Group 17-DTMC

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Question:

The Gadgets-R-Us company has a manufacturing setup consisting of two distinct machines, each producing one component per hour. Each component can be tested instantly to be identified as defective or nondefective. Let *a*i be the probability that a component produced by machine *i* is nondefective, *i*= 1, 2. (Obviously 1 - *ai* is the probability that a component produced by machine *i* is defective.) The defective components are discarded and the nondefective components produced by each machine are stored in two separate bins. When a component is present in each bin, the two are instantly assembled together and shipped out. Each bin can hold at most two components. When a bin is full, the corresponding machine is turned off. It is turned on again when the bin has space for at least one component.

1.Model this system by a DTMC.

2.Generate the 15 realization of Chain.

3.Compute limiting distribution.

States Assumed in Solving the problem:

A- Bin 1 and Bin 2 BOTH have 0 components.(State 1)

B- Bin1 has 1 component while Bin2 has 0.(State 2)

C- Bin1 has 0 components while Bin2 has 1.(State 3)

D- Machine 2 is stopped, Bin1 has 0 components while Bin2 has 2.(State 4)

E- Machine 1 is stopped, Bin1 has 2 components while Bin2 has 0.(State 5)

Setting Given probabilities

1. Given a1,a2:

```
a1=0.4;%Change given a1,a2 probabilities here
a2=0.8;
disp('a1 is:')
```

```
a1 is:
```

```
disp(a1)
```

```
    0.4000
```

```
disp('a2 is:')
```

```
a2 is:
```

```
disp(a2)
```

```
    0.8000
```

2.Setting transition Probabilities:

```
p11=a1*a2;
p10=a1*(1-a2);
p01=(1-a1)*a2;
p00=(1-a1)*(1-a2);
p1x=a1;
px1=a2;
p0x=1-a1;
px0=1-a2;
```

3. Transition Matrix:

```
disp('The Transition Matrix(T) is:')
```

```
The Transition Matrix(T) is:
```

```
T=[p00+p11,p10,p01,0,0;p01,p00+p11,0,0,p10;p10,0,p00+p11,p01,0;0,0,p1x,p0x,0;0,px1,0,0,px0];
disp(T)
```

```
    0.4400    0.0800    0.4800         0         0
    0.4800    0.4400         0         0    0.0800
    0.0800         0    0.4400    0.4800         0
         0         0    0.4000    0.6000         0
         0    0.8000         0         0    0.2000
```

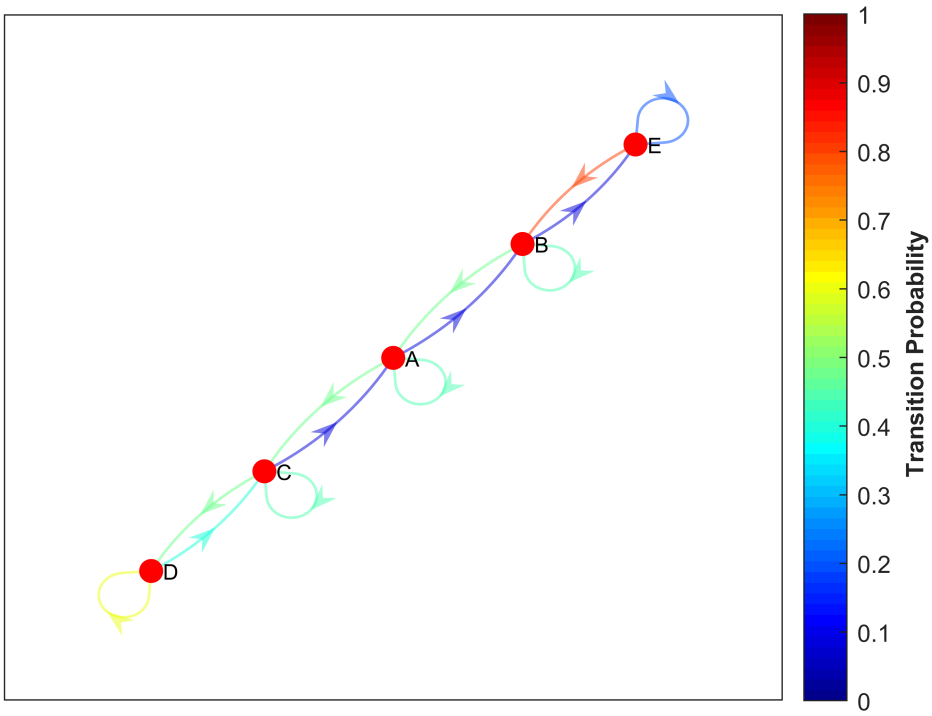
Graphing Markov Chain

```
mc=dtmc(T,'Statenames',["A","B","C","D","E"])
```

```
mc =
  dtmc with properties:

            P: [5×5 double]
    StateNames: ["A"    "B"    "C"    "D"    "E"]
     NumStates: 5
```

```
figure
graphplot(mc,'Coloredges',true)
```



