doMarkov5k (Calls: 1500, Time: 5268.037 s)

Generated 05-Mar-2017 01:52:13 using performance time.
function in file /Laboratory/Megan Crowe/Capstone project/MATLAB code for Capstone/doMarkov5k.m
Copy to new window for comparing multiple runs

Refresh

Show parent functions Show busy lines Show child functions
Show Code Analyzer results Show file coverage Show function listing

Parents (calling functions)

Function Name	Function Type	Calls
screenSystemV2k	function	1500

Lines where the most time was spent

Line Number	Code	Calls	Total Time	% Time	Time Plot
191	`trueStageR(pt) = randsample8(t...`	184217161	901.731 s	17.1%	
193	`trueStageL(pt) = randsample8(t...`	184217161	804.782 s	15.3%	
104	`ptAge(pt) = (randsample(length...`	18697943	653.189 s	12.4%	
139	`examStageR(pt) = randsample8(t...`	144817039	566.474 s	10.8%	
140	`examStageL(pt) = randsample8(t...`	144817039	510.343 s	9.7%	
All other lines			1831.518 s	34.8%	
Totals			5268.037 s	100%	

Children (called functions)

Function Name	Function Type	Calls	Total Time	% Time	Time Plot
randsample8	function	695464286	1476.785 s	28.0%	
maketpm	function	50001807	909.781 s	17.3%	
randsample	function	18697943	528.266 s	10.0%	
Self time (built-ins, overhead, etc.)			2353.205 s	44.7%	
Totals			5268.037 s	100%	

Code Analyzer results

Line number	Message
24	`The value assigned to variable 'NSTAGES' might be unused.`
26	`The value assigned to variable 'STAGE_NPDR1' might be unused.`

```
PerProc,costsPerScreen,dmInPopByAge,MortByAge,...
anceRate,resourcesPerYear)

the simulation on
```

27	The value assigned to variable 'STAGE_NPDR2' might be unused.
28	The value assigned to variable 'STAGE_NPDR3' might be unused.
62	The value assigned to variable 'RESOURCELASER' might be unused.
89	The variable 'ptUtils' appears to be preallocated, but preallocation is not recommended here.
102	FOR might not be aligned with its matching END (line 219).
103	Extra semicolon is unnecessary in IF statement before newline.
139	The variable 'examStageR' appears to change size on every loop iteration. Consider preallocating for speed.
140	The variable 'examStageL' appears to change size on every loop iteration. Consider preallocating for speed.
141	The variable 'canSeeOphth' appears to change size on every loop iteration. Consider preallocating for speed.
147	The variable 'canSeeOphth' appears to change size on every loop iteration. Consider preallocating for speed.

Coverage results

Show coverage for parent directory

Total lines in function	228
Non-code lines (comments, blank lines)	80
Code lines (lines that can run)	148
Code lines that did run	143
Code lines that did not run	5
Coverage (did run/can run)	96.62 %

Function listing

Color highlight code according to time

time	Calls	line	
		1	function costAndQaly = doMarkov5k(npatients,util,utilSD,costsI
		2	screenAcc,initScreenInt,screenRefer,morbidityIndex,compli
		3	% takes following inputs
		4	% npatients - note that if the npatients is very high, we do t
		5	% MAXSIMSIZE and scale everything down
		6	% utility by stage,
		7	% standard deviation of utility by stage,
		8	% cost per procedure or treatment,
		9	% cost per screen
		10	% proportion of each age with diabetes in the population
		11	% mortality by age
		12	% screening accuracy matrix
		13	% initial screening interval

opathy stages

elow that we use the actual number of subjects

ould be extended to kids

nto simulation to death
IENTS AS OTHERS DIE

ess as a percentage of the disutility of bilateral blindness

sting

k

rtality multipliers by stage (reference: Cost-Utility Analysis
With Type 2 Diabetes Mellitus)

