Probability
Extra Practice

1

Ch05, Q3

- Among women voluntarily tested for sexually transmitted diseases in one university, 24% tested positive for human papilloma virus (HPV) only, 2% tested positive for *Chlamydia* only, and 4% tested positive for both HPV and *Chlamydia* (Tábora et al. 2005). Use the following steps to calculate the probability that a woman from this population who gets tested would test positive for either HPV or *Chlamydia*.

Pr[HPV or C] = Pr[HPV] + Pr[C] – Pr[HPV and C]

Pr[HPV] = 0.24 + 0.04 = 0.28 Pr[C] = 0.02 + 0.04 = 0.06 0.04

Pr[HPV or C] = 0.28 + 0.06 – 0.04 = 0.30

2

Ch05, Q4a

- 1980s Canada
  - 52% adult men smoke
  - Smoker's probability of lung cancer = 17.2%
  - Non-smoker's probability of lung cancer = 1.3%
- A) What is conditional probability of man getting cancer, given that he smoked?

$$\Pr[cancer|smoker] = 0.172$$

3

Ch05, Q4d

- 1980s Canada
  - 52% adult men smoke
  - Smoker's probability of lung cancer = 17.2%
  - Non-smoker's probability of lung cancer = 1.3%
- D) Using general probability rule, calculate the probability that a man both smoked and eventually contracted lung cancer?

$$\Pr[A\ and\ B] = \Pr[A]\Pr[B|A]$$

$$\Pr[smoker\ and\ cancer] = \Pr[smoker]\Pr[cancer|smoking]$$
$$\Pr[smoker\ and\ cancer] = \Pr[0.52]\Pr[0.172] = 0.08944$$

4

Ch05, Q4e

- 1980s Canada
  - 52% adult men smoke
  - Smoker's probability of lung cancer = 17.2%
  - Non-smoker's probability of lung cancer = 1.3%
- E) Using general probability rule, calculate the probability that a man both did not smoke and never contracted lung cancer?

$$\Pr[A \text{ } and \text{ } B] = \Pr[A] \Pr[B|A]$$

$$\Pr[nonsmoker \text{ } and \text{ } no \text{ } cancer] = \Pr[nonsmoker] \Pr[no \text{ } cancer|nonsmoking]$$

$$\Pr[nonsmoker \text{ } and \text{ } no \text{ } cancer] = (1 - 0.52)(1 - 0.013) = 0.47376$$

5

Ch05, Q10a

- The gene *Prdm9* is thought to regulate hotspots of recombination (crossing over) in mammals, including humans. In the people of Han Chinese descent living in the Los Angeles area there are five alleles at the Prdm9 gene, labeled A1, A2, A3, A4, and A5. The relative frequencies with which these alleles occur in that population are 0.06, 0.03, 0.84, 0.03, and 0.04, respectively. Assume that in this population, the two alleles present in any individual are independently sampled from the population as a whole.
- A) What is the probability that a single allele chosen at random from this population is either A1 or A4?
- Pr[A1 or A4] = Pr[A1] + Pr[A4] – Pr[A1 and A4]
  = 0.06 + 0.03 + 0
  = 0.09

6

Ch05, Q10b

- The gene *Prdm9* is thought to regulate hotspots of recombination (crossing over) in mammals, including humans. In the people of Han Chinese descent living in the Los Angeles area there are five alleles at the Prdm9 gene, labeled A1, A2, A3, A4, and A5. The relative frequencies with which these alleles occur in that population are 0.06, 0.03, 0.84, 0.03, and 0.04, respectively. Assume that in this population, the two alleles present in any individual are independently sampled from the population as a whole.
- B) What is the probability that an individual has two A1 alleles (i.e., what is the probability that its first allele is A1 and its second allele is also A1)?
- Pr[A1 and A1] = Pr[A1] * Pr[A1]
  = 0.06 * 0.06 = 0.0036

