def main():

population = 1000000

P\_ill = 0.01

P\_positive\_if\_ill = 0.99 # sensitivity

P\_negative\_if\_healthy = 0.99 # specificity

calculate\_without\_bayes(population, P\_ill, P\_positive\_if\_ill, P\_negative\_if\_healthy)

print()

calculate\_with\_bayes(P\_ill, P\_positive\_if\_ill, P\_negative\_if\_healthy)

def calculate\_without\_bayes(population, P\_ill, P\_positive\_if\_ill, P\_negative\_if\_healthy):

heading = "Calculate P(ill | positive) without Bayes' Theorem"

print(heading)

print("=" \* len(heading) + "\n")

percent\_ill = P\_ill \* 100

number\_ill = population \* P\_ill

number\_healthy = population \* (1 - P\_ill)

ill\_positive = number\_ill \* P\_positive\_if\_ill

healthy\_positive = number\_healthy \* (1 - P\_negative\_if\_healthy)

P\_ill\_if\_positive = ill\_positive / (ill\_positive + healthy\_positive)

print(f"Population: {population}")

print(f"Percent ill: {percent\_ill}%")

print(f"Number ill: {number\_ill:>.0f}")

print(f"Number healthy: {number\_healthy:>.0f}")

print(f"P(positive if ill): {P\_positive\_if\_ill}")

print(f"P(negative if healthy): {P\_negative\_if\_healthy}")

print(f"Ill and test positive: {ill\_positive:>.0f}")

print(f"Healthy but test positive: {healthy\_positive:>.0f}")

print(f"P(ill | positive): {P\_ill\_if\_positive:>.2f}")

def calculate\_with\_bayes(P\_ill, P\_positive\_if\_ill, P\_negative\_if\_healthy):

P\_healthy = 1 - P\_ill

P\_positive\_if\_healthy = 1 - P\_negative\_if\_healthy

P\_ill\_if\_positive = (P\_positive\_if\_ill \* P\_ill) / ((P\_healthy \* P\_positive\_if\_healthy) + (P\_ill \* P\_positive\_if\_ill))

heading = "Calculate P(ill | positive) with Bayes' Theorem"

print(heading)

print("=" \* len(heading) + "\n")

print(f"P(ill): {P\_ill}")

print(f"P(healthy): {P\_healthy}")

print(f"P(positive if ill): {P\_positive\_if\_ill}")

print(f"P(positive if healthy): {P\_positive\_if\_healthy:>.2f}\n")

print(" P(positive if ill) \* P(ill)")

print("P(ill | positive) = -------------------------------------------------------------------")

print(" P(healthy) \* P(positive if healthy) + P(ill) \* P(positive if ill)")

print("\n")

print(f" {P\_positive\_if\_ill} \* {P\_ill}")

print(" = -------------------------------------------------------------------")

print(f" {P\_healthy} \* {P\_positive\_if\_healthy:>.2f} + {P\_ill} \* {P\_positive\_if\_ill}")

print("\n")

print(f" = {P\_ill\_if\_positive:>.2f}")

main()