 through 15

   0.29514008412125   0.46930738462377   0.59994486368055   0.41931718767270   0.30195692126096
   0.70485991587875   0.53069261537623   0.40005513631945   0.58068281232730   0.69804307873904

  Columns 16 through 20

   0.47487723787111   0.33682538984935   0.50274496208593   0.35471549934831   0.26270012530185
   0.52512276212889   0.66317461015065   0.49725503791407   0.64528450065169   0.73729987469815

  Columns 21 through 25

   0.20904167863522   0.17890967417912   0.16234666053411   0.15334907658032   0.14849260335693
   0.79095832136478   0.82109032582088   0.83765333946589   0.84665092341968   0.85150739664307

  Columns 26 through 30

   0.14588039891348   0.14447796935928   0.14372579475250   0.14332259316537   0.14310652025475
   0.85411960108652   0.85552203064072   0.85627420524750   0.85667740683463   0.85689347974525

  Columns 31 through 35

   0.33357574831686   0.50019087750696   0.62081674382283   0.43365424592481   0.57504995184480
   0.66642425168314   0.49980912249304   0.37918325617717   0.56634575407519   0.42495004815520

  Columns 36 through 40

   0.40243603774914   0.29156780227853   0.22559974425105   0.18811982446663   0.16738252919335
   0.59756396225086   0.70843219772147   0.77440025574895   0.81188017553337   0.83261747080665

  Columns 41 through 45
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```
   0.15607679696115   0.34608742211544   0.25755818811001   0.20611815751162   0.17729156119713
   0.84392320303885   0.65391257788456   0.74244181188999   0.79388184248838   0.82270843880287

  Columns 46 through 50

   0.16146433463862   0.35122941115435   0.51396198230507   0.62992433142680   0.43996370882442
   0.83853566536138   0.64877058884565   0.48603801769493   0.37007566857320   0.56003629117558

  Columns 51 through 55

   0.31479212786679   0.23910214112447   0.19568814324264   0.38316120637540   0.27981962271384
   0.68520787213321   0.76089785887553   0.80431185675736   0.61683879362460   0.72018037728616

  Columns 56 through 60

   0.21883130224182   0.18434559801077   0.16531604728747   0.15495663413151   0.14935867950418
   0.78116869775818   0.81565440198923   0.83468395271253   0.84504336586849   0.85064132049582

  Columns 61 through 65

   0.33963038975670   0.50494259194870   0.35613796076880   0.51774617922745   0.36445964204260
   0.66036961024330   0.49505740805130   0.64386203923120   0.48225382077255   0.63554035795740

  Columns 66 through 70

   0.26853542264432   0.44717458257519   0.31930866128682   0.24174706107252   0.19717680140609
   0.73146457735568   0.55282541742481   0.68069133871318   0.75825293892748   0.80282319859391

  Columns 71 through 75

   0.17235757326362   0.15877836559142   0.15142045391762   0.34161739356776   0.25490343592007
   0.82764242673638   0.84122163440858   0.84857954608238   0.65838260643224   0.74509656407993

  Columns 76 through 80

   0.43558408567198   0.31205752562953   0.23750376628465   0.19478949660408   0.17104399909746
   0.56441591432802   0.68794247437047   0.76249623371535   0.80521050339592   0.82895600090254

  Columns 81 through 85

   0.36029392630249   0.52093514441191   0.63449034433520   0.70478337316691   0.49309035978040
   0.63970607369751   0.47906485558809   0.36550965566480   0.29521662683309   0.50690964021960

  Columns 86 through 90

   0.61607330698114   0.69387867258886   0.48520790875271   0.61076914434047   0.42673132012232
   0.38392669301886   0.30612132741114   0.51479209124729   0.38923085565953   0.57326867987768
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  Columns 91 through 95

   0.57011299785161   0.39911626009125   0.55007467404878   0.65324605878697   0.71570304334075
   0.42988700214839   0.60088373990875   0.44992532595122   0.34675394121303   0.28429695665925

