When Laypeople are Right and Experts are Wrong: Lessons from Love Canal

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The Love Canal controversy

- Love Canal is a suburb outside Buffalo, in the state of New York
- In 1978 it was known that the suburb was built on top of a chemical waste site
- More than 80 different chemicals were found in the ground, 8 – 10 of them carcinogenic

Examples of reported health problems in Love Canal

- miscarriages in pregnant women
- birth defects
  - club feet
  - missing ear
  - extra set of teeth
  - heart defects
- asthma
- urinary system disease
- various symptoms of central nervous system toxicity

A map of Love Canal

The course of events

- New York state health commissioner declared a health emergency.

- The area was fenced in, and 239 houses closest to the toxic site were evacuated (the red area in the map). The state of New York purchased the houses, and helped to relocate the affected residents.

What about the remaing part of Love Canal?

- Was it safe?

- The state of New York brought in researchers to answer the question.

Important questions:

- Is there an excess of physical (and mental) ailments among the residents of Love Canal compared to the normal population?

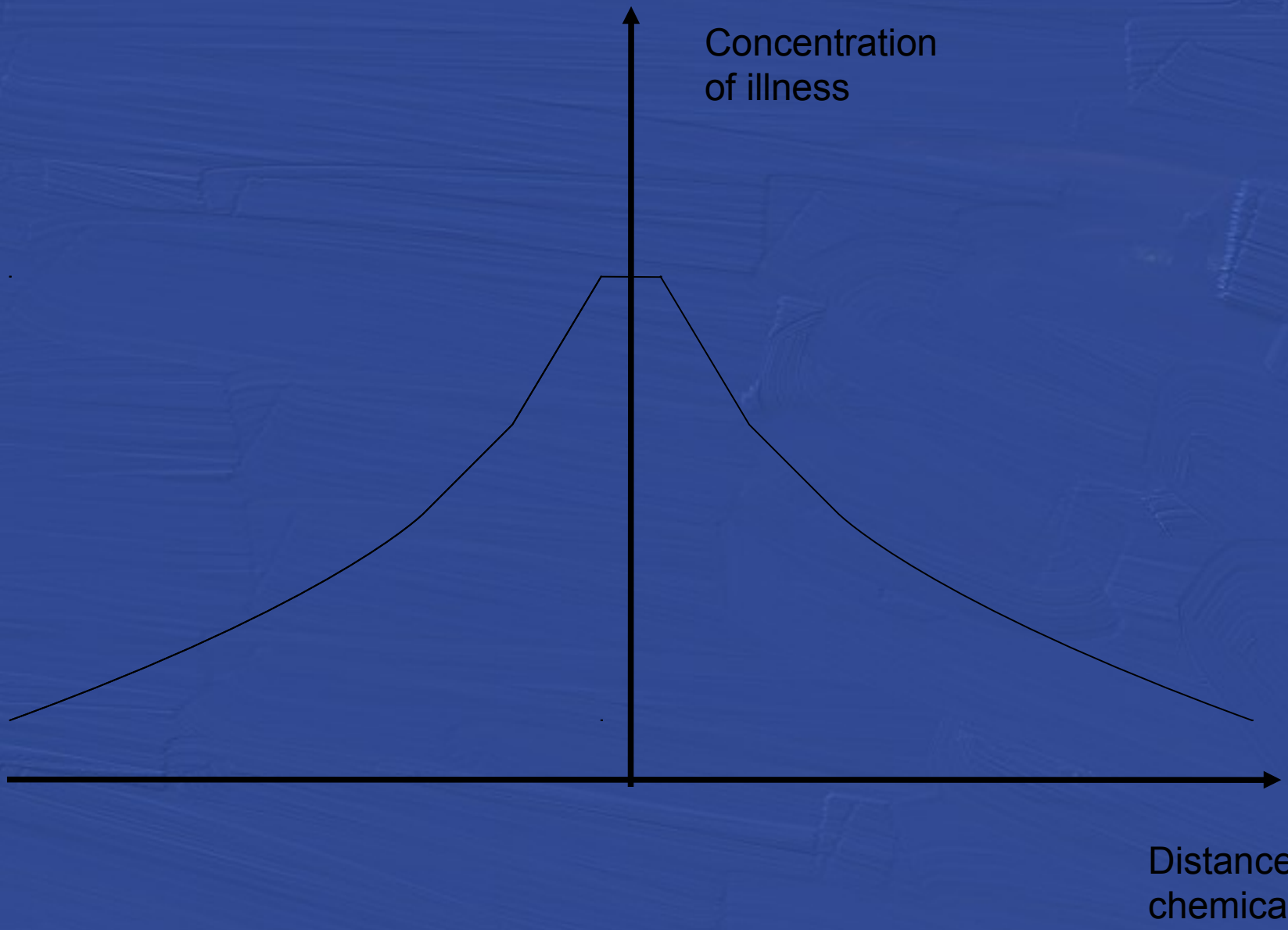
- Is there a causal relationship between the toxics in the waste site and the ailments?