7

Ch05, Q10d

- The gene *Prdm9* is thought to regulate hotspots of recombination (crossing over) in mammals, including humans. In the people of Han Chinese descent living in the Los Angeles area there are five alleles at the Prdm9 gene, labeled A1, A2, A3, A4, and A5. The relative frequencies with which these alleles occur in that population are 0.06, 0.03, 0.84, 0.03, and 0.04, respectively. Assume that in this population, the two alleles present in any individual are independently sampled from the population as a whole.
- D) What is the probability that an individual is not A1A1?
- From question B) Pr[A1 and A1] = 0.0036
- Pr[not A1A1] = 1 – Pr[A1 and A1] = 1 – 0.0036 = 0.9964

8

Ch05, Q10e

- The gene *Prdm9* is thought to regulate hotspots of recombination (crossing over) in mammals, including humans. In the people of Han Chinese descent living in the Los Angeles area there are five alleles at the Prdm9 gene, labeled A1, A2, A3, A4, and A5. The relative frequencies with which these alleles occur in that population are 0.06, 0.03, 0.84, 0.03, and 0.04, respectively. Assume that in this population, the two alleles present in any individual are independently sampled from the population as a whole.
- E) What is the probability, if you drew two individuals at random from this population, that neither of them would have an A1A1 genotype?
- From question D) Pr[not A1A1] = 0.9964
- Pr[ind1 not A1A1 AND ind2 not A1A1] = 0.9964 * 0.9964 = 0.992813

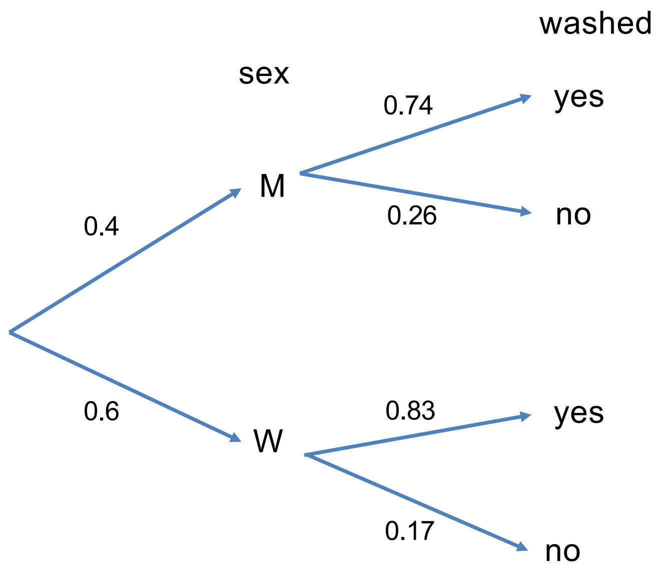
9

Ch05, Q17

- Studies have shown that the probability that a man washes his hands after using the restroom at an airport is 0.74, and the probability that a woman washes hers is 0.83 (American Society for Microbiology 2005). A waiting room in an airport contains 40 men and 60 women. Assume that individual men and women are equally likely to use the restroom. What is the probability that the next individual who goes to the restroom will wash his or her hands? Try to solve without doing a probability tree…
- Pr[next person washes] = Pr[man]*Pr[washes|man] + Pr[woman]*Pr[washes|woman]
- = (40/100)*0.74 + (60/100)*0.83
- = 0.794

