Final exam:

COMP 7H Tuesday, Dec. 7, 11:30 a.m., SE 12 303

COMP 7D Wednesday, Dec. 8, 11:30 a.m., SE 12 303

On the exam, you will be asked to reconstruct the "Burn the witch" argument from *Monty Python and the Holy Grail* (text pp 124-5, Exercise VIII)

As usual, you will be asked to put in premise numbers, give numbers of supporting premises for intermediate and final conclusions, and provide a diagram.

Inductive arguments summary:

Inductive vs. deductive arguments: Deductively valid arguments provide 100% support for their conclusions, *if their premises are all true.*

> However, not all deductive arguments are valid, since attempts to produce valid arguments sometimes fail (e.g. deductive fallacies)
>
> Not all invalid arguments are deductive arguments: people may seek to produce arguments whose premises provide *strong* (50% < strength < 100%) support for their conclusions, *if their premises are all true*

Deductive arguments are **not defeasible**, since adding premises to a valid argument doesn't diminish (or strengthen) the support of the original premises for the conclusion

In contrast, inductive arguments are **defeasible**, since adding premises to an inductive argument can weaken (or strengthen) the support of the original premises for the conclusion

Statistical generalization: When a pattern is observed in a subset of a population (a sample), and that pattern is generalized to the wider population

Causes and predictions: We can explain and predict events, from causal generalizations.

Suppose we find that a dry, brown powdery clump of Nitrogen tri-iodide explodes when touched.

We can explain this fact by referring to the weak chemical bonds holding the iodine to the nitrogen molecule: "The process 2 NI_3 (s) → N_2 (g) + 3 I_2 (s) is exothermic, so that N_2 (g) + 3 I_2 (s) → 2 NI_3 (s) is endothermic. Endothermic compounds tend to be unstable."

As an argument:

1. The process 2 NI_3 (s) → N_2 (g) + 3 I_2 (s) is exothermic.

∴ 2. Thus, N_2 (g) + 3 I_2 (s) → 2 NI_3 (s) is endothermic. (1)

3. Endothermic compounds tend to be unstable (explode when touched).

4. NI_3 is an endothermic compound. (2)

∴ 5. **(Prediction)** NI_3 (s) tends to be unstable (explode when touched). (3,4)

As a prediction from a causal generalization:

1. **Causal generalization:** All substances with unstable molecular structures of a certain sort are liable to explode when touched.
2. **Facts:** This dry brown powdery clump of nitrogen triiodide has the above unstable molecular structure.

∴ 3. **(Prediction)** This dry brown powdery clump of nitrogen triiodide will explode when someone touches it.

ANALYSIS OF CAUSAL GENERALIZATIONS: a kind of general conditional…

For all *x*, if *x* has feature *F*, then *x* has feature *G*

General conditionals are ways of expressing categorical generalizations that bring out their ***conditional structure***: All things with feature *F* are things with feature *G*

In other words: Having *F* is *sufficient* for having *G*; correlatively, having *G* is *necessary* for having F

Not all general conditionals are causal: the type of relationship between F and G determines the kind of the conditional

e.g., If something is a triangle, it's internal angles add to 180°.

•If you are 16 or older, you can get a learner's permit

•Every mammal species has hair and feeds its offspring with milk?

Since causal conditionals are all general conditionals, they can also be refuted in the same way—by finding exceptions: an *F* that is not a *G*

SUFFICIENT & NECESSARY CONDITIONS

F is a ***sufficient condition*** for G if and only if anything that has F also has G:

$$F \supset G$$

F is a ***necessary condition*** for G *if and only if anything that lacks F also lacks G*:

$$\sim F \supset \sim G$$

Therefore: If F is sufficient for G, G is necessary for F

Why?

Don't confuse sufficient and necessary conditions: e.g., Being a woman is sufficient for being human, but being a woman is not necessary for being human

e.g., What's a necessary condition for being a bachelor?

a sufficient condition?

an aunt?

