MATH-505A: Homework # 2

Due on Friday, September 4, 2014

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Contents

Exercise # 1.5

(1)

Given: A, B are independent
To Prove: A^C, B; A^C, B^C are independent

Since A, B are independent:

$$P(A \cap B) = P(A)(B) \tag{1}$$

Thus,

$$P(A \cap B) = (1 - P(A^C))P(B) = P(B) - P(B)P(A^C) \tag{2}$$

Rearranging 2:

$$P(B)P(A^C) = P(B) - P(A \cap B) \tag{3}$$

$$P(B) - P(A \cap B) = P(A^C \cap B) = P(A^C)P(B) \tag{4}$$

From 3 and 4 : $A^C.B$ are independent.
Similiary to prove A^C, B^C are independent, we perform substitute B^C in $P(B \cap A^C)$

(2)

$A_{ij} = i^{th}$ and j^{th} rolls produce the same number For any $i \neq j$, total outcome are $6*6 = 36$ and facourable outcomes are $\binom{6}{1} * 1 = 6$, thus $p(A_{ij}) = \frac{6}{36} = \frac{1}{6}$
Consider $P(A_{ij} \cap A_{kj})$, such that $i \neq j \neq k$, then :
$P(A_{ij} \cap A_{kj}) = \frac{\binom{6}{1}*1*1}{6*6*6} = \frac{1}{36} = P(A_{ij})P(A_{kj})$
Thu, A_{ij} are pairwise independent.
Consider:
$P(A_ij \cap A_jk \cap A_kl) = \frac{\binom{6}{1}*1*1*1}{6*6*6} = \frac{1}{36} \neq P(A_{ij})P(A_{jk})P(A_{kl})$
Since $P(A_ij \cap A_jk \cap A_kl) \neq P(A_{ij})P(A_{jk})$, it will not be true in general consider other A_{lm}.

(3)

(4)

Given: $\omega = \{1, 2, 3, ...p\}$ where p is prime. F is set of all subsets of ω; $P(A) = \frac{|A|}{p}$ **To Prove:** A 'or' B is a null set or is the set *omega*
$P(A) = \frac{|A|}{p}$
$P(B) = \frac{|B|}{p}$
Now, by definition:

$$P(A \cap B) = \frac{|A \cap B|}{p} \tag{5}$$

Since A, B are independent:

$$P(A \cap B) = P(A)P(B) = \frac{|A \cap B|}{p} = \frac{|A|}{p}\frac{|B|}{p} \tag{6}$$

Thus:

$$p|A \cap B| = |A||B| \implies |A||B| \; mod p = 0 \tag{7}$$

and $0 \leq |A|, |B| \leq p \implies |A| or |B| = pOR|A|, |B| = 0 \implies$ A,B are either null or full sets.

(5)

(6)

(7)

$A = \{$all children of same sex $\}$
$B = \{$ there is at most one boy $\}$
$C = \{$ one boy and one girl included $\}$

$P(A) = P($ all boys $) + P($all girls$) = \frac{1}{2} * \frac{1}{2} * \frac{1}{2} * 2 = \frac{1}{4}$

$P(B) = P($ 0 boys $) + P(+1 boy) = \frac{1}{8} + 3 * \frac{1}{8} = \frac{1}{2}$

$P(C) = P(1$ boy + 1 girl $) = 2 * \frac{1}{2} *] frac12 * \frac{1}{2} * 3 = \frac{3}{4}$

Part a): A is independent of B and B is independent of C
$P(A \cap B) =$ all chidren are of same sex AND there is at most one boy $\implies$ all children are boys
$\implies P(A \cap B) = \frac{1}{2} * \frac{1}{2} * \frac{1}{2} = \frac{1}{8} = P(A) * P(B)$.
Hence A,B are independent

$P(B \cap C) =$ there is at most one boy AND there is one boy and a girl $\implies$ there is one boy and two girls.
$P(B \cap C) = \frac{1}{2} * \frac{1}{2} * \frac{1}{2} * 3 = \frac{3}{8} = P(B) * P(C)$
Hence B,C are independent

Part b): Is A independednt of C?
$P(A \cap C) =$ the family includes boy and girl AND all children are of same sex

Clearky $P(A \cap B) = \phi$ and hence A,B are not necessarily independent!
Part c): Do the results hold if boys and girls are not equally likely?
NO. Since
Part d): Do these results hold if there are 4 children?
Yes, the calculaions are independent of the number of children since independence relations are not dependent on the number.