

research

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Application Areas of DTMCs

Name
Institution

Application area

The Markov chain is a stochastic model describing a sequence of possible events in which the probability of each event depends only on the state attained in the previous event. Considering our cases, the Markov chain is important in study of growth. This can be used in children growth plants and other things that exhibit growth affected by a number of factors. The example 2.9 studies trees growth which is important as trees plays a major role in climate and weather improvements. Considering our current case, the issue of climate change has brought about the need of land reclamation and forest restoration so as to reduce the amount of greenhouse gases emitted and to purify our environment. Modeling trees growth is important in identifying the factors that affect their growth, the stage at which the trees are most prone to be affected and develop ways to control it.

The next model was developed on school dropout by college students. College dropout is a major concern as it's a problem that have persisted over a long period of time leading to numerous ways being developed to reduce it and try to eliminate it. The model studies the likelihood of students dropping out at the different stages of their study. This is important when accompanied by the different factors affecting the students at their different levels of education in order to develop solution to it. This data should be collected classifying the different students depending on their levels and ethnicity.

The Markov chain is also used in marketing in studying customers behavior on different brands of goods in the same category. Different customers react differently where some customers become loyal to one brand while others try different brands and are flexible depending on the satisfaction required. Shop owners use the Markov chain model to studying customers buying pattern so as to determine the brands to stock and also understand their preferences and buying pattern.

Marketing data collection sheet

The brands available for breakfast

- Brand A
- Brand B
- Brand C
- Brand D
- Others

If a customer buys brand A, the next time he is likely to buy which brand?

- Brand A=0.427
- Brand B=0.012
- Brand C=0.085
- Brand D=0.107
- Others=0.177

If a customer buys brand B, the next time he is likely to buy which brand?

- Brand A=0.107
- Brand B=0.588
- Brand C=0.117
- Brand D=0.074
- Others=0.135

If a customer buys brand C, the next time he is likely to buy which brand?

- Brand A=0.100
- Brand B=0.082
- Brand C=0.617
- Brand D=0.123
- Others=0.227

If a customer buys brand D, the next time he is likely to buy which brand?

- Brand A=0.213
- Brand B=0.118
- Brand C=0.085
- Brand D=0.467
- Others=0.149

If a customer buys others, the next time he is likely to buy which brand?

- Brand A= 0.153
- Brand B=0.200
- Brand C=0.096
- Brand D=0.230
- Others=0.312

Data sheet for Growth

The trees growth is measured after every three years.

The trees can be in any of the growth stages which are:

- 0-1 inch
 - 1-3 inch
 - 3-8 inch
 - >8 inch

Assume the following transitional probabilities

If a tree is in stage 0-1 inch the probability of the tree moving to the next stage will be:

0-1inch=0.92

1-3inch=0

3-8 inch=0

>8 inch=0

If a tree is in 1-3-inch stage, the probability of the tree moving to the next stage will be

0-1inch=0

1-3inch=0.97

3-8inch=0

>8inch=0

If a tree is in 3-8inch stage, the probability of the tree moving to the next stage will be

0-1inch=0

1-3inch=0

3-8inch=0.98

>8 inch=0

If a tree is in the >inch stage, the probability of moving to the next stage will be:

