

Record	Study Hours	Attendance	Preparation	Passed Exam
1	High	High	Good	Yes
2	High	High	Average	Yes
3	Medium	High	Good	Yes
4	Low	High	Good	Yes
5	Low	Low	Poor	No
6	Medium	Low	Average	No
7	Medium	Low	Poor	No
8	Low	High	Average	No
9	High	Low	Good	Yes
10	High	Low	Poor	No
11	Medium	High	Average	Yes
12	Medium	High	Poor	No
13	Low	High	Poor	No
14	High	High	Poor	No
15	High	Low	Average	Yes

training

test

$$P(\text{Passed Exam} = \text{Yes}) = \frac{6}{12} = 0.5$$

$$P(\text{Passed Exam} = \text{No}) = \frac{6}{12} = 0.5$$

(1)

k)

$$P(\text{Study Hours} = \text{High}) = \frac{4+1}{12+3} = \frac{1}{3}$$

$$P(\text{High} | \text{Passed Exam} = \text{Yes}) = \frac{3+1}{6+3} = \frac{4}{9}$$

$$P(\text{High} | \text{Passed Exam} = \text{No}) = \frac{1+1}{9} = \frac{2}{9}$$

Laplacian estimate

$$\frac{hc + 1}{h + K}$$

$$P(\text{Study Hours} = \text{Medium}) = \frac{5+1}{12+3} = \frac{6}{15}$$

$$P(\text{Medium} | \text{Passed Exam} = \text{Yes}) = \frac{2+1}{6+3} = \frac{3}{9} = \frac{1}{3}$$

$$P(\text{Medium} | \text{Passed Exam} = \text{No}) = \frac{3+1}{6+3} = \frac{4}{9}$$

$$P(\text{Study Hours} = \text{Low}) = \frac{3+1}{12+3} = \frac{4}{15}$$

$$P(\text{Low} | \text{Passed Exam} = \text{Yes}) = \frac{1+1}{6+3} = \frac{2}{9}$$

$$P(\text{Low} | \text{Passed Exam} = \text{No}) = \frac{2+1}{6+3} = \frac{3}{9} = \frac{1}{3}$$

$$P(\text{Attendance} = \text{High}) = \frac{7+1}{12+2} = \frac{8}{14} = \frac{4}{7}$$

$$P(\text{High} | \text{Passed Exam} = \text{Yes}) = \frac{5+1}{6+2} = \frac{6}{8} = \frac{3}{4}$$

$$P(\text{High} | \text{Passed Exam} = \text{No}) = \frac{2+1}{6+2} = \frac{3}{8}$$

$$P(\text{Attendance} = \text{Low}) = \frac{5+1}{12+2} = \frac{6}{14} = \frac{3}{7}$$

$$P(\text{Low} | \text{Passed Exam} = \text{Yes}) = \frac{1+1}{6+2} = \frac{1}{4}$$

$$P(\text{Low} | \text{Passed Exam} = \text{No}) = \frac{4+1}{6+2} = \frac{5}{8}$$

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$$K) P(\text{Preparation} = \text{Good}) = \frac{4+7}{12+3} = \frac{5}{15} = \frac{1}{3}$$

$$P(\text{Good} | \text{Passed Exam} = \text{Yes}) = \frac{4+1}{6+3} = \frac{5}{9}$$

$$P(\text{Good} | \text{Passed Exam} = \text{No}) = \frac{0+1}{6+3} = \frac{1}{9}$$

$$P(\text{Preparation} = \text{Average}) = \frac{4+1}{12+3} = \frac{1}{3}$$

$$P(\text{Average} | \text{Passed Exam} = \text{Yes}) = \frac{2+1}{6+3} = \frac{1}{3}$$

$$P(\text{Average} | \text{Passed Exam} = \text{No}) = \frac{2+1}{6+3} = \frac{1}{3}$$

$$P(\text{Preparation} = \text{Poor}) = \frac{4+1}{12+3} = \frac{5}{15} = \frac{1}{3}$$

$$P(\text{Poor} | \text{Passed Exam} = \text{Yes}) = \frac{0+1}{6+3} = \frac{1}{9}$$

$$P(\text{Poor} | \text{Passed Exam} = \text{No}) = \frac{4+1}{6+3} = \frac{5}{9}$$

