

# Homework Assignment 1

## The WarmUp Company

Your firm, “The WarmUp Company,” manufactures and sells insulated clothing under the brand name WarmUps. Selling exclusively online, you have extensive data on your customers’ demographics. For example, 35% of purchases are made by male customers, and the rest by females. Male customers making a purchase have a 60% chance of spending over \$50, while for only 50% of females do.

- A. What is the probability that a random customer will spend more than \$50?
- B. Given that a customer *does* spend over \$50, what is the probability that the customer is male?

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## OraQuick HIV home testing kit

### The New York Times

#### Rapid H.I.V. Home Test Wins Federal Approval

By Donald G. McNeil Jr.

Published: July 3, 2012

After decades of controversy, the Food and Drug Administration approved a new H.I.V. test on Tuesday that for the first time makes it possible for Americans to learn in the privacy of their homes whether they are infected.



The availability of an H.I.V. test as easy to use as a home-pregnancy kit is yet another step in the normalization of a disease that was once seen as a mark of shame and a death sentence.

The OraQuick test, by OraSure Technologies, uses a mouth swab and gives results in 20 to 40 minutes. A previous test sold over the counter required a user to prick a finger and mail a drop of dried blood to a lab.

Dr. Anthony S. Fauci, the longtime AIDS researcher and director of the National Institute of Allergy and Infectious Diseases, called the new test a “positive step forward” and one that could help bring the 30-year-old epidemic under control.

Getting an infected person onto antiretroviral drugs lowers by as much as 96 percent the chance that he or she will transmit the virus to someone else, so testing and treatment have become crucial to prevention. About 20 percent of the 1.2 million infected Americans do not know they have the disease, the Centers for Disease Control and Prevention estimates, and about 50,000 more get infected each year.

Dr. Robert Gallo, who headed the National Institutes of Health lab that developed the first American blood test for the virus in 1984, called the F.D.A. approval “wonderful because it will get more people into care.”

The idea of a home test has long been mired in controversy. The first application for one was made in 1987, and the F.D.A. has been considering OraSure’s simple mouth-swab test since 2005.

But the history of AIDS and the human immunodeficiency virus that causes it are unique. AIDS emerged in the 1980s wrapped in a shroud of stigma. It was spread by sex, drug injections and blood transfusions. Along with hemophiliacs, heroin users and Haitians, the most vocal group of early victims was gay men, who were then in the throes of a loud and defiant liberation movement.

Because merely being tested for H.I.V. was seen as tantamount to being publicly revealed as gay or addicted to drugs, and because an H.I.V.-positive result was a death sentence, groups like the Gay Men’s Health Crisis and newspapers like The New York Native advised their members and readers to shun testing until ironclad guarantees of anonymity were put in place.

Alarmists predicted a wave of suicides if home tests were made available. At hearings, advocates for AIDS patients handed out copies of an obituary of a San Francisco man who jumped off the Golden Gate Bridge after learning he was infected. C.D.C. officials warned their F.D.A. counterparts that home testing could lead to a surge of new patients that would swamp overburdened health clinics, according to an F.D.A. document.

So, even as tests for other stigmatized diseases like syphilis were once part of getting a marriage license and home pregnancy kits became available at every corner pharmacy, H.I.V. tests lived in a special limbo, usually requiring a counseling session and the signing of a consent form, adding to the air of dread.

Even when antiretroviral drugs emerged in the mid-1990s, states were slow to rewrite laws governing testing.

Mark Harrington, the executive director of the Treatment Action Group, an AIDS advocacy organization, said in an interview that he thought such fears were “a thing of the past” now that it is clear that early treatment saves lives. “Any tool that speeds up diagnosis is really needed,” he said.

The new test has some drawbacks. While it is extremely accurate when administered by medical professionals, it is less so when used by consumers. Researchers found the home test accurate 99.98 percent of the time for people who do not have the virus. By comparison, they found it to be accurate 92 percent of the time in detecting people who do. One concern is the “window period” between the time someone gets the virus and begins to develop the antibodies to it, which the test detects. That can take up to three months.

So, while only about one person in 5,000 would get a false positive test, about one person in 12 could get a false negative.

Any positive test needs confirmation in a doctor’s office, the F.D.A. said, and people engaged in high-risk sex should test themselves regularly.

The agency does not intend for the home test to replace medical testing, but instead to provide another way for people to find out their H.I.V. status, said Dr. Karen Midthun, director of the F.D.A.’s Center for Biologics Evaluation and Research.

The home test should be available in 30,000 pharmacies, grocery stores and online retailers by October, said Douglas Michels, OraSure’s chief executive. The price has not yet been set. But he

said it would be higher than the \$17.50 now charged to medical professionals because the company will do more complicated packaging for the home kit, open a 24-hour question line, and advertise to high-risk groups, including gay men, blacks and Hispanics, and sexually active adults. Still, he said, it will be kept inexpensive enough to appeal to people who might want to buy several a year.

Because the F.D.A. approved the home test only for people 17 and older, retail stores may ask customers to show ID, he said. The restriction is not for medical reasons, but because only a few subjects age 14 to 16 were tested, he said, “so that was the deal we worked out with the F.D.A.”

Whether having to show identification would deter teenagers or young-looking people from buying a test is unclear. Mr. Harrington said he thought it might.

In contrast, teenage girls are not legally required to show identification to buy pregnancy tests.

[end of article]

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Read the NY Times article “Rapid HIV Home Test Wins Federal Approval.”