E CHANGED TO A VARIABLE, TO ADAPT TO STAGE OF DISEASE

we limit our simulation to MAXSIMSIZE
YEARS,1); % There will be a new set of resources each year

```
                    14 % when to refer to ophthalmologist based on stage
                    15 % morbidity index, which drives the transitions between retino
                    16 % compliance rate - likelihood of being at appointments
                    17 % resources provided each year
                    18
                    19 %% Simulation parameters
< 0.01      1500    20 MAXSIMSIZE = 10000; % Maximum subjects within a simulation. Be
< 0.01      1500    21 simsize = min(npatients,MAXSIMSIZE);
                    22
                    23 %% Stage of disease parameters
< 0.01      1500    24 NSTAGES = 8; %total number of stages
< 0.01      1500    25 STAGE_HEALTH = 1;
< 0.01      1500    26 STAGE_NPDR1 = 2;
< 0.01      1500    27 STAGE_NPDR2 = 3;
< 0.01      1500    28 STAGE_NPDR3 = 4;
< 0.01      1500    29 STAGE_PDR = 5;
< 0.01      1500    30 STAGE_ME = 6;
< 0.01      1500    31 STAGE_BLIND = 7;
< 0.01      1500    32 STAGE_DEATH = 8; % labels each stage of disease
                    33
< 0.01      1500    34 MINAGE = 18; % At the moment we are only doing adults. This co
< 0.01      1500    35 MAXAGE = 120;
                    36 %MAXYEARS = MAXAGE - MINAGE + 1; % Maximum years from entry in
< 0.01      1500    37 SIMYEARS = 20; %Length of the simulation. NOTE WE ADD NEW PATI
                    38
                    39 %% Initialize utilities
< 0.01      1500    40 unilatVsBilatBlind = 0.25;  % Disutility of unilateral blindne
                    41
                    42 %% Initialize cost variables
< 0.01      1500    43 cost_fa = costsPerProc(1); % cost of fluorescein angiogram tes
< 0.01      1500    44 cost_focal = costsPerProc(2); % cost of focal laser treatment
< 0.01      1500    45 cost_scatter = costsPerProc(3); % cost of scatter treatment
                    46
                    47 %% Initialize morbidities
< 0.01      1500    48 MORBIDITYSD = 0; %Amount of variability in the morbidity index
                    49
                    50
                    51 %% Initialize epidemiology variables
< 0.01      1500    52 mortMult = [1 1.23 1.23 1.49 1.76 1.76 2.34 1000] * 1.8; %xMor
                    53 % of Screening Intervals for Diabetic Retinopathy in Patients
                    54
                    55 %% Initialize screening variables
< 0.01      1500    56 FUPSCREENINT = 1; %screening interval - NOTE THAT THIS MUST BE
                    57
                    58 %% Initialize resources
                    59 % Note that the resources provided need to be scaled down if w
  0.01      1500    60 resources = repmat(resourcesPerYear * simsize / npatients,SIMY
```

ame as use of the ophthalmology resource
lmologist will need referral to ophthalmologist
n a different
t.