(3)

2) Record 13: $P(X|C_i) =$

Study Hours = Low

Attendance = High

Preparation = Poor

$$P(X \mid \text{Passed Exam} = \text{Yes}) = \frac{2}{9} \cdot \frac{3}{4} \cdot \frac{1}{9} = 0.0185$$

$$P(X \mid \text{Passed Exam} = \text{No}) = \frac{3}{9} \cdot \frac{3}{8} \cdot \frac{5}{9} = 0.0694$$

$$P(X|C_i) \cdot P(C_i) =$$

$$P(X \mid \text{Passed Exam} = \text{Yes}) \cdot P(\text{Passed Exam} = \text{Yes}) = 0.0185 \cdot 0.5 = 0.0092$$

$$P(X \mid \text{Passed Exam} = \text{No}) \cdot P(\text{Passed Exam} = \text{No}) = 0.0694 \cdot 0.5 = \underline{0.0347}$$

Passed Exam = No \Rightarrow מבחן 13 כוונתית 0.0347

Record 14: $P(X|C_i) =$

Study Hours = High

Attendance = High

Preparation = Poor

$$P(X \mid \text{Passed Exam} = \text{Yes}) = \frac{4}{9} \cdot \frac{3}{4} \cdot \frac{1}{9} = 0.037$$

$$P(X \mid \text{Passed Exam} = \text{No}) = \frac{2}{9} \cdot \frac{3}{8} \cdot \frac{5}{9} = 0.0462$$

$$P(X|C_i) \cdot P(C_i) =$$

$$P(X \mid \text{Passed Exam} = \text{Yes}) \cdot P(\text{Passed Exam} = \text{Yes}) = 0.037 \cdot 0.5 = 0.0185$$

$$P(X \mid \text{Passed Exam} = \text{No}) \cdot P(\text{Passed Exam} = \text{No}) = 0.0462 \cdot 0.5 = \underline{0.0231}$$

(מבחן 14) Passed Exam = No כוונתית Record 14 כוונתית 0.0231

2) Record 15: $P(X|C_i) =$

Study Hours = High

Attendance = Low

Preparation = Average

$$P(X \mid \text{Passed Exam} = \text{Yes}) = \frac{4}{9} \cdot \frac{1}{4} \cdot \frac{1}{3} = 0.037$$

$$P(X \mid \text{Passed Exam} = \text{No}) = \frac{2}{9} \cdot \frac{5}{8} \cdot \frac{1}{3} = 0.0462$$

$$P(X|C_i) \cdot P(C_i) =$$

$$P(X \mid \text{Passed Exam} = \text{Yes}) \cdot P(\text{Passed Exam} = \text{Yes}) = 0.037 \cdot 0.5 = 0.0185$$

$$P(X \mid \text{Passed Exam} = \text{No}) \cdot P(\text{Passed Exam} = \text{No}) = 0.0462 \cdot 0.5 = 0.0231$$

(Passed Exam = No) הולך וגדל record 15 (NON) מ-15% ל-

. הולך וגדל test set מ-~~הולך וגדל~~ מ-15% ל-66.66%

מ-15% ל-66.66% סinx (ב-3 מילון נס) מ-1 ל-66.66%

הוירוג: 66.66%

(5)

$$\text{d) m-estimate } \frac{h_0 + m \cdot p}{h + m}, m = 3$$

$$P(\text{Study Hours} = \text{High}) = \frac{4 + 3 \cdot \frac{1}{3}}{12 + 3} = \frac{4 + 1}{15} = \frac{5}{15} = \frac{1}{3}$$