- A. What is the probability that a randomly chosen American has HIV? (In other words, what percentage of the population is infected? Use the fact that, at the time of this article, the US population was 314 million.)

Define the events

H = "has HIV"

P = "OraQuick test result is positive for HIV"

Draw yourself a probability tree with event H in the first stage of the tree, and P in the second. Fill it in with the appropriate probability information (use the test accuracy in the article. Be complete: Include all conditional probabilities and calculate the terminal (path) probabilities.

- B. How likely is it that a randomly chosen American who takes the OraQuick test will test positive for HIV?
- C. If a randomly chosen American takes the OraQuick test and tests positive for HIV, then what is the probability that the person actually has HIV?
- D. What is the probability that someone both has HIV *and* tests negative.
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## Bad Debt

When a firm bills a customer, it hopes to get paid. Sometimes that payment never arrives. Estimating such Bad Debt is a standard accounting procedure (that you will soon learn in Accounting!).

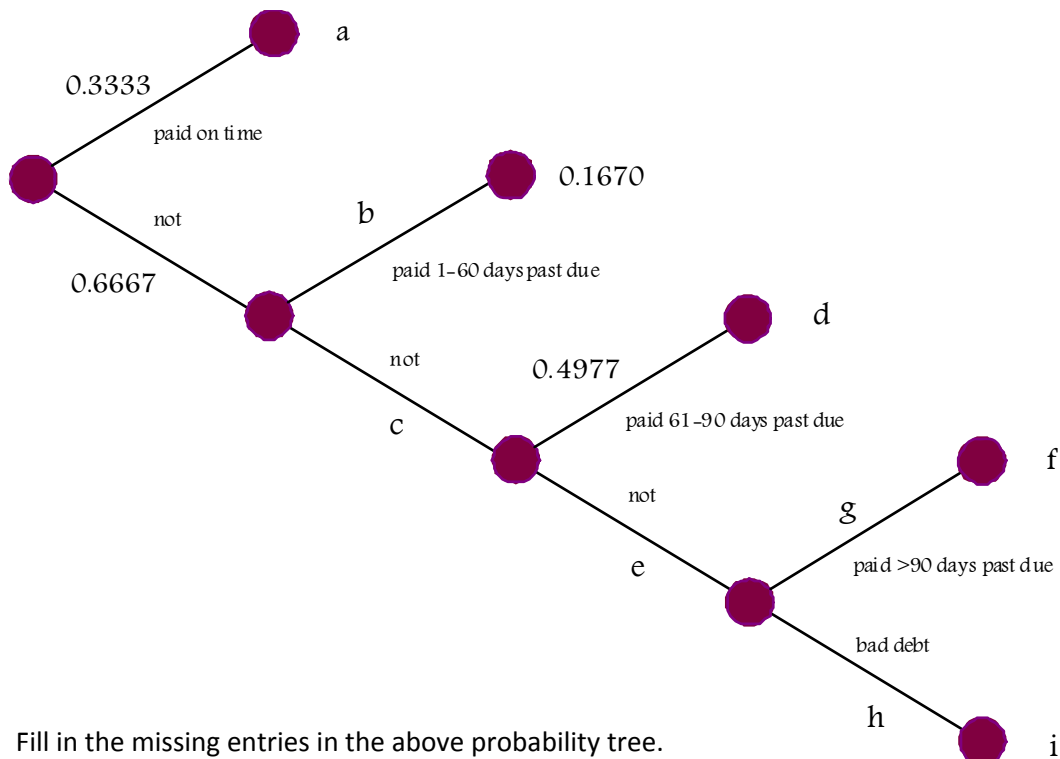
The file BadDebt.xls contains a record of sales invoices that your manufacturing firm sent out in 2011, including the date the invoice was sent (billing date), the dollar-amount of the invoice, and the date on which payment was submitted. Some invoices are marked as “Not Paid”. Those invoices were still unpaid after one year, at which time the firm classified them as uncollectable Bad Debt.

Using the data, we want to estimate the probability that an invoice will end up as Not Paid (“Bad Debt”), given that the invoice has already gone a certain length of time without being paid. A standard way to do this is to group invoices into age-based categories. The firm’s payment terms are “net 31” meaning that any payment made within 31 days is considered on time:

| Category              | # days to receive payment | Description                      |
|-----------------------|---------------------------|----------------------------------|
| On time               | 1-31                      | paid on time                     |
| Paid 1-60 past due    | 32-91                     | payment late, no penalty         |
| Paid 61-90 past due   | 92-121                    | payment late, late fee charged   |
| Paid over 90 past due | 122-366                   | payment late, late fee increases |
| Bad debt              | n/a                       | not paid                         |

[For example, an invoice paid 50 days after the transaction (second column) is past due 19 days when it is finally paid (first column), and hence is paid late but charged no penalty (third column).]

- What is the probability that a randomly chosen invoice from the data set is in the “bad debt” category? (Hint: Use Excel’s =COUNTIF command.)
- What is the probability that it was paid in 31 days or less (“on time” category)?



- Fill in the missing entries in the above probability tree.
- Using the information in your probability tree, calculate the following three conditional probabilities.
  - $\Pr(\text{bad debt} \mid \text{not paid on time})$
  - $\Pr(\text{bad debt} \mid \text{not paid in first 91 days})$
  - $\Pr(\text{bad debt} \mid \text{not paid in first 121 days})$