  Columns 96 through 100

   0.50103389650267   0.35360916541151   0.51579903995398   0.63113019319904   0.70280743332362
   0.49896610349733   0.64639083458849   0.48420096004602   0.36886980680096   0.29719256667638

  Column 101

   0.49165834658560
   0.50834165341440


BACKWARD =

  Columns 1 through 5

   1.00000000000000   0.82870449605679   0.77615133028273   0.82119410978302   0.98195719107088
   1.86321296709204   1.45678801051524   1.23252497474508   1.10018468586452   1.00651593239544

  Columns 6 through 10

   1.32312857590261   0.89815395436986   1.11440578344636   1.56549148241625   1.11423714346307
   0.91382819210860   1.06694978345774   0.95371959655207   0.83718781704897   0.92118491554081

  Columns 11 through 15

   1.52852751467302   1.13854709591087   0.86649307498572   0.95623360086141   1.21813637093047
   0.77869410413767   0.87747865083245   1.20021438710924   1.03160417875605   0.90563936669899

  Columns 16 through 20

   0.85725638732013   1.00083337764454   0.66868529063847   0.60939526869797   0.57866201223388
   1.12908542040408   0.99957672874426   1.33497257603503   1.21471700028698   1.15012282787367

  Columns 21 through 25

   0.56411904424043   0.55991455140596   0.56435672589945   0.57923301412425   0.61052935110414
   1.11519859418115   1.09589145279506   1.08443257777670   1.07621113608299   1.06791897617526

  Columns 26 through 30

   0.67083878671911   0.78442868910949   0.99700547137998   1.39410598163464   2.13551590138071
   1.05621949085254   1.03640503006831   1.00050263222130   0.93406585627305   0.81036180904441

  Columns 31 through 35
```

```
   1.50869825243758   1.15134057178196   0.89752679339519   1.01121181952097   0.71361662276789
   0.74537331167680   0.84854383404521   1.16777397582070   0.99141504442326   1.38753907194836

  Columns 36 through 40

   0.65067374538095   0.63316884828940   0.65405829433022   0.72174759869600   0.86347364814347
   1.23525761704421   1.15097584928461   1.10078039069008   1.06447354482617   1.02744612847620

  Columns 41 through 45

   1.13626430542648   0.71490915631056   0.78449047612431   0.95401394518987   1.29169257844077
   0.97479901458507   1.15088615588399   1.07476174105628   1.01193951087102   0.93714099651557

  Columns 46 through 50

   1.93340182592320   1.36552645769919   1.02722937042800   0.76144405930518   0.70976708536812
   0.82026870054691   0.80211241892538   0.97120624170828   1.40605801518764   1.22800656235388

  Columns 51 through 55

   0.72796860237705   0.82337255408078   1.03436767342679   0.64729770569343   0.63679921518911
   1.12497425378040   1.05550285101740   0.99163838485787   1.21908777135072   1.14111840558351

  Columns 56 through 60

   0.66617234591348   0.74723628618182   0.91260962148306   1.22883543197414   1.82315696044788
   1.09351621548295   1.05712698646093   1.01730838588717   0.95803816734033   0.85546712383369

  Columns 61 through 65

   1.26456167226610   0.92239028765730   1.11742070227362   0.78901886759272   0.84250342093738
   0.86393501082930   1.07915940388606   0.93505135120297   1.22650867756311   1.09031864949156

  Columns 66 through 70

   1.02052504301084   0.66236824290340   0.63105641107529   0.63726485621151   0.68349173837878
   0.99246484208486   1.27310672643654   1.17306946154569   1.11564762951347   1.07773577887931

  Columns 71 through 75

   0.78833787444916   0.99399135250811   1.38320321491746   0.91186836275887   1.16229688537340
   1.04407890307849   1.00113411637214   0.93162125458553   1.04572918529596   0.94447695008245

  Columns 76 through 80

   0.78274015329572   0.87293746314007   1.09966234993784   1.55414458956718   2.41925917845039
   1.16766878693098   1.05763682623174   0.96895698310314   0.86594617781012   0.70715482441332
```