$$P(\text{High} | \text{Passed Exam} = \text{Yes}) = \frac{3 + \frac{1}{3} \cdot 3}{6 + 3} = \frac{4}{9}$$

$$P(\text{High} | \text{Passed Exam} = \text{No}) = \frac{1 + \frac{1}{3} \cdot 3}{6 + 3} = \frac{2}{9}$$

$$P(\text{Study Hours} = \text{Medium}) = \frac{5 + \frac{1}{3} \cdot 3}{12 + 3} = \frac{5 + 1}{15} = \frac{6}{15}$$

$$P(\text{Medium} | \text{Passed Exam} = \text{Yes}) = \frac{2 + \frac{1}{3} \cdot 3}{6 + 3} = \frac{2 + 1}{9} = \frac{1}{3}$$

$$P(\text{Medium} | \text{Passed Exam} = \text{No}) = \frac{3 + 1}{6 + 3} = \frac{4}{9}$$

$$P(\text{Study Hours} = \text{Low}) = \frac{3 + \frac{1}{3} \cdot 3}{12 + 3} = \frac{3 + 1}{15} = \frac{4}{15}$$

$$P(\text{Low} | \text{Passed Exam} = \text{Yes}) = \frac{1 + \frac{1}{3} \cdot 3}{6 + 3} = \frac{1 + 1}{9} = \frac{2}{9}$$

$$P(\text{Low} | \text{Passed Exam} = \text{No}) = \frac{2 + \frac{1}{3} \cdot 3}{6 + 3} = \frac{2 + 1}{9} = \frac{1}{3}$$

$$P(\text{Attendance} = \text{High}) = \frac{7 + \frac{1}{2} \cdot 3}{12 + 3} = \frac{7 + 1.5}{15} = \frac{8.5}{15}$$

$$P(\text{High} | \text{Passed Exam} = \text{Yes}) = \frac{5 + 3 \cdot \frac{1}{2}}{6 + 3} = \frac{5 + 1.5}{9} = \frac{13}{18}$$

$$P(\text{High} | \text{Passed Exam} = \text{No}) = \frac{2 + 3 \cdot \frac{1}{2}}{6 + 3} = \frac{2 + 1.5}{9} = \frac{7}{18}$$

$$P(\text{Attendance} = \text{Low}) = \frac{5 + \frac{1}{2} \cdot 3}{12 + 3} = \frac{5 + 1.5}{15} = \frac{6.5}{15}$$

$$P(\text{Low} | \text{Passed Exam} = \text{Yes}) = \frac{1 + 3 \cdot \frac{1}{2}}{6 + 3} = \frac{1 + 1.5}{9} = \frac{5}{18}$$

$$P(\text{Low} | \text{Passed Exam} = \text{No}) = \frac{4 + \frac{1}{2} \cdot 3}{6 + 3} = \frac{4 + 1.5}{9} = \frac{11}{18}$$

d)

$$P(\text{Preparation} = \text{Good}) = \frac{4 + 3 \cdot \frac{1}{3}}{12+3} = \frac{4+1}{15} = \frac{5}{15} = \frac{1}{3}$$

$$P(\text{Good} | \text{Passed Exam} = \text{Yes}) = \frac{4 + 3 \cdot \frac{1}{3}}{6+3} = \frac{4+1}{9} = \frac{5}{9}$$

$$P(\text{Good} | \text{Passed Exam} = \text{No}) = \frac{0 + 3 \cdot \frac{1}{3}}{6+3} = \frac{1}{9}$$

$$P(\text{Preparation} = \text{Average}) = \frac{4 + \frac{1}{3} \cdot 3}{12+3} = \frac{4+1}{15} = \frac{1}{3}$$

$$P(\text{Average} | \text{Passed Exam} = \text{Yes}) = \frac{2 + \frac{1}{3} \cdot 3}{6+3} = \frac{2+1}{9} = \frac{1}{3}$$

$$P(\text{Average} | \text{Passed Exam} = \text{No}) = \frac{2 + \frac{1}{3} \cdot 3}{3+6} = \frac{1}{3}$$

