



# **Advanced Logical Thinking Skills (2)**

*A Logical Explanation of Causal Relation*

by Paul W. L. Lai

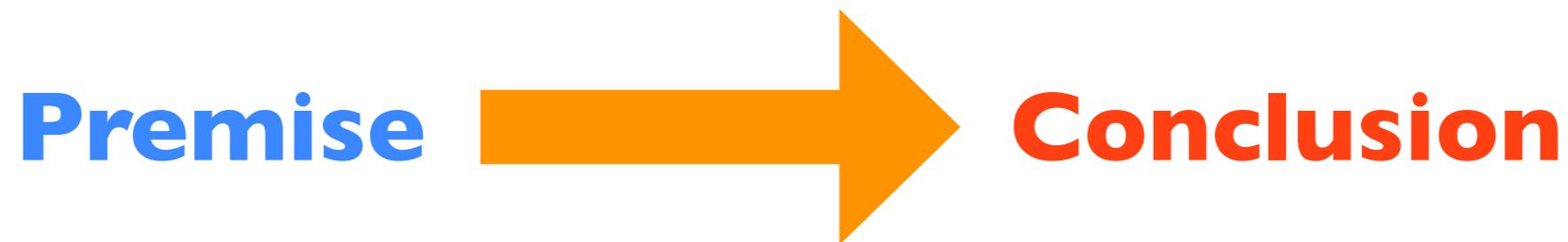
## Group Discussion:

Think about your thesis statement again, and judge whether it can be best supported through either

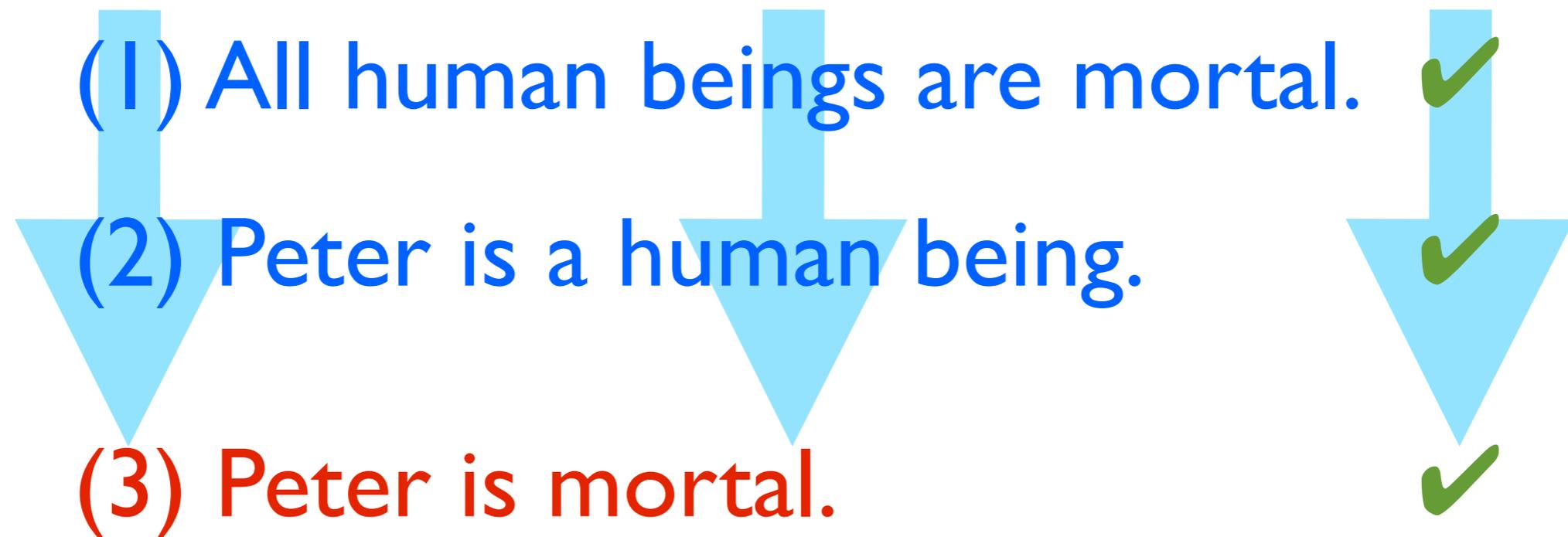
(1) a relation from group to individual

(2) a relation from individual to individual

**Logic is essentially a study of  
an inferential relation  
between premise and conclusion.**



Consider a typical logical argument:



A logical relation between  $P$  and  $C$  is a relation based on which the truth of  $C$  can be inferred from the truth of  $P$ .