10

Ch05, Q17



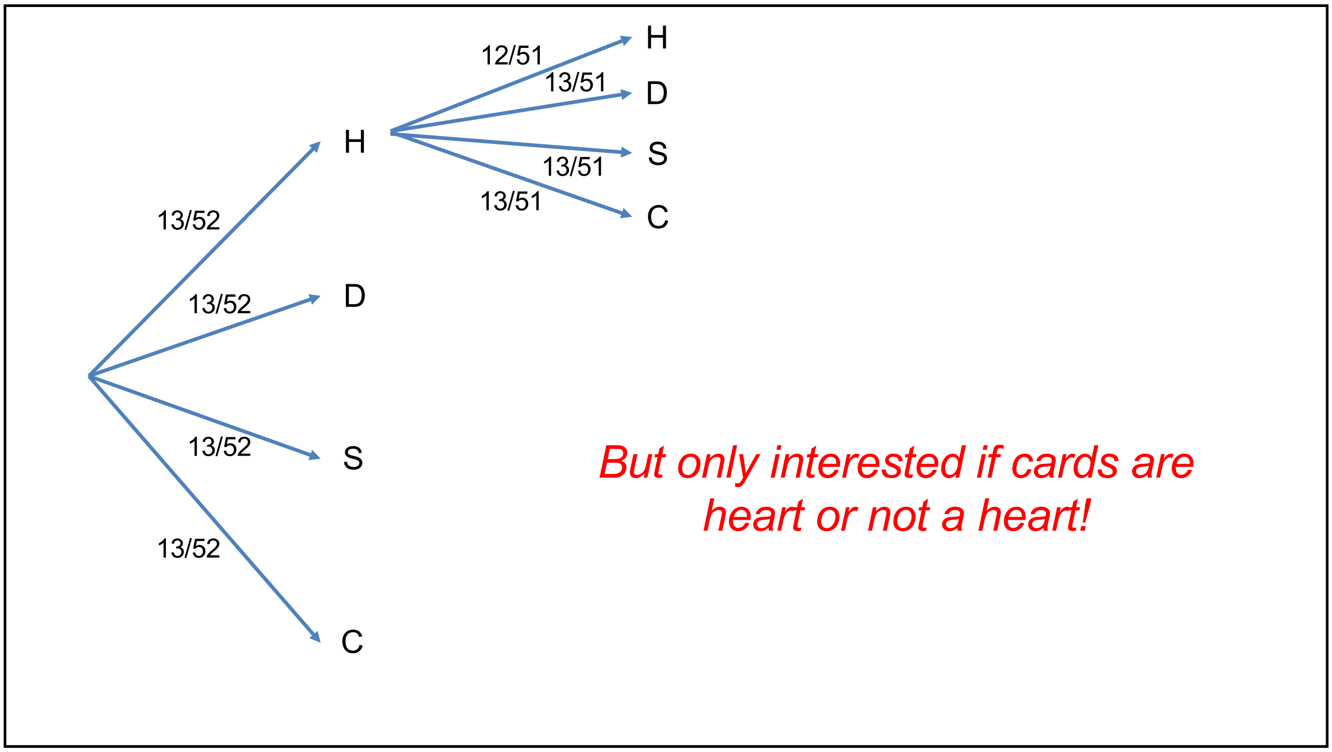
0.4 * 0.74 = 0.296

0.6 * 0.83 = 0.498

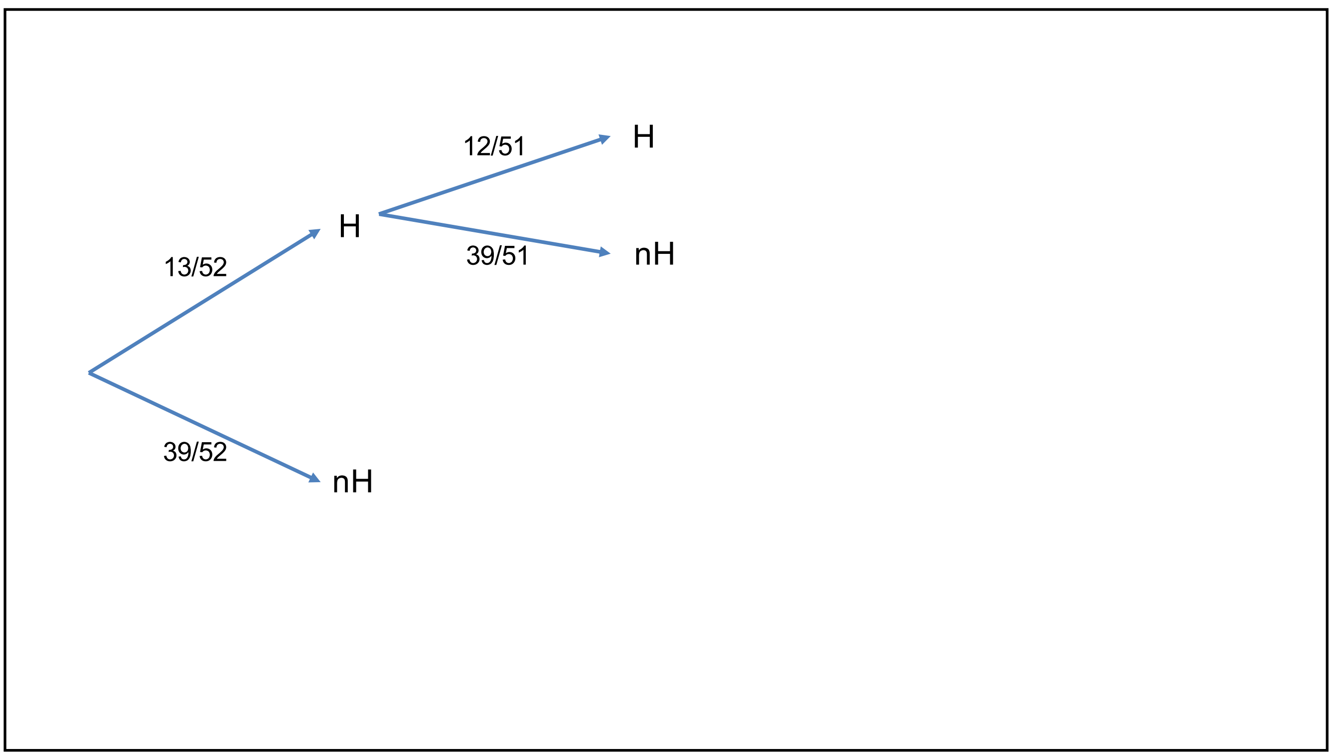
0.296 + 0.498 = 0.794

Playing cards