Computing n realizations

```
n=15;%Change n here to change number of realizations
disp('Now generating 15 realizations')
```

```
Now generating 15 realizations
```

```
cA=cumsum(T(1,:));
cB=cumsum(T(2,:));
cC=cumsum(T(3,:));
cD=cumsum(T(4,:));
cE=cumsum(T(5,:));
cT=[cA;cB;cC;cD;cE];
%disp('CDF matrix is:')
%disp(cT)
disp('x is a random number, we assume initial distribution to be uniform.')
```

```
x is a random number, we assume initial distribution to be uniform.
```

```
%Realizations code:
for i=(1:n)
    if i==1
        %Selecting Initial State
        x=rand
        g1=0.2;
        g2=0.4;
```

```
        g3=0.6;
        g4=0.8;
        g5=1;
        if x<g1
            disp('INITIAL STATE SELECTED IS A')
            State=1;
        end
        if x>g1 && x<g2
            disp('INITIAL STATE SELECTED IS B')
            State=2;
        end
        if x>g2 && x<g3
            disp('INITIAL STATE SELECTED IS C')
            State=3;
        end
        if x>g3&& x<g4
            disp('INITIAL STATE SELECTED IS D')
            State=4;
        end
        if x>g4 && x<g5
            disp('INITIAL STATE SELECTED IS E')
            State=5;
        end
        %disp(State)
    else
    %Other Realizations:
         fprintf('%ith Realization:',i)
         x=rand
         g1=cT(State,1);
         g2=cT(State,2);
         g3=cT(State,3);
         g4=cT(State,4);
         g5=cT(State,5);
         if x<g1
            disp('STATE IS A')
            State=1;
        end
        if x>g1 && x<g2
            disp('STATE IS B')
            State=2;
        end
        if x>g2 && x<g3
            disp('STATE IS C')
            State=3;
        end
        if x>g3&& x<g4
            disp('STATE IS D')
            State=4;
        end
        if x>g4 && x<g5
            disp('STATE IS E')
            State=5;
        end
```

```
    end

end
```

```
x = 0.0196
INITIAL STATE SELECTED IS A
2th Realization:
x = 0.3309
STATE IS A
3th Realization:
x = 0.4243
STATE IS A
4th Realization:
x = 0.2703
STATE IS A
5th Realization:
x = 0.1971
STATE IS A
6th Realization:
x = 0.8217
STATE IS C
7th Realization:
x = 0.4299
STATE IS C
8th Realization:
x = 0.8878
STATE IS D
9th Realization:
x = 0.3912
STATE IS C
10th Realization:
x = 0.7691
STATE IS D
11th Realization:
x = 0.3968
STATE IS C
12th Realization:
x = 0.8085
STATE IS D
13th Realization:
x = 0.7551
STATE IS D
14th Realization:
x = 0.3774
STATE IS C
15th Realization:
x = 0.2160
STATE IS C
```

```
fprintf('\n \n')
```