- The researchers from New York state health department: Yes, it is safe.

The research group used two different approaches

1) It applied a theoretical model for the dispersion of the toxics in the ground

The model



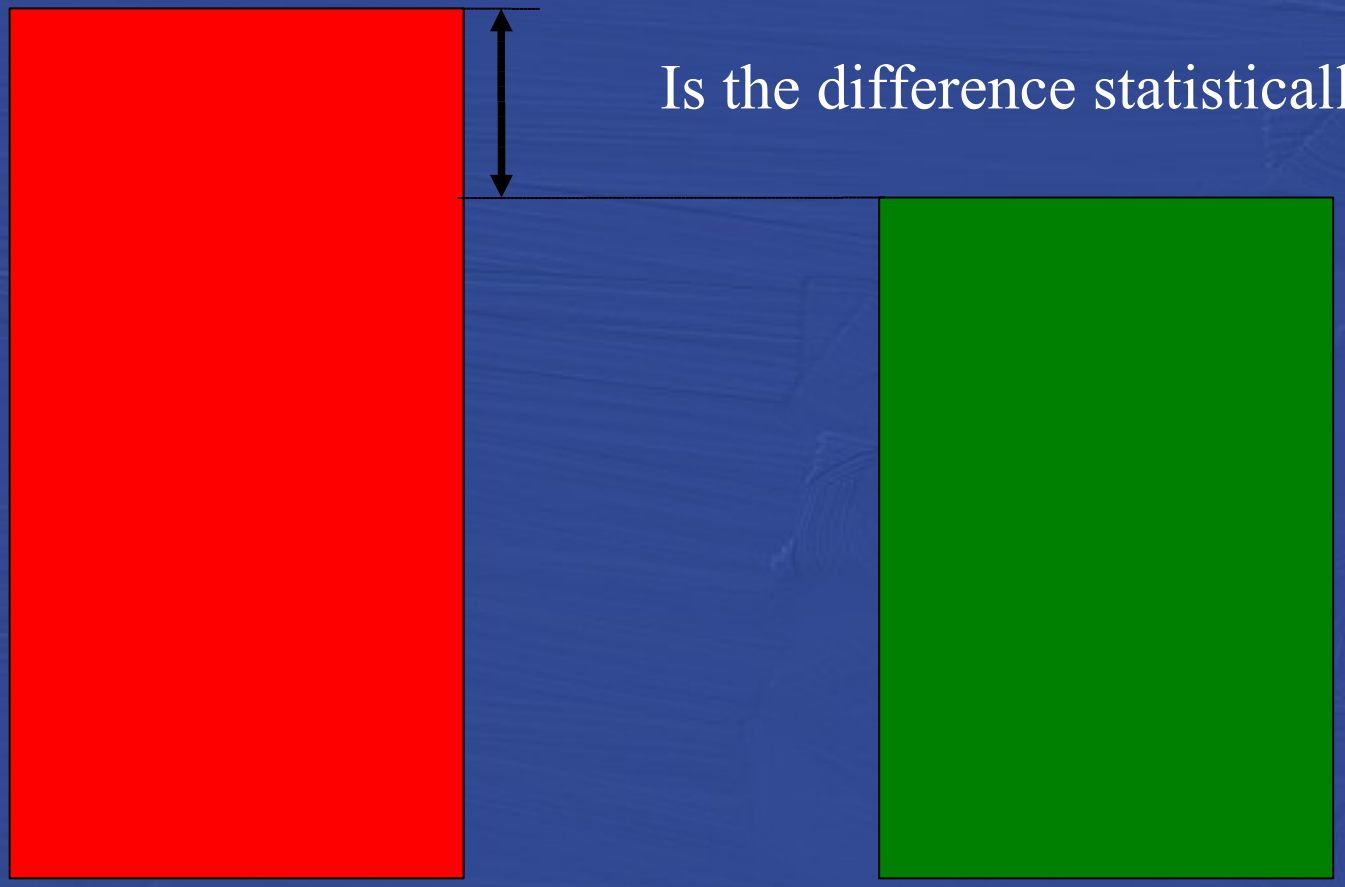
A map of Love Canal

If this model was valid, the following should be expected

- the concentration of toxics in the ground and in the houses (in particular in the basements) should decrease with increasing distance from the site
- the number of ailments should decrease in the same way
- However, that turned out not to be the case

The research group used two different approaches

1) It applied a theoretical model for the dispersion of the toxics in the ground
2) It compared the frequency of miscarriages among residents of Love Canal to a population outside Love Canal



Is the difference statistically significant?

Love Canal

Sample from normal population

Null hypothesis:

H_0: The difference is due to random variations in the samples

The null hypothesis should only be rejected if there is less than 5 % probability that the difference is due to random variations (if p_0=0.05)

Two kinds of statistical error

Type 1 error: We reject a true null hypothesis ("false positive")

Type 2 error: We fail to reject a false null hypothesis ("false negative")

- In standard methodology: type 1 error is regarded as more serious than type 2 error (normally $p_0 = 0.05$)

- However, any textbook on statistics says that one should control the probability of a type 2 error. However, it is very often not done.

You pass on the following information to the decision-makers:

"We have investigated the case, and found no significant difference."

Normally it will be interpreted as

"We have investigated the case, and found no significant difference

...and we would probably have found it if there was any."