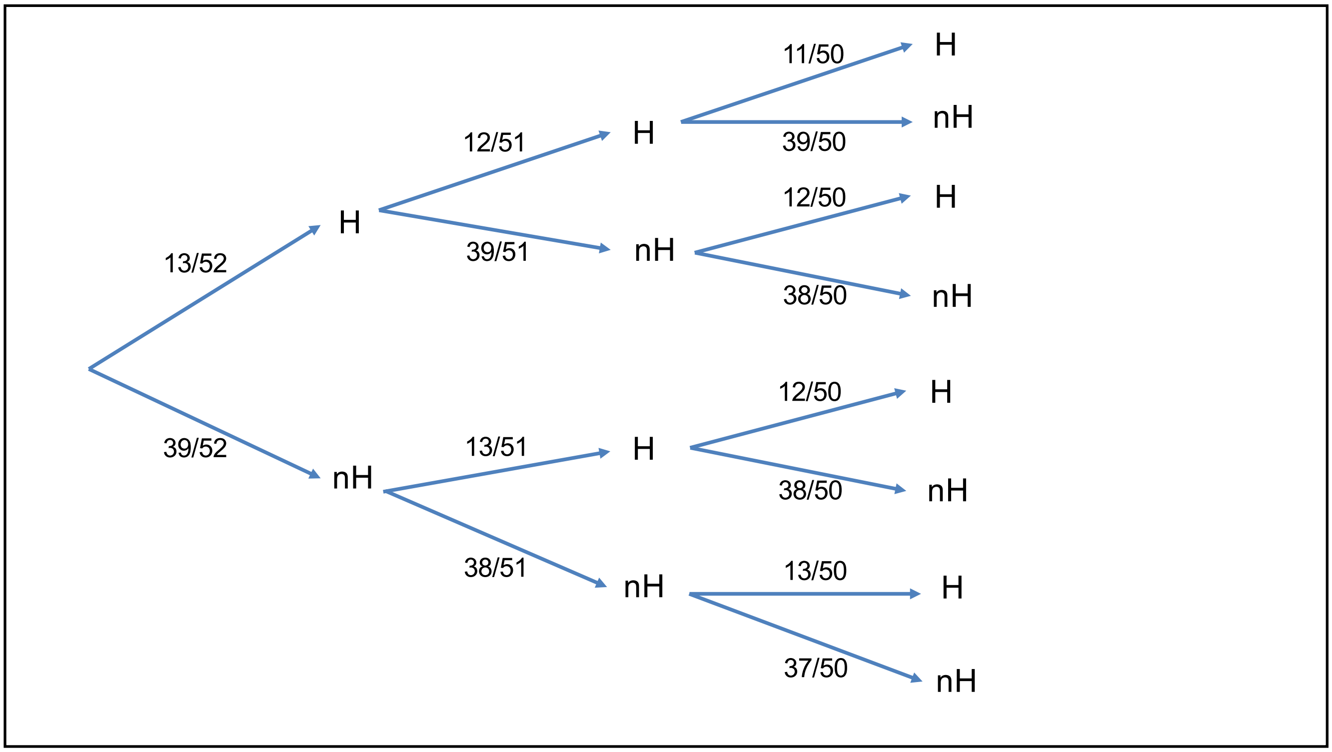
- Standard deck has 52 cards
  - 13 of each suit (diamonds, hearts, spades, clovers)
- I deal you three cards. What is the probability that you have one, and only one, heart in your hand?
- Draw a probability tree for this question…


12/51
H
13/51
D
H
S
13/51
13/51
C
13/52
D
13/52
13/52
S
13/52
C
But only interested if cards are heart or not a heart!