eople who start out seeing and alive
add to 1

lation in each eye
on in each eye
lation in each eye
on in each eye

ach stage
greater than 1

s
s last screened -999 means not screened yet

ialize patient at beginning or year after they die.
E:MAXAGE)),1,true,dmInPopByAge(MINAGE:MAXAGE))') + MINAGE - 1;
n
yIndex;
e);

```
< 0.01      1500    61 RESOURCESCREEN = 1; % Number of screens possible
< 0.01      1500    62 RESOURCELASER = 2; % Not used because it is essentially the sa
< 0.01      1500    63 RESOURCEOPHTH = 3; % Detection of retinopathy by a non-ophtha
                    64     % Note that the ophthalmologist is probably going to be in
                    65     % regions, yet we don't really keep track properly of that
                    66
                    67 %% Initial stages of disease (reference: xxx)
< 0.01      1500    68 startStages = [0.498 0.141 0.141 0.141 0.027 0.027 0 0];
                    69     % Stage 7 is 0.27 in literature, but we will only study pe
< 0.01      1500    70 startStages = startStages / sum(startStages); % Normalize to a
                    71
< 0.01      1500    72 qalys = 0;
< 0.01      1500    73 costs = 0;
< 0.01      1500    74 nUniBlind = 0;
< 0.01      1500    75 nBlind = 0;
                    76
                    77 %% Initialize arrays for speed
  0.01      1500    78 ptAge = zeros(1,simsize);
< 0.01      1500    79 ptMorbidity = zeros(1,simsize);
  0.86      1500    80 tpmR = zeros(simsize,8,8);
  0.37      1500    81 tpmL = zeros(simsize,8,8);
  0.02      1500    82 trueStageR = zeros(1,simsize);
  0.01      1500    83 trueStageL = zeros(1,simsize);
  0.01      1500    84 hadScatterR = zeros(1,simsize); % 1 if had scatter photocoagul
< 0.01      1500    85 hadFocalR = zeros(1,simsize); % 1 if had focal photocoagulatio
< 0.01      1500    86 hadScatterL = zeros(1,simsize); % 1 if had scatter photocoagul
< 0.01      1500    87 hadFocalL = zeros(1,simsize); % 1 if had focal photocoagulatio
< 0.01      1500    88 years_seeing = zeros(1,simsize);
  0.05      1500    89 ptUtils = zeros(simsize,8); %sets up matrix of utilities of ea
  0.07      1500    90 ptUtils = zeros(simsize,8); %Utility cannot be less than 0 or
  0.01      1500    91 utilUnilatBlind = zeros(1,simsize);
< 0.01      1500    92 screeningInt = zeros(1,simsize); % screening interval in years
  0.04      1500    93 lastScreened = -999 * ones(1,simsize); % year that patient was
                    94
                    95
                    96
                    97 %% Debugging variables
                    98 %ageWhenBlind = zeros(NUMEYES,simsize);
                    99
                   100 %% MAIN LOOP
< 0.01      1500   101 for year = 1:SIMYEARS   %for every year
< 0.01     30000   102  for pt = 1:simsize  % For all patients
 13.10 193792800   103         if year == 1 || trueStageR(pt) == STAGE_DEATH; % Initi
653.19  18697943   104             ptAge(pt) = (randsample(length(dmInPopByAge(MINAGE
                   105 % Age chosen based on prevalence of diabetes in the population
  3.63  18697943   106             ptMorbidity(pt) = rand() * MORBIDITYSD + morbidity
448.19  18697943   107             tpmR(pt,:,:) = maketpm(ptMorbidity(pt),false,false
```

```
e);
ages);
ages);
ulation in each eye
ion in each eye
ulation in each eye
ion in each eye

s up matrix of utilities of each stage
lity cannot be less than 0 or greater than 1
 * unilatVsBilatBlind;
erval in years
 BECOMES FUPSCREENINT,

last screened -999 means not screened yet

ons on deceased patients. Note we keep track of death in right eye stage



Age(pt)) * mortMult(trueStageR(pt)),MortByAge(ptAge(pt)) * mortMult(trueStageL(pt))))
 eyes to figure out increased mortality
atient

rand() < complianceRate) % if they are due for a screening and likely to show up
ESOURCESCREEN) - 1; % Use up a screen resource -- right now 1 per screen
gative to keep track of how much we overused the resources
the resources to screen the patient (0 is OK because we subtracted 1 already)

ey were screened this year
system for the cost of screening
creenAcc(trueStageR(pt),:)); % Apparent vs true stage of disease R eye
creenAcc(trueStageL(pt),:)); % Apparent vs true stage of disease L eye

eenRefer(examStageL(pt)) == 1) % One or both eyes requires referral to an ophthalmologis
to ophthalmologists
(year,RESOURCEOPHTH) - 1; % Use up a ophth referral resource -- 1 per screen
tive to keep track of how much we overused the resources
 don't have the resources to send patient to ophthalmologist




catterR(pt) == 0)
d has not had scatter for that eye, assign them to scatter
```