But what if the situation was the following?

"We have investigated the case, and found no significant difference

...and we would probably not have found it if there was any."

The reseachers from the Health Department argued that they had used a "conservative" scientific approach.

"A high-level official, in response to an informal query, replied that the health department professionals were *scientists*, who did not worry about people's reactions to cautionary statements and recommended actions. They deal with numbers – with data on physical conditions – and only with these."

A. D. Levine: *Love Canal: Science, Politics, and People* (1982: p. 40)

Beverly Paigen, a cancer researcher at a nearby institute, assisted the resisents in Love Canal:

"At the beginning, I thought our differences could be resolved in the traditional scientific manner by examining protocols, experimental design, and statistical analysis. But I was to learn that actual facts made little difference in resolving our disagreements – the Love Canal controversy was predominantely political in nature, and it raised a series of questions that had more to do with values than science." (Beverly Paigen)

Beverly Paigen: If the health of people are at stake your question should not be: "Can this be published in New England Journal of Medicine?" but "Would you let your daughter work with this substance?"

Type 1 error: Harms the producer (“producer risk”)

Type 2 error: Harms the consumer (“comsumer risk”)

Traditional methodology: The burden of proof is on the consumer. (“The defendant (producer) is assumed innocent until proved guilty”.)

ASA Statement on Statistical Significance and P-Values

3. Scientific conclusions and business or policy decisions should not be based only on whether a p-value passes a specific threshold.

.....