Computing limiting distribution

```
disp('Now Computing limiting distributions of each state.')
```

```
Now Computing limiting distributions of each state.
```

```
K=30; %Variable to calculate approx. upto
I5=eye(5);
fprintf('The columns in the matrix represent the period(n) \nwhereas the Ith row represents the
```

```
The columns in the matrix represent the period(n)
whereas the Ith row represents the Probability that the system is in State I in period n
```

```
s=[1:K;1:K;1:K;1:K;1:K];
for j=(1:5)
    fprintf('Limiting distribution of State %i is',j)
    for i=(1:K)
        s(:,i)=I5(1,:)*(T^(i-1));
    end
    disp(s)
    fprintf('\n \n')
end
```

```
Limiting distribution of State 1 is
  Columns 1 through 12

    1.0000    0.4400    0.2704    0.1866    0.1424    0.1171    0.1015    0.0915    0.0847    0.0801    0.0769    0
         0    0.0800    0.0704    0.0577    0.0459    0.0364    0.0293    0.0241    0.0204    0.0178    0.0160    0
         0    0.4800    0.4224    0.4078    0.4054    0.4069    0.4091    0.4112    0.4129    0.4141    0.4150    0
         0         0    0.2304    0.3410    0.4003    0.4348    0.4562    0.4701    0.4794    0.4858    0.4903    0
         0         0    0.0064    0.0069    0.0060    0.0049    0.0039    0.0031    0.0026    0.0021    0.0019    0

  Columns 13 through 24

    0.0732    0.0721    0.0713    0.0708    0.0704    0.0701    0.0700    0.0698    0.0697    0.0697    0.0696    0
    0.0137    0.0131    0.0126    0.0123    0.0121    0.0120    0.0118    0.0118    0.0117    0.0117    0.0117    0
    0.4161    0.4164    0.4166    0.4168    0.4169    0.4170    0.4170    0.4171    0.4171    0.4171    0.4171    0
    0.4955    0.4970    0.4981    0.4988    0.4994    0.4997    0.5000    0.5002    0.5003    0.5004    0.5004    0
    0.0015    0.0014    0.0013    0.0013    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012    0

  Columns 25 through 30

    0.0696    0.0696    0.0696    0.0695    0.0695    0.0695
    0.0116    0.0116    0.0116    0.0116    0.0116    0.0116
    0.4171    0.4171    0.4171    0.4171    0.4171    0.4171
    0.5005    0.5005    0.5005    0.5006    0.5006    0.5006
    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012


Limiting distribution of State 2 is
  Columns 1 through 12

    1.0000    0.4400    0.2704    0.1866    0.1424    0.1171    0.1015    0.0915    0.0847    0.0801    0.0769    0
         0    0.0800    0.0704    0.0577    0.0459    0.0364    0.0293    0.0241    0.0204    0.0178    0.0160    0
         0    0.4800    0.4224    0.4078    0.4054    0.4069    0.4091    0.4112    0.4129    0.4141    0.4150    0
         0         0    0.2304    0.3410    0.4003    0.4348    0.4562    0.4701    0.4794    0.4858    0.4903    0
         0         0    0.0064    0.0069    0.0060    0.0049    0.0039    0.0031    0.0026    0.0021    0.0019    0
```

```
  Columns 13 through 24

    0.0732    0.0721    0.0713    0.0708    0.0704    0.0701    0.0700    0.0698    0.0697    0.0697    0.0696    0
    0.0137    0.0131    0.0126    0.0123    0.0121    0.0120    0.0118    0.0118    0.0117    0.0117    0.0117    0
    0.4161    0.4164    0.4166    0.4168    0.4169    0.4170    0.4170    0.4171    0.4171    0.4171    0.4171    0
    0.4955    0.4970    0.4981    0.4988    0.4994    0.4997    0.5000    0.5002    0.5003    0.5004    0.5004    0
    0.0015    0.0014    0.0013    0.0013    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012    0

  Columns 25 through 30

    0.0696    0.0696    0.0696    0.0695    0.0695    0.0695
    0.0116    0.0116    0.0116    0.0116    0.0116    0.0116
    0.4171    0.4171    0.4171    0.4171    0.4171    0.4171
    0.5005    0.5005    0.5005    0.5006    0.5006    0.5006
    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012


Limiting distribution of State 3 is
  Columns 1 through 12

    1.0000    0.4400    0.2704    0.1866    0.1424    0.1171    0.1015    0.0915    0.0847    0.0801    0.0769    0
         0    0.0800    0.0704    0.0577    0.0459    0.0364    0.0293    0.0241    0.0204    0.0178    0.0160    0
         0    0.4800    0.4224    0.4078    0.4054    0.4069    0.4091    0.4112    0.4129    0.4141    0.4150    0
         0         0    0.2304    0.3410    0.4003    0.4348    0.4562    0.4701    0.4794    0.4858    0.4903    0