NECESSARY & SUFFICIENT CONDITIONS: A person's being the brother or brother-in-law of one's parent is both a necessary and a sufficient condition of that person's being one's uncle

Complex conditions: F and G can be any sort of properties, positive, negative or disjunctive

F = being a racing cyclist
G = having no hair on one's legs

F = being either under 18 or over 59
G = being excluded from many surveys

F = being a sister of a sibling who has a child
G = ?

THE SUFFICIENT CONDITION TEST

General question: Are any of the properties A, B, C, or D candidates for being sufficient conditions for target property, G?

Recall format: If <sufficient condition>, then <necessary condition>: SC $\supset$ NC

Since we here want to know whether certain properties are *sufficient conditions* for a particular ***target property***, G, we can ignore that the consequent (target) is also a necessary condition for the antecedent. We get:

If SC (either A, B, C or D), then G

By contraposition, if the target is absent (~G), then the candidate(s) for SC must also be absent (to really be sufficient conditions).

SC ⊃ G
∴ ~ G ⊃ ~ SC

Which is false when: ~ G & SC

(or SC is not a sufficient condition when it is present but the target is absent)

We get the sufficient condition test:

SCT: *Any candidate that is present when G is absent is eliminated as a possible sufficient condition for G.*

TABLE 1

Case 1:	A	B	C	D	G
Case 2:	~A	B	C	~D	~G
Case 3:	A	~B	~C	~D	~G

After three tests, the only candidate left standing is D. We have thus **validly ruled out** A, B, and C as potential sufficient conditions

A property is a candidate for a sufficient condition for a target property, if, when it is present, the target is present

D also meets this test

Can we be sure that D is a sufficient condition for G?

No! Though D remains after 3 tests, for all we know, some further test may eliminate it.

Case n: ~A B C D ~G

However, so long as D remains, we have some reason to believe that D is sufficient for G

In other words, though arguments to rule out candidates for SC are deductive, arguments in support of candidates for SC are defeasible, and so inductive

THE NECESSARY CONDITION TEST: Again, we first approach the issue deductively by asking when something might fail to be a necessary condition for G.

Here, we note that the necessary condition is in the consequent position of the conditional; so we put the target property, G, in the antecedent position.

If anything is G, then it is NC (here, either A, B, C or D)

So, if the putative necessary conditions are absent, when the target is present, they are not necessary conditions: i.e., when: G & ~NC

We get the necessary condition test:

NCT: *Any candidate that is absent when G is present is eliminated as a possible necessary condition.*

TABLE 2

Case 1:	A	B	C	D	~G
Case 2:	A	B	~C	~D	G
Case 3:	A	~B	C	~D	G

Which are validly ruled out?

Which is inductively supported?

THE JOINT TEST: we can also evaluate candidates for being both necessary and sufficient conditions:

Any candidate that fails either SCT or NCT is not a necessary and sufficient condition for the target; and candidate that remains after both has some inductive support for being both a necessary and sufficient condition

RIGOROUS TESTING: Since evidence for being (causally) necessary or sufficient is *defeasible* (inductive), the greater the number of tests passed, the greater the support for being a necessary or a sufficient condition

TABLE 3					
Case 1:	A	~B	C	D	G
Case 2:	A	~B	~C	~D	~G
Case 3:	A	~B	C	~D	~G
Case 4:	A	~B	~C	D	G

Which of these can't be sufficient conditions?

Which can't be necessary conditions?

Which are candidates for sufficient condition?

Which are candidates for necessary condition?

Which are candidates for being both necessary and sufficient conditions?

In Table 3, A is always present, regardless of whether G is; so under these conditions, A cannot fail the NCT

Whereas B is always absent, regardless of whether G is; so under these conditions, B cannot fail the SCT

To *rigorously test* A with the NCT, we should look at more cases where A might fail NCT: If A is not a necessary condition, then in some case, G is present, even though A is not

Of course, if A is a necessary condition for G, then whenever G is present, so will A

Correlatively, to **rigorously** test B with SCT, we should look at more cases where B might fail the SCT: If B is not a sufficient condition, G can be absent, even though B is present

Positive Conclusions: we've seen how to rule out candidates for necessary or sufficient conditions, and we've seen how to rigorously test surviving candidates;