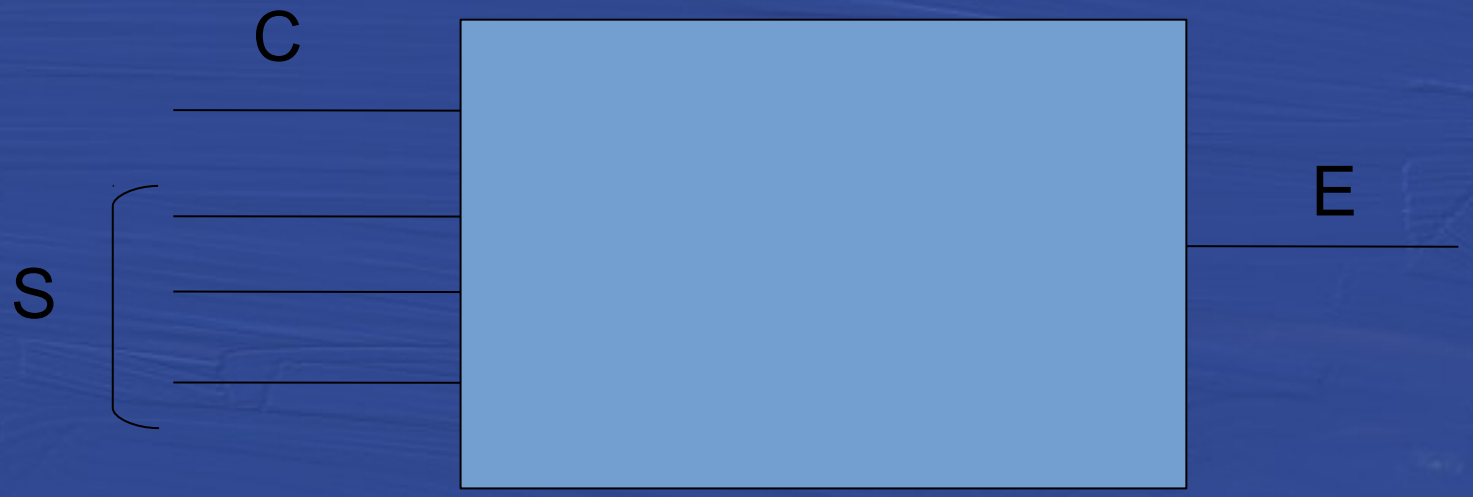
.... Researchers should bring many contextual factors into play to derive scientific inferences, including the design of a study, the quality of the measurements, the external evidence for the phenomenon under study, and the validity of assumptions that underlie the data analysis...

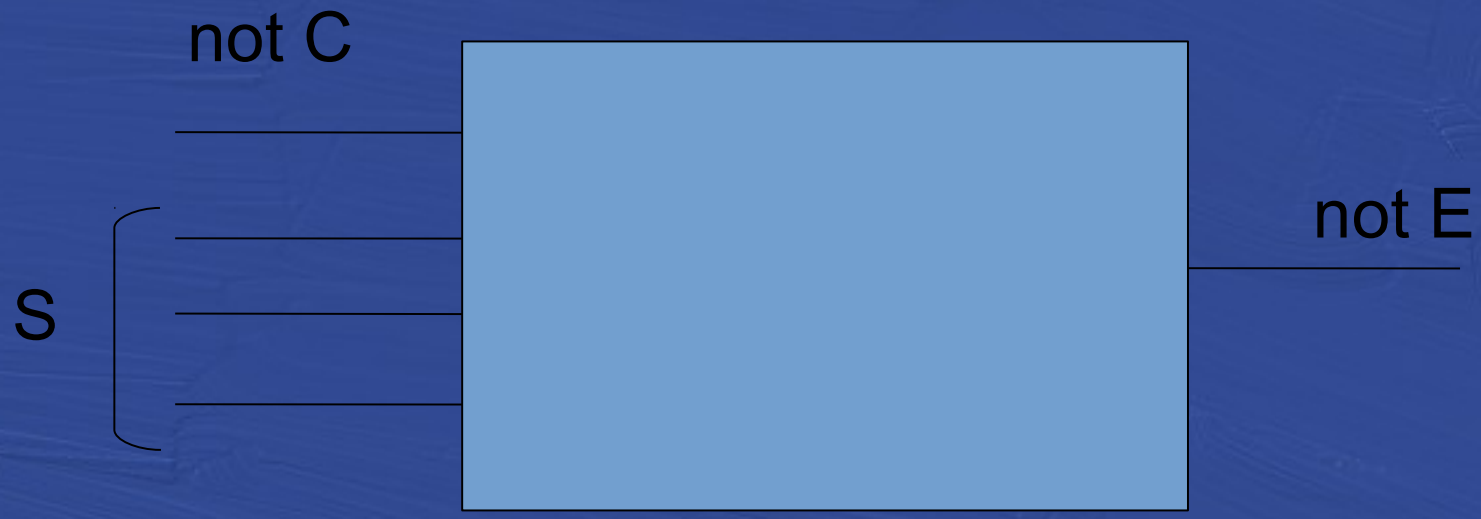
- p-values (at best) only says something about random errors. Normally they are not very important.

- Systematic errors are normally much more important.