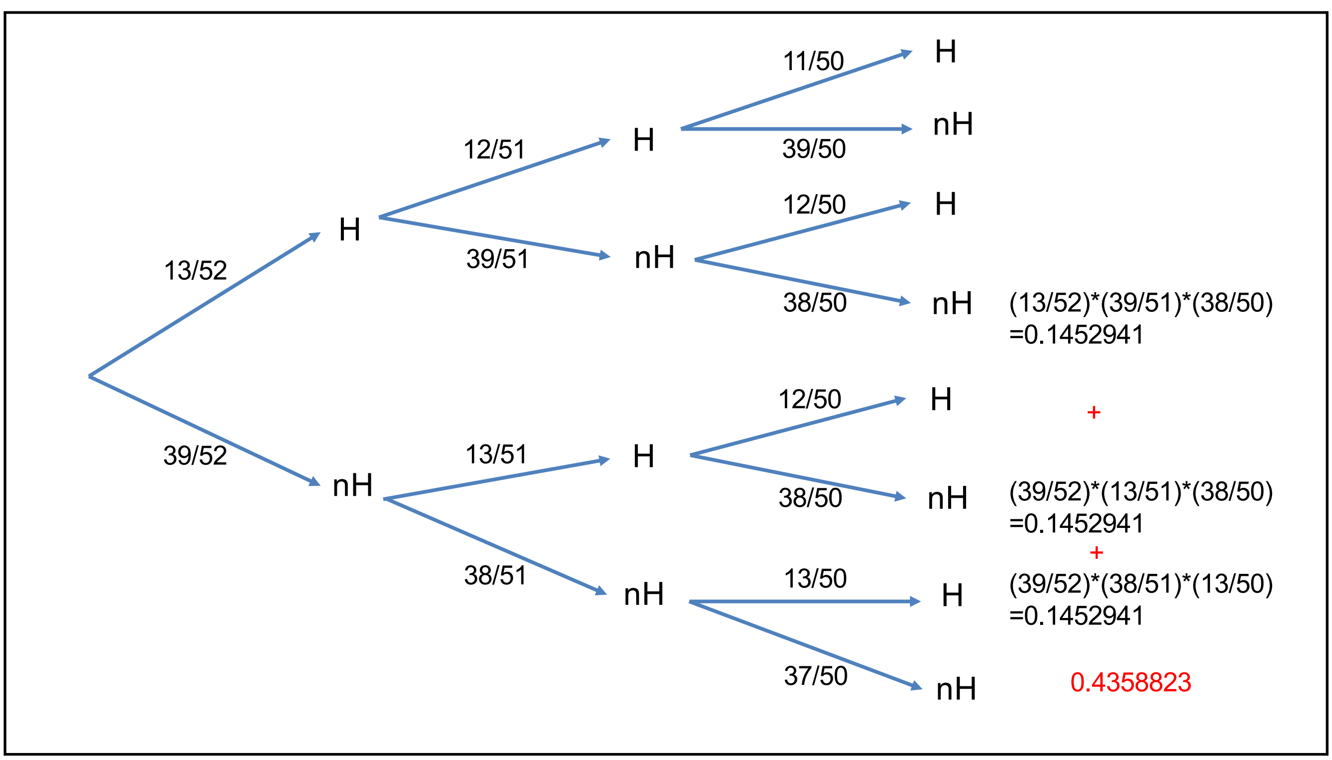
13


12/51
H
H
39/51
nH
13/52
39/52
nH

14


13/52
39/52
H
nH
12/51
39/51
13/51
38/51
H
nH
H
nH
11/50
39/50
12/50
38/50
12/50
38/50
13/50
37/50
H
nH
H
nH
H
nH
H
nH

15

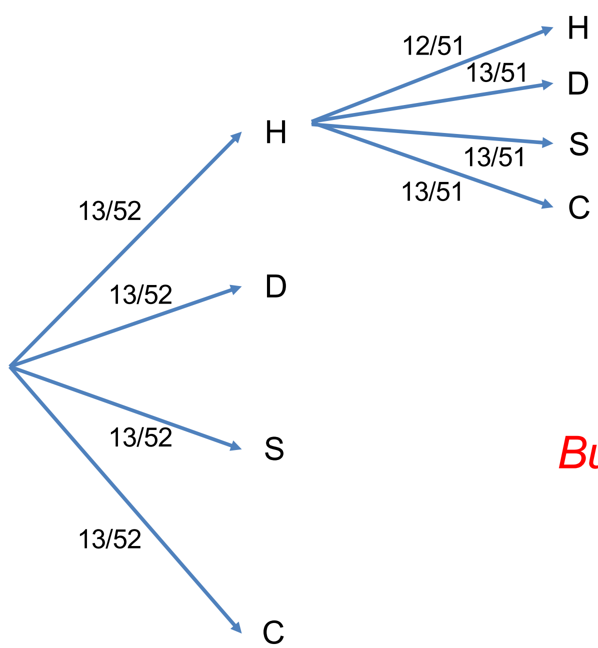

13/52
39/52
H
nH
12/51
39/51
13/51
38/51
H
nH
H
nH
11/50
39/50
12/50
38/50
12/50
38/50
13/50
37/50
H
nH
H
nH
H
nH
H
nH
(13/52)*(39/51)*(38/50)
=0.1452941
+
(39/52)*(13/51)*(38/50)
=0.1452941
+
(39/52)*(38/51)*(13/50)
=0.1452941
0.4358823