In particular, suppose some candidate, C, has rigorously passed SCT; then

(a) we haven't found a case where C is present, but G is absent;
(b) we've tested several cases where C is present
(c) we've tested several cases where G is absent

However, to have **strong** evidence that C is a sufficient condition for G:

(d) we also have to actively seek out those cases where it is **plausible** that C is present, but G is absent

If passed, this last requirement strengthens the inductive support, since it focuses on possible problem areas

But to know what these problem areas might be, and if we've looked at enough cases, we need background information about the topic

E.g., testing potential software problems and the coloured iMac

So, to find why our Blueberry iMac computer's software keeps crashing, do we need to test the software on the other coloured computers?

Our background assumptions may be wrong, and we may still miss cases where C is present, but G is absent

Still, we can have good reasons to accept C as a sufficient condition for G

Necessary conditions: In parallel, we have good reasons to accept C as a necessary condition for G, when:

(a) We haven't found a case where C is absent, but G is present;
(b) We've tested several cases where C is absent
(c) we've tested several cases where G is present
(d) we have tested enough cases of the various kinds likely to have C absent, but G present

ACTUALLY USING THESE METHODS (further complications)

Normality: we ordinarily accept claims, such as: if you strike a match, then it will light

This suggests we (ordinarily) accept that striking a match is sufficient for lighting it

However, if the match is wet, if the room is full of nitrogen, if the striking surface is of the wrong kind, etc., etc., the match will not light

So it seems that—**really**—striking the match is **not sufficient** to light it

We might try to add the other preconditions: if the match is not wet, if the room has sufficient oxygen, if the match is struck at the right end, …, then, if the match is struck, it will light

However, it's impossible to list all such conditions (the "frame problem")

Still, we can preserve our common belief that striking the match is sufficient for its lighting, by relativizing this action to normal contexts

We get a *contextualized* definition of necessary and sufficient conditions:

That F is a sufficient condition for G means that whenever F is present in a normal context, G is present there as well

That F is a necessary condition for G means that whenever F is absent in a normal context, G is absent there as well

Normal contexts? What we count as normal will vary with our investigation

Background assumptions: What we use to direct our attention to relevant tests

e.g., when we test medications for people, we assume that age, diet, gender, previous illnesses, etc. can affect the action of the drug

We also assume that the person's name, favourite colour, shoe preference are unlikely to be important

We determine these relevancies within a larger framework of beliefs, which includes both common and specialized knowledge

Generally, if someone makes a claim that doesn't fit within our framework of beliefs, we do not take them seriously (without considerable new evidence)

E.g., Human beings first arrived here from another solar system 20,000 years ago???

You don't need food to survive; all you need to do is breathe correctly and deeply????1

You can get rid of your allergies simply by thinking positive thoughts???

Dead people can rise from their coffins several days
later and survive forever on human blood.

In contrast, some of our beliefs are not so central, in that rejecting them won't have much effect on others: e.g., Toronto, not Ottawa, is the capital of Ontario; Canberra, not Sydney is the capital of Australia

What about: The exam is 2 weeks from today?

The reasons that some beliefs are more central, is that they are supported, or otherwise connected to, many other things we believe

Wittgenstein: (105) "All testing, all confirmation and disconfirmation of a hypothesis takes place already within a system. And this system is not a more or less arbitrary and doubtful point of departure for all our arguments: no, it belongs to the essence of what we call an argument. The system is not so much the point of departure, as the elements in which arguments have their life" (294; from On Certainty)

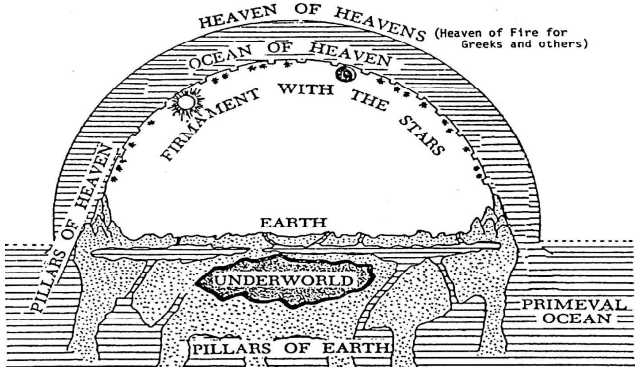
In normal cases, we presuppose our framework beliefs, and use these to focus on what is relevant; we also use it to add new beliefs to the system.