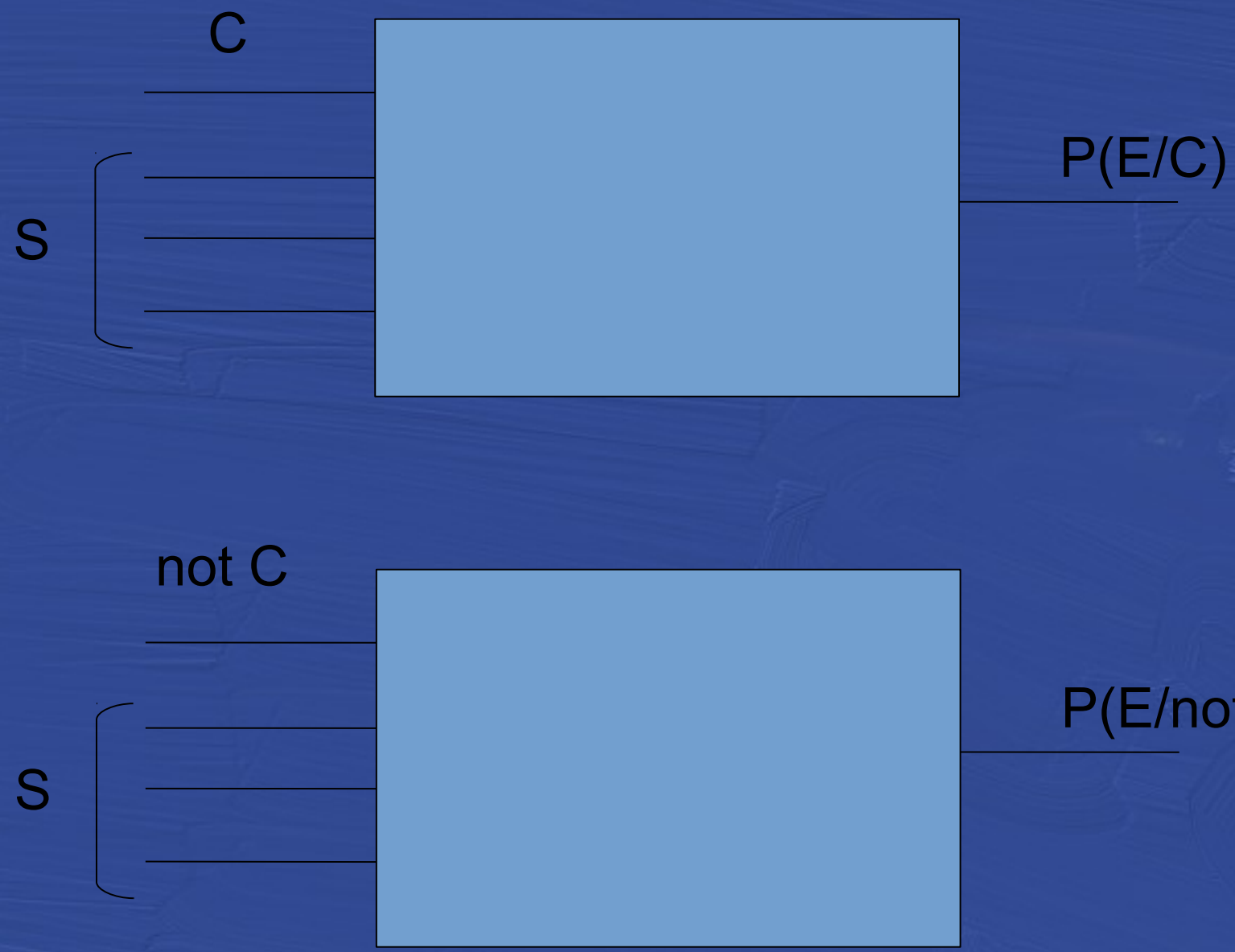
First systematic error

About causal relationships

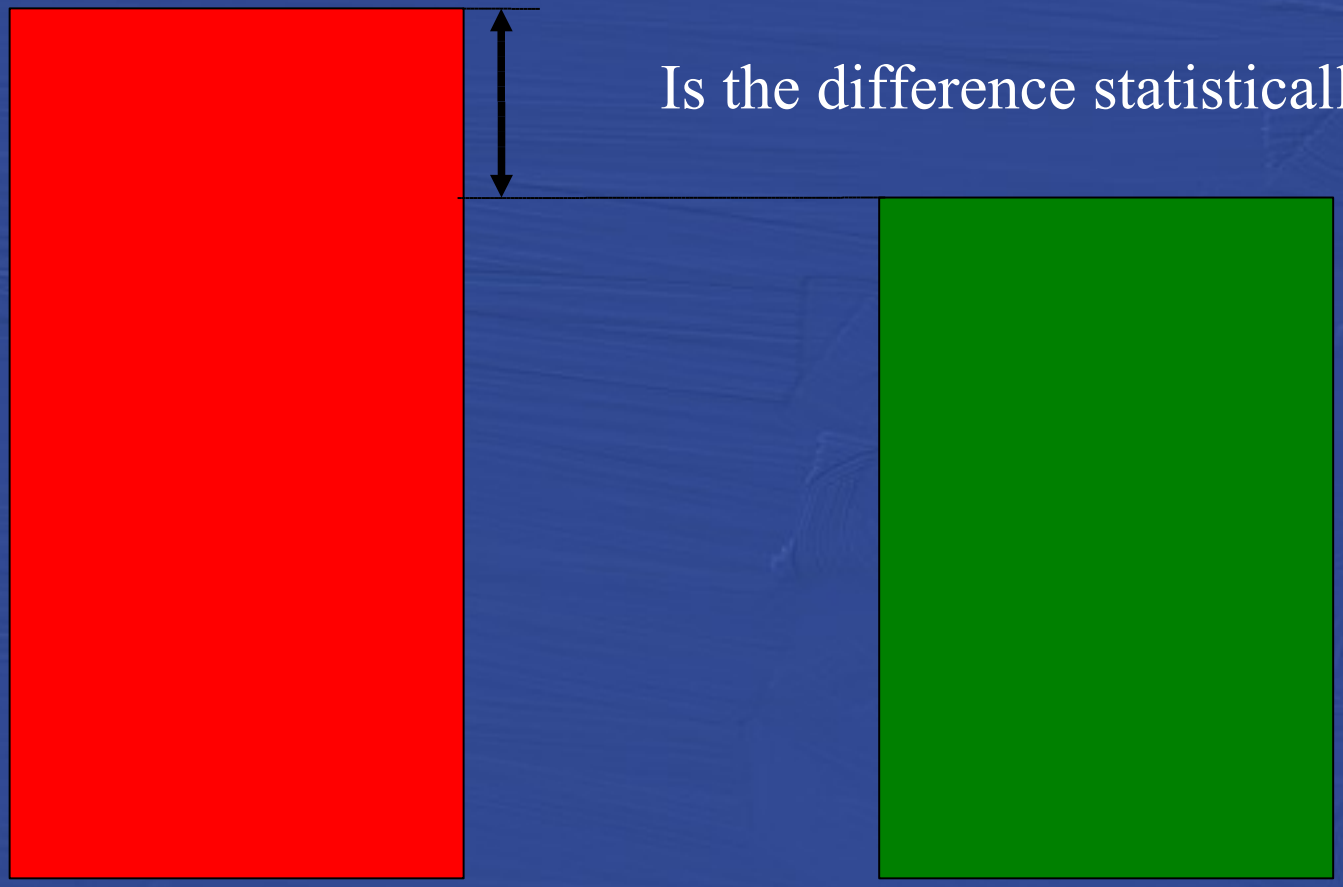




S = ceteris paribus (everyting equal)



P(E/C) > P(E/not C)



Is the difference statistically significant?