         0         0    0.0064    0.0069    0.0060    0.0049    0.0039    0.0031    0.0026    0.0021    0.0019    0

  Columns 13 through 24

    0.0732    0.0721    0.0713    0.0708    0.0704    0.0701    0.0700    0.0698    0.0697    0.0697    0.0696    0
    0.0137    0.0131    0.0126    0.0123    0.0121    0.0120    0.0118    0.0118    0.0117    0.0117    0.0117    0
    0.4161    0.4164    0.4166    0.4168    0.4169    0.4170    0.4170    0.4171    0.4171    0.4171    0.4171    0
    0.4955    0.4970    0.4981    0.4988    0.4994    0.4997    0.5000    0.5002    0.5003    0.5004    0.5004    0
    0.0015    0.0014    0.0013    0.0013    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012    0

  Columns 25 through 30

    0.0696    0.0696    0.0696    0.0695    0.0695    0.0695
    0.0116    0.0116    0.0116    0.0116    0.0116    0.0116
    0.4171    0.4171    0.4171    0.4171    0.4171    0.4171
    0.5005    0.5005    0.5005    0.5006    0.5006    0.5006
    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012


Limiting distribution of State 4 is
  Columns 1 through 12

    1.0000    0.4400    0.2704    0.1866    0.1424    0.1171    0.1015    0.0915    0.0847    0.0801    0.0769    0
         0    0.0800    0.0704    0.0577    0.0459    0.0364    0.0293    0.0241    0.0204    0.0178    0.0160    0
         0    0.4800    0.4224    0.4078    0.4054    0.4069    0.4091    0.4112    0.4129    0.4141    0.4150    0
         0         0    0.2304    0.3410    0.4003    0.4348    0.4562    0.4701    0.4794    0.4858    0.4903    0
         0         0    0.0064    0.0069    0.0060    0.0049    0.0039    0.0031    0.0026    0.0021    0.0019    0

  Columns 13 through 24

    0.0732    0.0721    0.0713    0.0708    0.0704    0.0701    0.0700    0.0698    0.0697    0.0697    0.0696    0
    0.0137    0.0131    0.0126    0.0123    0.0121    0.0120    0.0118    0.0118    0.0117    0.0117    0.0117    0
    0.4161    0.4164    0.4166    0.4168    0.4169    0.4170    0.4170    0.4171    0.4171    0.4171    0.4171    0
    0.4955    0.4970    0.4981    0.4988    0.4994    0.4997    0.5000    0.5002    0.5003    0.5004    0.5004    0
    0.0015    0.0014    0.0013    0.0013    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012    0

  Columns 25 through 30

    0.0696    0.0696    0.0696    0.0695    0.0695    0.0695
    0.0116    0.0116    0.0116    0.0116    0.0116    0.0116
```

```
    0.4171    0.4171    0.4171    0.4171    0.4171    0.4171
    0.5005    0.5005    0.5005    0.5006    0.5006    0.5006
    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012

Limiting distribution of State 5 is
  Columns 1 through 12

    1.0000    0.4400    0.2704    0.1866    0.1424    0.1171    0.1015    0.0915    0.0847    0.0801    0.0769    0
         0    0.0800    0.0704    0.0577    0.0459    0.0364    0.0293    0.0241    0.0204    0.0178    0.0160    0
         0    0.4800    0.4224    0.4078    0.4054    0.4069    0.4091    0.4112    0.4129    0.4141    0.4150    0
         0         0    0.2304    0.3410    0.4003    0.4348    0.4562    0.4701    0.4794    0.4858    0.4903    0
         0         0    0.0064    0.0069    0.0060    0.0049    0.0039    0.0031    0.0026    0.0021    0.0019    0

  Columns 13 through 24

    0.0732    0.0721    0.0713    0.0708    0.0704    0.0701    0.0700    0.0698    0.0697    0.0697    0.0696    0
    0.0137    0.0131    0.0126    0.0123    0.0121    0.0120    0.0118    0.0118    0.0117    0.0117    0.0117    0
    0.4161    0.4164    0.4166    0.4168    0.4169    0.4170    0.4170    0.4171    0.4171    0.4171    0.4171    0
    0.4955    0.4970    0.4981    0.4988    0.4994    0.4997    0.5000    0.5002    0.5003    0.5004    0.5004    0
    0.0015    0.0014    0.0013    0.0013    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012    0

  Columns 25 through 30

    0.0696    0.0696    0.0696    0.0695    0.0695    0.0695
    0.0116    0.0116    0.0116    0.0116    0.0116    0.0116
    0.4171    0.4171    0.4171    0.4171    0.4171    0.4171
    0.5005    0.5005    0.5005    0.5006    0.5006    0.5006
    0.0012    0.0012    0.0012    0.0012    0.0012    0.0012
```

```
fprintf('We can clearly notice that each row in all the 5 tables \nis converging to a single va
```

```
We can clearly notice that each row in all the 5 tables
is converging to a single value.
 Thus this is the limiting distribution.
```