$$P(\text{Preparation} = \text{Poor}) = \frac{4 + \frac{1}{3} \cdot 3}{12+3} = \frac{4+1}{15} = \frac{1}{3}$$

$$P(\text{Poor} | \text{Passed Exam} = \text{Yes}) = \frac{0 + \frac{1}{3} \cdot 3}{6+3} = \frac{1}{9}$$

$$P(\text{Poor} | \text{Passed Exam} = \text{No}) = \frac{4 + \frac{1}{3} \cdot 3}{6+3} = \frac{5}{9}$$

3) Record 13: $P(X|C_i) =$

StudyHours = Low

Attendance = High

Preparation = Poor

$$P(X | \text{Passed Exam} = \text{Yes}) = \frac{2}{9} \cdot \frac{13}{18} \cdot \frac{7}{9} = 0.0178$$

$$P(X | \text{Passed Exam} = \text{No}) = \frac{1}{9} \cdot \frac{7}{18} \cdot \frac{5}{9} = 0.072$$

$$P(X | C_i) \cdot P(C_i) =$$

$$P(X | \text{Passed Exam} = \text{Yes}) \cdot P(\text{Passed Exam} = \text{Yes}) = 0.0178 \cdot 0.5 = 0.0089$$

$$P(X | \text{Passed Exam} = \text{No}) \cdot P(\text{Passed Exam} = \text{No}) = \underline{0.036}$$

(Passed Exam = No) ה蕪 נא אַתְּ חַדְשָׁה יְמִינָה 13 יְמִינָה כְּלֹנִי יְמִינָה סְבִיבָה

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3) Record 14: $P(X|C_i) =$

Study Hours = High

Attendance = High

Preparation = Poor

$$P(X|\text{Passed Exam}=\text{Yes}) = \frac{4}{9} \cdot \frac{13}{18} \cdot \frac{1}{9} = 0.0356$$

$$P(X|\text{Passed Exam}=\text{No}) = \frac{2}{9} \cdot \frac{7}{18} \cdot \frac{5}{9} = 0.048$$

$$P(X|C_i) \cdot P(C_i)$$

$$P(X|\text{Passed Exam}=\text{Yes}) \cdot P(\text{Passed Exam}=\text{Yes}) = 0.0356 \cdot 0.5 = 0.0178$$

$$P(X|\text{Passed Exam}=\text{No}) \cdot P(\text{Passed Exam}=\text{No}) = 0.048 \cdot 0.5 = 0.024$$

(Passed Exam = No) מזוזה 14 בונד כוונת ה. נ. י. ב. ו.

Record 15: $P(X|C_i) =$

Study Hours = High

Attendance = Low

Preparation = Average

$$P(X|\text{Passed Exam}=\text{Yes}) = \frac{4}{9} \cdot \frac{5}{18} \cdot \frac{1}{3} = 0.0411$$

$$P(X|\text{Passed Exam}=\text{No}) = \frac{2}{9} \cdot \frac{17}{18} \cdot \frac{1}{3} = 0.0452$$

$$P(X|C_i) \cdot P(C_i) =$$

$$P(X|\text{Passed Exam}=\text{Yes}) \cdot P(\text{Passed Exam}=\text{Yes}) = 0.0411 \cdot 0.5 = 0.0205$$

$$P(X|\text{Passed Exam}=\text{No}) \cdot P(\text{Passed Exam}=\text{No}) = 0.0452 = 0.0226$$

(Passed Exam = No) מזוזה 15 בונד כוונת ה. נ. י. ב. ו.

מזהה 15 בונד כוונת ה. נ. י. ב. ו. מזוזה 14 בונד כוונת ה. נ. י. ב. ו.

כפיה (בונד כוונת ה. נ. י. ב. ו. מזוזה 14 בונד כוונת ה. נ. י. ב. ו.)

כ. ג. ו. ו. 66.66 %.

(8)