16

Playing cards

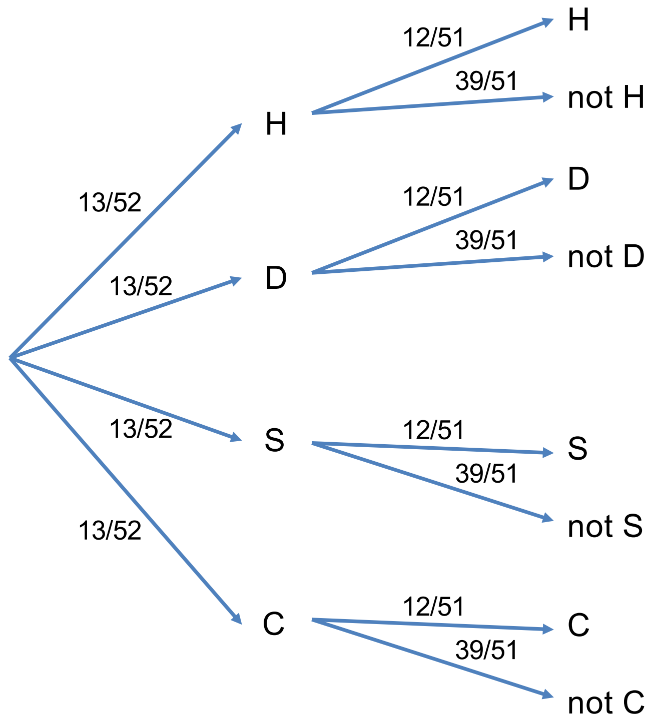
- Standard deck has 52 cards
  - 13 of each suit (diamonds, hearts, spades, clovers)
- I deal you three cards. What is the probability that the cards in your hand are all the same suit (3-card flush)?
- Draw a probability tree for this question…

17



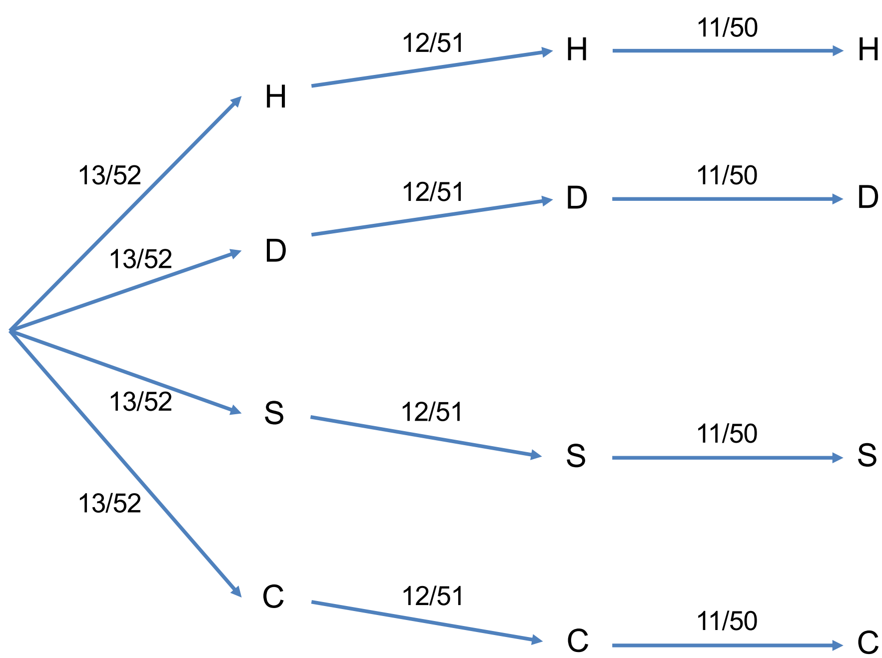
But only interested if cards match suit!

18



…and only looking for outcomes with matching suits!

19



(13/52)*(12/51)*(11/50)
= 0.01294118

4 paths, all with same prob
Any path gets answer
(path1 or path2 or …)

0.01294118
+
0.01294118
+
0.01294118
+
0.01294118

0.01294118 * 4
= 0.05176472

20