0-1inch=0

1-3inch=0

3-8inch=0

>8inch=1

College transition data sheet

The student spends one year in each stage

The student can be in any of the following stages at one time

1-Freshman

2-sophomore

3-junior

4-senior

5- graduation

6-leaving college before graduation

The probability that a student moves from freshman to the next stage

1-Freshman= P_1 & q_1 & r_1

2-sophomore= 0

3-junior=0

4-senior=0

5- graduation=0

6-leaving college before graduation=0

The probability that a student moves from freshman to the next stage

The probability that a student moves from sophomore to the next stage

1-Freshman=0

2-sophomore= P_2 & q_2 & r_2

3-junior=0

4-senior=0

5- graduation=0

6-leaving college before graduation=0

The probability that a student moves from freshman to the next stage

The probability that a student moves from junior to the next stage

1-Freshman=0

2-sophomore= 0

3-junior= P_3 & q_3 & r_3

4-senior=0

5- graduation=0

6-leaving college before graduation=0

The probability that a student moves from freshman to the next stage

The probability that a student moves from senior to the next stage

1-Freshman=0

2-sophomore= 0

3-junior=0

4-senior= P_4 & q_4 & r_4

5- graduation=0

6-leaving college before graduation=0

The probability that a student moves from freshman to the next stage

The probability that a student graduates and move to the next stage

1-Freshman=0

2-sophomor= 0

3-junior=0

4-senior=0

5- graduation=1

6-leaving college before graduation=0

The probability that a student moves from freshman to the next stage

The probability that a student moves to next stage after leaving college before graduation

1-Freshman= P_1 & q_1

2-sophomor= 0

3-junior=0

4-senior=0

5- graduation=0

6-leaving college before graduation=1

The probability that a student moves from freshman to the next stage

Section 3 data description

The data to be recorded for Markov chain model matrix is the probability of an outcome as explained by Ching, Fung & Ng, (2004). In each study different outcomes were expected where the results for the outcome were only determined by most recent experiences while past factors have no impact. Considering the data for market brands. The four brands of cereals used were brand A, brand B, brand C, brand D and others. The probability of buying each cereal again after buying for the first time for a population was studied and the probability obtained as given in the data sheet.

The data for college student involved chances of a student moving from one study stage to the other. The other options if the student did not advance to the other stage was dropping out or repeating. The terminal stage was graduation or dropping out. The probability for the population was obtained covering each stage of study from freshman, to sophomore to junior, senior and then graduation as shown in the data sheet.

The data for growth considered growth in tree diameter which was collected after three years. The probability of diameter of a tree in a population to change from one stage to the other was obtained and recorded as in the data sheet.

Section 4 constructing transitional matrix

The brand marketing data transitional matrix

The data shows the probability of a customer buying the same brand of cereal again.

0.427	0.107	0.100	0.213	0.153
0.012	0.588	0.082	0.118	0.200
0.085	0.117	0.617	0.085	0.096
0.107	0.074	0.123	0.467	0.230
0.177	0.135	0.227	0.149	0.312

The college student transitional matrix

P_0 represents the probability of repeating a grade j , q_0 represent the probability of advancing to the next grade while r_0 is the probability of dropping out from grade j .

The freshman year can only dropout or repeat in that year.

The sophomore can repeat the year, advance to the next year or drop out which will apply to student in junior.

Student in senior can repeat the grade, advance to graduation or drop out.

Student at graduation can only graduate while student at dropping out can only drop out.

As represented in the transitional matrix.

$$\begin{array}{cccccc}
 P_1 & q_1 & 0 & 0 & 0 & r_1 \\
 0 & P_2 & q_2 & 0 & 0 & r_2 \\
 0 & 0 & P_3 & q_3 & 0 & r_3 \\
 0 & 0 & 0 & P_4 & q_4 & r_4 \\
 0 & 0 & 0 & 0 & 1 & 0 \\
 0 & 0 & 0 & 0 & 0 & 1
 \end{array}$$

The matrix has two absorbing states representing termination of the processes flow which are graduation or drop out.

The growth transitional matrix

The matrix represents the probability of a tree moving from one stage of growth to the other of tree trunk diameter. Change in diameter shows growth of the tree where changes can only occur by the diameter increasing or remaining constant.

To terminate the process 1 is used when the diameter is above 8 inches

$$\begin{array}{cccc}
 0.92 & 0 & 0 & 0 \\
 0 & 0.97 & 0.03 & 0 \\
 0 & 0 & 0.98 & 0.01 \\
 0 & 0 & 0 & 1
 \end{array}$$

References

Ching, W. K., Fung, E. S., & Ng, M. K. (2004). Higher-order Markov chain models for categorical data sequences. *Naval Research Logistics (NRL)*, 51(4), 557-574.