Occasionally, however, even these framework beliefs can be given up, if the evidence is strong enough

"Epistemological crises": we learn, e.g., that our "best friend" actually despises us, is a terrorist, a drug smuggler, a contract killer, etc.

In science, we've learned that:

- the earth rotates
- moving faster makes time slow down
  that all bodies fall at the same speed
- that the universe is billions of years old
- that the sky is not a ceiling, etc.



Even so, most scientific revolutions leave much of our framework beliefs in place

Discovering the cause of Legionnaires' Disease

"The 58th convention of the American Legion's Pennsylvania Department was held at the Bellevue-Stratford Hotel in Philadelphia from July 21 through 24, 1976....Between July 22 and August 3, 149 of the conventioneers developed what appeared to be the same puzzling illness, characterized by fever, coughing and pneumonia. This, however, was an unusual, explosive outbreak of pneumonia with no apparent cause....Legionnaires' disease, as the illness was quickly named by the press, was to prove a formidable challenge to epidemiologists and laboratory investigators alike" (286)

Investigators' assumption: The outbreak was the same disease—*normally*, if people in the same setting suddenly get similar symptoms, they have the same illness, with the same cause

This assumption could be wrong, but investigators needed some plausible assumptions to begin their investigation

Target property, G? the event of a pneumonia-like disease

One puzzle: available tests for pneumonia-type illnesses were negative

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Necessary Condition Tests: If G (disease), then ?

"The initial step...is to determine the character of the illness, who has become ill and just where and when. The next step is to find out what was *unique* about the people who became ill: where they were and what they did that was different from other people who stayed well." (286)

Result: Not only Legionnaires, but 72 other people who were either at or very near the Bellevue-Stratford Hotel, got the disease

Common knowledge tells us that all of these people breathed air, were more than two feet tall, usually wore clothes, etc., but these were not **relevant** necessary conditions for Legionnaires' disease

For example, it didn't distinguish sick people from well people

One clear necessary condition: Presence at the hotel (If LD, you were at the hotel)
However, this was not a sufficient condition, since not everyone at the hotel got LD (i.e., you could be at the hotel, but not get LD!)

For example, older people and men were more likely to get the disease than younger people or women

Medical background knowledge is that gender does affect vulnerability to disease; this suggests that we make being at the hotel, together with other factors (to be discovered) the sufficient condition for LD

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Perhaps LD is food poisoning?

But not everyone who ate in the hotel or local restaurants got LD

Food and drink were also not necessary conditions for LD, since many who got the sickness ate at different restaurants [G & ~NC = LD & ~F/D]

Another clue: "Certain observations suggested that the disease might have been spread through the air. Legionnaires who became ill had spent on the average about 60 percent more time in the lobby of the Bellevue-Stratford than those who remained well; the sick Legionnaires' had also spent more time on the sidewalk in front of the hotel than their unaffected fellow conventioneers...." (287)

Airborne cause? The rate of LD varied with time spent in lobby or near front door

What might be in the air, then? Perhaps: "heavy metals, toxic organic substance, and infectious organisms" (288)?

But tissue samples from those who died showed "no unusual levels of metallic or toxic organic substances that might be related to the epidemic" (288)

So they were not necessary for LD: [LD & ~(heavy metals or toxic organics)]

So perhaps an infectious organism (thus, a single disease with a single cause)?

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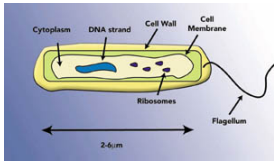
However, the usual pneumonia tests failed to reveal anything

Next hypothesis: perhaps "some previously unknown organism had been responsible but had somehow escaped detection" (288)



It took four months to find the bacterium, because the background assumption that all bacteria will grow in synthetic nutrient cultures turned out to be false

The bacterium would only multiply in a live-tissue culture

Did the bacterium cause the disease, though?