st

```
371.57  18697943   108              tpmL(pt,:,:) = maketpm(ptMorbidity(pt),false,false
 85.67  18697943   109              trueStageR(pt) = randsample8(STAGE_HEALTH,startSta
 60.43  18697943   110              trueStageL(pt) = randsample8(STAGE_HEALTH,startSta
  2.35  18697943   111              hadScatterR(pt) = 0; % 1 if had scatter photocoagu
  1.86  18697943   112              hadFocalR(pt) = 0; % 1 if had focal photocoagulati
  1.64  18697943   113              hadScatterL(pt) = 0; % 1 if had scatter photocoagu
  1.72  18697943   114              hadFocalL(pt) = 0; % 1 if had focal photocoagulati
  1.57  18697943   115              years_seeing(pt) = 0;
 71.94  18697943   116              ptUtils(pt,:) = util + randn(1,8) .* utilSD; %sets
  4.14  18697943   117              ptUtils(pt,:) = max(min(ptUtils(pt,:),1),0); %Util
  1.86  18697943   118              utilUnilatBlind(pt) = 1 - ptUtils(pt,STAGE_BLIND)
  1.65  18697943   119              screeningInt(pt) = initScreenInt; % screening inte
                   120                  %NOTE THAT ONCE RETINOPATHY IS DETECTED, THIS
                   121                  %WHICH SHOULD BE STAGE-DEPENDENT
  2.08  18697943   122              lastScreened(pt) = -999; % year that patient was
  1.03  18697943   123          end
                   124  %           if trueStageR == STAGE_DEATH % Don't do calculatio
                   125  %               error('Reached STAGE_DEATH AT TOP OF LOOP')
                   126  %               break
                   127  %           end
 31.91  193792800  128          if (ptAge(pt) > MAXAGE) || (rand() < max(MortByAge(ptA
  0.67   9575639   129              trueStageR(pt) = STAGE_DEATH; % Use stage of both
  1.02   9575639   130              continue % Continue in the for loop to the next pa
                   131          end
 21.10  184217161  132          if (year >= lastScreened(pt) + screeningInt(pt)) && (r
 10.10  144817039  133              resources(year,RESOURCESCREEN) = resources(year,RE
                   134                  % Note that if we have no resources, we go neg
  9.72  144817039  135              if resources(year,RESOURCESCREEN) >= 0 % We have t
                   136  % All of the following is done if patient is screened
  6.92  144817039  137                  lastScreened(pt) = year; % keep track that the
  6.79  144817039  138                  costs = costs + costsPerScreen; % Charge the s
566.47  144817039  139                  examStageR(pt) = randsample8(trueStageR(pt),sc
510.34  144817039  140                  examStageL(pt) = randsample8(trueStageL(pt),sc
 13.13  144817039  141                  canSeeOphth(pt) = true;
 13.07  144817039  142                  if (screenRefer(examStageR(pt)) == 1) || (scre
                   143                      % Note that ophthalmologists don't refer t
  3.36   48766974  144                      resources(year,RESOURCEOPHTH) = resources(
                   145                          % If we have no resources, we go negat
  2.52   48766974  146                      if resources(year,RESOURCEOPHTH) < 0 % We
                   147                          canSeeOphth(pt) = false;
                   148                      end
  2.26   48766974  149                  end
                   150
                   151  % RIGHT EYE
  8.95  144817039  152                  if canSeeOphth(pt)
  9.66  144817039  153                      if (examStageR(pt) == STAGE_PDR) && (hadSc
  0.19    3300468  154                          hadScatterR(pt) = 1; %if p has PDR and
```

```
),true,hadFocalR(pt)); % Change tpm to include scatter
of that pt now cost of scatter treatment
adFocalR(pt) == 0)
 edema in that eye and has not had focal treatment, assign them to it
),hadScatterR(pt),true);% Change tpm to include focal
 % cost of p now includes cost of focal laser treatment


catterL(pt) == 0)
d has not had scatter for that eye, assign them to scatter
),true,hadFocalL(pt)); % Change tpm to include scatter
of that pt now cost of scatter treatment
adFocalL(pt) == 0)
 edema in that eye and has not had focal treatment, assign them to it
),hadScatterL(pt),true);% Change tpm to include focal
 % cost of p now includes cost of focal laser treatment



;
 % Establish best and worst eyes


en there is perceived retinopathy in either eye and not bilaterally blind, screen fixed

ing if bilaterally blindX
 essentailly never screen again (999 years)









n occurs
guring out when patient went blind
pt,trueStageR(pt),:)); % MARKOV!
g out when patient went blind
pt,trueStageL(pt),:)); % MARKOV!
 ~= STAGE_BLIND) % This year patient became blind in R eye
ageL ~= STAGE_BLIND) % This year patient became blind in both eyes

                % This year patient became blind in R eye only



ageL ~= STAGE_BLIND) %This year patient became blind in L eye only
```