```
  Columns 81 through 85

   1.77375195328388   1.43288892108756   1.23841224548454   1.10002918423058   1.44018686139072
   0.56420903177998   0.52927656873466   0.58613879172062   0.76119601855277   0.57181343452115

  Columns 86 through 90

   1.21992990184995   1.05931925139744   1.34558249829446   1.10664395120795   1.46484173525698
   0.64708642456886   0.86554232020776   0.67427751096035   0.83265757613692   0.65397982778950

  Columns 91 through 95

   1.18646897510991   1.63860486766608   1.33955531532536   1.15476311276180   0.99843188021377
   0.75270620913184   0.57582878428754   0.58486271248625   0.70844341926270   1.00394766133452

  Columns 96 through 100

   1.19573262578887   1.66698653607003   1.32179164312530   1.10432156767840   0.91360806041472
   0.80345622781925   0.63512392233936   0.65720881558461   0.82150750766320   1.20430153418304

  Column 101

   1.00000000000000
   1.00000000000000


SCALE =

  Columns 1 through 5

   1.00000000000000   0.27500000000000   0.29886363636364   0.31791825095057   0.33107901031544

  Columns 6 through 10

   0.33928447453533   0.15592175939491   0.32779472271793   0.33729848529632   0.15706061281256

  Columns 11 through 15

   0.32677743950743   0.16332475736061   0.17856439615458   0.31000482442795   0.32580974607864

  Columns 16 through 20

   0.16392123061033   0.32094824168628   0.16697222161182   0.31850981581748   0.33146239380702

  Columns 21 through 25

   0.33951373903609   0.34420885311942   0.34684540350933   0.34829466720327   0.34908195579922

  Columns 26 through 30
```

```
   0.34950689720627   0.34973546509507   0.34985817768106   0.34992399295916   0.34995927309803
  Columns 31 through 35
   0.15002182052229   0.16668787797773   0.18126670178186   0.30817853491550   0.17544474651842
  Columns 36 through 40
   0.31218312921358   0.32728684669695   0.33698781730063   0.34276002237803   0.34603951535917
  Columns 41 through 45
   0.34785402869558   0.15115671973410   0.33221735056490   0.33996365854037   0.34446466121773
  Columns 46 through 50
   0.34698698839525   0.15162812928088   0.16823257347601   0.18247167345169   0.30738162100016
  Columns 51 through 55
   0.32400317547786   0.33495568881166   0.34157856265161   0.15462271253373   0.32897339444215
  Columns 56 through 60
   0.33801578301254   0.34335226105384   0.34636976017406   0.34803484586235   0.34894129451349
  Columns 61 through 65
   0.15056888445662   0.16721765910371   0.31831752320449   0.16866207156727   0.31719720931760
  Columns 66 through 70
   0.33060978132127   0.16099684948138   0.32337222402467   0.33456049213740   0.34134713215615
  Columns 71 through 75
   0.34524702987697   0.34741871233943   0.34860689301075   0.15074928971779   0.33260847806282
  Columns 76 through 80
   0.15980405064301   0.32438639250370   0.33519496650742   0.34171842045009   0.34545591904714
  Columns 81 through 85
   0.15246634992103   0.16902571855147   0.18308182513604   0.19301790512933   0.30083145484790
  Columns 86 through 90
```

```
   0.18064540648078   0.19140641436085   0.30178561614847   0.17995569201586   0.30905769987021

  Columns 91 through 95

   0.17483899051070   0.31261511268798   0.17242267275798   0.18563153397927   0.19465903014386

  Columns 96 through 100

   0.29987598370768   0.31865953405602   0.16844080197351   0.18263241599597   0.19272389190492

  Column 101

   0.30100434958418
```

****

7. (Local) maximum likelihood estimation

```
[estS, estT] = hmmtrain(DNAseq,S,T,'Symbols',{'A','C','G','T'})

estS =

   0.82882751711803   0.17117248288197
   0.29891709552263   0.70108290447737


estT =

   0.23147178529797   0.29174573977644   0.19563648364480   0.28114599128079
   0.06060765205038   0.34248443779953   0.59690264136317   0.00000526878691
```