Love Canal

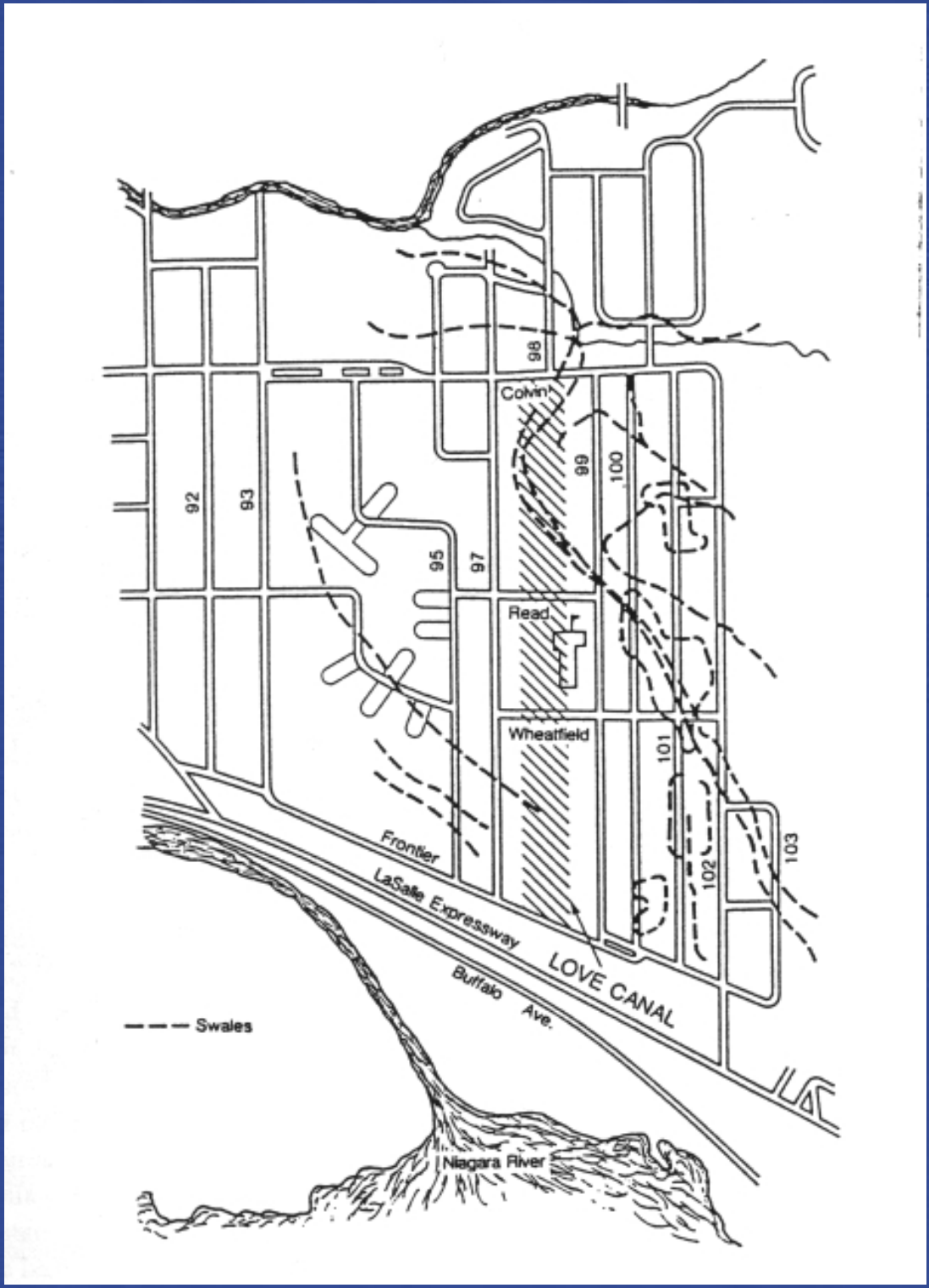
Sample from normal population

Ceteris paribus: similar in "all relevant aspects"

- The research group had selected a reference group that was not a representative population. (They had a higher than normal frequency of miscarriages.)
- (They had used this study: D. Wartburton and F.C. Fraser, "Spontaneous Abortion Risks in Man: Data from Reproductive Histories Colllected in a Medical Genetics Unit", *American Journal of Human Genetics* 16 (1964), 1-25.)

Second (and by far the worst) error

A map of Love Canal
(the chemical site is the
shaded rectangular area)



Lois Gibbs, the head of the residents' union came up with a new hypothesis: What if the toxics spreads along the swales?

Beverly Paigen divided the homes into two categories:

- "Wet homes": All the houses close to the swales
- "Dry homes": All the other houses
- She found significant differences in health conditions between "wet" and "dry" homes

Conclusion: The lessons

First lesson: Scientists are not outside

Second lesson: Be aware of and inform about uncertainty

Third lesson: Involve non-experts

- They have local knowledge
- They represent common sense
- They are affected

David Parnas' ethical rules

- I am responsible for my own actions and cannot rely on any external authority to make my decisions for me.
- I cannot ignore ethical and moral issues. I must devote some of my energy to deciding whether the task that I have been given is of benefit to society.
- I must make sure that I am solving the real problem, not simply providing short-term satisfaction to my supervisor.

David Parnas: “A Violation of Professional Responsibility” (1988)