basis X

```
 83.84   3300468   155                     tpmR(pt,:,:) = maketpm(ptMorbidity(pt
  0.27   3300468   156                     costs = costs + cost_scatter; % Cost c
  9.00 141516571   157                 elseif (examStageR(pt) == STAGE_ME) && (ha
  0.33   3002933   158                     hadFocalR(pt) = 1; % if p has macular
 76.35   3002933   159                     tpmR(pt,:,:) = maketpm(ptMorbidity(pt
  0.27   3002933   160                     costs = costs + cost_focal + cost_fa;
  0.26   3002933   161                 end
                   162 % LEFT EYE
 10.25 144817039   163                 if (examStageL(pt) == STAGE_PDR) && (hadSc
  0.22   3301103   164                     hadScatterL(pt) = 1; %if p has PDR and
 83.41   3301103   165                     tpmL(pt,:,:) = maketpm(ptMorbidity(pt
  0.31   3301103   166                     costs = costs + cost_scatter; % Cost c
  9.75 141515936   167                 elseif (examStageL(pt) == STAGE_ME) && (ha
  0.18   3001417   168                     hadFocalL(pt) = 1; % if p has macular
 75.56   3001417   169                     tpmL(pt,:,:) = maketpm(ptMorbidity(pt
  0.27   3001417   170                     costs = costs + cost_focal + cost_fa;
  0.23   3001417   171                 end
  6.94 144817039   172             end
                   173
  9.28 144817039   174             worstEye = max(examStageR(pt),examStageL(pt))
  7.97 144817039   175             bestEye = min(examStageR(pt),examStageL(pt));
 11.09 144817039   176             if worstEye > STAGE_HEALTH
  7.65 129142396   177                 if bestEye < STAGE_BLIND
  7.50 129080988   178                     screeningInt(pt) = FUPSCREENINT; % Whe
< 0.01    61408   179                 else
< 0.01    61408   180                     screeningInt(pt) = 999; % Stop screen
                   181                                         %Sets interval to
  5.84 129142396   182                 end
  5.85 129142396   183             end
  6.51 144817039   184         end
  5.97 144817039   185     end
                   186     % Above is performed only if patient is screened
                   187
                   188     % Below is performed every year, even if not screened
                   189     % Next lines are where the progression in the Markov chai
 10.93 184217161   190             prevStageR = trueStageR(pt); % Only needed for fig
901.73 184217161   191             trueStageR(pt) = randsample8(trueStageR(pt),tpmR(p
 11.51 184217161   192             prevStageL = trueStageL(pt); % Needed for figurin
804.78 184217161   193             trueStageL(pt) = randsample8(trueStageL(pt),tpmL(p
 11.38 184217161   194             if (trueStageR(pt) == STAGE_BLIND) && (prevStageR
  0.11   924912   195                 if (trueStageL(pt) == STAGE_BLIND) && (prevSta
< 0.01     5956   196                     nBlind = nBlind + 1;
  0.09   918956   197                 else
  0.06   918956   198                     nUniBlind = nUniBlind + 1;
  0.09   924912   199                 end
 10.13 183292249   200             else
 10.26 183292249   201                 if (trueStageL(pt) == STAGE_BLIND) && (prevSta
```

```
 % Establish stage of true best eye X
; % Establish stage of true worst eye X

 eye, then utility is 0.85 (Clinical Ophthalmology 2014:8 1703?1709)
lUnilatBlind(pt);

%X Keep track of true non-blind years


ye);
ing of the worst eye
s(pt,trueBestEye) + unilatVsBilatBlind * ptUtils(pt,trueWorstEye); % qalys dependent mos
e one year older X



imsize);



MYEARS * resourcesPerYear * simsize / npatients - sum(resources,1)) * 100 ./ (SIMYEARS *

npatients / (simsize * SIMYEARS); nBlind * npatients / (simsize * SIMYEARS)];
```

stly on best eye only

k resourcesPerYear * simsize / npatients));

```
 0.09    919580   202                    nUniBlind = nUniBlind + 1;
 0.08    919580   203                end
 8.76 184217161   204            end
                   205
10.75 184217161   206            trueBestEye = min(trueStageR(pt),trueStageL(pt));
 9.76 184217161   207            trueWorstEye = max(trueStageR(pt),trueStageL(pt))
11.06 184217161   208            if trueBestEye < STAGE_BLIND
 9.65 183857989   209                if trueWorstEye == STAGE_BLIND % If one blind
 1.56  10407102   210                    years_seeing(pt) = years_seeing(pt) + uti
 8.24 173450887   211                 else
13.01 173450887   212                    years_seeing(pt) = years_seeing(pt) + 1; %
 8.68 183857989   213                end
 8.41 183857989   214            end
                   215        %        ptUtil_over_time(pt,year) = ptUtils(pt,trueBestEy
                   216        % Utitity dependent mostly on best eye, but with a weight
20.41 184217161   217            qalys = qalys + (1 - unilatVsBilatBlind) * ptUtils
11.50 184217161   218            ptAge(pt) = ptAge(pt) + 1; % If not deceased, make
11.81 184217161   219        end
                   220
                   221    % Above is done for each patient
                   222    % fprintf('Uni %d Blind %d simsize %d\n',nUniBlind, nBlind, si
 0.01    30000   223    end
                   224    % Above is done for each year
 0.02     1500   225    if any(sum(resources,1) < 0)
                   226        fprintf('Resource utilization %.1f%% %.1f%% %.1f%%\n',(SIM
                   227    end
 0.65     1500   228    costAndQaly = [costs / simsize; qalys / simsize; nUniBlind * r
```

Other subfunctions in this file are not included in this listing.