# **Kinds of logical relation**

**Certainty**  
**Vs**  
**Probability**

# **Two Ways of building an inferential relation**

**(1) By associating with a group**

**(2) By eliminating possibilities**

**(1) By associating with a group**

**All human beings are mortal.  
Peter is a human being.  
Peter is mortal.**



**(2) By eliminating possibilities**

**e.g. Try the following:**

I could not submit my homework on Monday  
because my computer broke down on Saturday

My computer broke down on Saturday.



*The assignment must be done on a computer.*



*No other computer was available during the period.*



*My computer was not repaired in time.*



I could not submit my assignment on Monday.

**How to build an  
individual relation  
that can be  
logically related?**

A logical relation between  $P$  and  $C$  is a relation based on which the truth of  $C$  can be inferred from the truth of  $P$ .

Let us look at the  
relation between  
P and C  
and ask the following  
questions:

What makes P and C related?

What makes P and C unrelated?

# What makes P and C unrelated?

**Only two reasons!!**

# What makes P and C unrelated?

(1) The possibility for **P** to be related to **non-C**.

(2) The possibility for **non-P** to be related to **C**.

# What makes P and C related?

Eliminate the two possibilities!!!

~~(1) The possibility for **P** to be related to **non-C**.~~

~~(2) The possibility for **non-P** to be related to **C**.~~

e.g. Smoking causes heart disease.

What makes smoking and heart disease unrelated?

(1) The possibility for **smoking** to cause **non-heart disease**.

(2) The possibility for **heart disease** to be caused by **non-smoking**.

What makes smoking and heart disease related?

e.g. Smoking causes heart disease.

Eliminate the two possibilities!!!

(1) The possibility for **smoking** to cause **non-heart disease**.

(2) The possibility for **non-smoking** to cause **heart disease**.

Let us look at the  
relation between  
P and C

# Four possibilities between P & C

**P** → **C**  
e.g. Smoking causes heart disease

**non-P** → **C**  
e.g. Stress causes lung cancer.

**P** → **non-C**  
e.g. Smoking causes lung cancer.

**non-P** → **non-C**  
e.g. Non-smoking causes Non-heart disease.

What makes P and C related?

What makes P and C unrelated?

# What makes P and C unrelated?

**P** → **C**  
e.g. Smoking causes heart disease

**non-P** → **C**  
e.g. Stress causes lung cancer.

**P** → **non-C**  
e.g. Smoking causes lung cancer.

**non-P** → **non-C**  
e.g. Non-smoking causes Non-heart disease.

# What makes P and C unrelated?

(1) The possibility for **non-P** to be related to **C**.



(2) The possibility for **P** to be related to **non-C**.



# What makes P and C related?

Eliminate the two possibilities!!!