If Legionella pneumophila causes LD, then whenever the disease was present (G), then so should be antibodies to Legionella pneumophila (C)

They were; so Legionella pneumophila turned out to be a ? condition for LD

Lessons about induction in science: our investigations always begin against the background of accepted scientific beliefs. Those framework beliefs suggest plausible hypotheses, and our accepted tests evaluate these.

If our belief system works as it is, we add the new success to the system; if our basic principles fail, we need to modify them and the one's they are connected with

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What should we call **the cause** of the disease?

Clearly, L. pneumophila is not a sufficient condition for LD

However, everyone who got the disease, had L. pneumophila present; so the bacterium was a necessary condition for LD

But, probably, so is being in a run-down condition; yet we don't generally call being run-down a cause of LD, though we might call it a **causally relevant factor**

Why draw this distinction?

(i) The cause involves changes prior to the effect, whereas,

(ii) causal factors are permanent features of the context

However, if we switch our focus to asking why some people who came in contact with the bacterium did not get the disease, while others did, we will then cite being run-down as the cause

Sufficient conditions are also called causes: when, in normal contexts, their presence leads to the target feature

e.g., in normal contexts, flipping a light switch up is sufficient to cause the light to go on

Concomitant variation: Sometimes certain features of the world are *always present*, such as carbon dioxide or ozone

This means the NCT cannot rule them out as necessary conditions for some G—since it's never the case that both G and not C

It also means that the SCT cannot rule out other things as sufficient for them—it's never the case that these other things are present, minus the omnipresent things

Example: Does SO_2 from Midwest industries cause environmental damage?

Problem: there's always a certain amount of acid in the air (from natural sources), and the environment is always being degraded in some form; it's also true that Midwest industries discharge a lot of SO_2, which is known to *increase* rain acidity

We can't use NCT to see whether SO_2 causes environmental degradation, because there never is both environmental degradation and no SO_2

We can't use SCT either, since there never is both no environmental degradation and SO_2 being present

We ask a new question: Does the amount of environmental damage **vary** in direct proportion to the amount of SO_2 released?

If it increases when SO_2 increases, and decreases when SO_2 decreases, this suggests that environmental damage is **positively correlated** with the presence of SO_2

We can then conclude that increasing SO_2 is associated with increasing environmental damage

Explaining such correlations requires some background knowledge

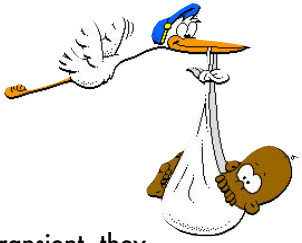
e.g., Why is driving faster correlated with using more gas (we have a good theory about this)

More problematic: There seems a positive correlation between high cholesterol and heart attacks, though no clear theory about why

Sometimes a correlation occurs without a direct cause: Increasing shoe size seems correlated with improved writing ability, yet one doesn't cause the other

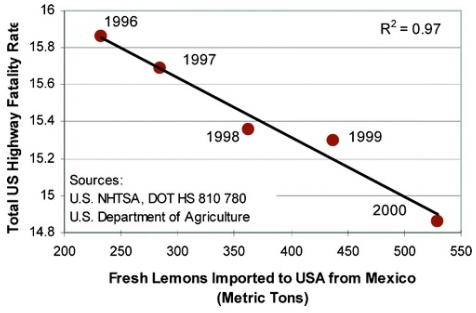
Sometimes the causal order is reversed: Does forward passing reduce your chance of winning at football?

Inexplicable correlations: the birth rate in Holland is strongly correlated with the number of storks nesting in chimneys



So far the correlation seems to be *accidental*—no causal relation produces it (if we reject the storks- bring- babies theory)

Accidental correlations should turn out to be transient—they disappear inexplicably, since they never were truly connected.



So, if we find a correlation between A's and B's, either:

(a) A causes B
(b) B causes A
(c) Some 3rd thing causes both (common cause)
(d) the correlation is accidental

IN CLASS WORKSHEET