~~(1) The possibility for **P** to be related to **non-C**.~~

~~(2) The possibility for **non-P** to be related to **C**.~~

# What makes P and C related?



A new look at the  
***Necessary & Sufficient***  
Conditions between P and C

# Sufficient Condition



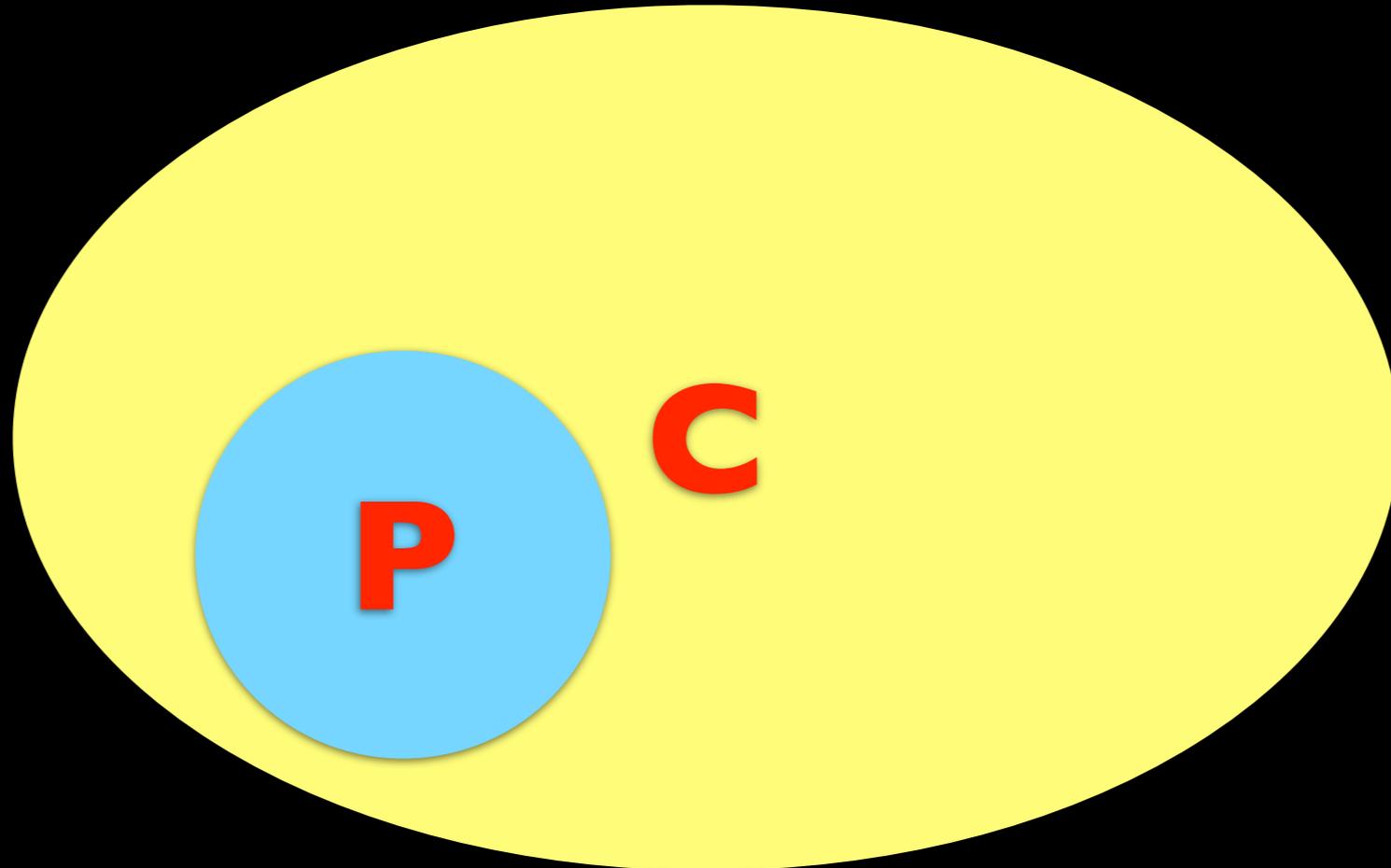
# Necessary Condition



If P, then C

**Sufficient  
condition**

**Necessary  
condition**



# Sufficient Condition

To say that the occurrence of  $P$  is a sufficient condition of the occurrence of  $C$  is just to say:

***If it is the case that  $P$ , then it is the case that  $C$ .***

***$P$ , therefore  $C$***



# Sufficient Condition

“P, therefore C”      **P**  **C**

suggests that the presence of P **guarantees** the presence of C. In other words, it is impossible for the presence of P without the presence of C. For example, if there is fire, then there is heat; the presence of fire guarantees the presence of heat. Thus it is impossible for the presence of fire without the presence of heat.

*However,* although the presence of P guarantees the presence of C, the absence of P does not guarantee the absence of C. Thus it is possible that the presence of C is caused by the presence of non-P. For, example, heat can be caused by electricity.

**Non-P**  **C**

If P, then C

**Sufficient  
condition**

**Necessary  
condition**

**Fire Heat**

**Explosion**

# Necessary Condition

To say that the occurrence of P is a necessary condition of the occurrence of C is just to say:

*If it is not the case that P, then it is not the case that C.*

***Not P, therefore Not C***

**non-P → non-C**

# Necessary Condition

“Not P, therefore Not C” **non-P**  $\longrightarrow$  **non-C**

suggests that the absence of P **guarantees** the absence of C. In other words, it is impossible for C to occur without the occurrence of P. For example, if there is no heat, then there is no fire.

*However*, it does not suggest that the occurrence of P (alone) is sufficient enough for causing the occurrence of C. Thus it is possible that the occurrence of C is not followed by the occurrence of P. For example, the occurrence of heat alone cannot cause the occurrence of fire.

**P**  $\longrightarrow$  **non-C**

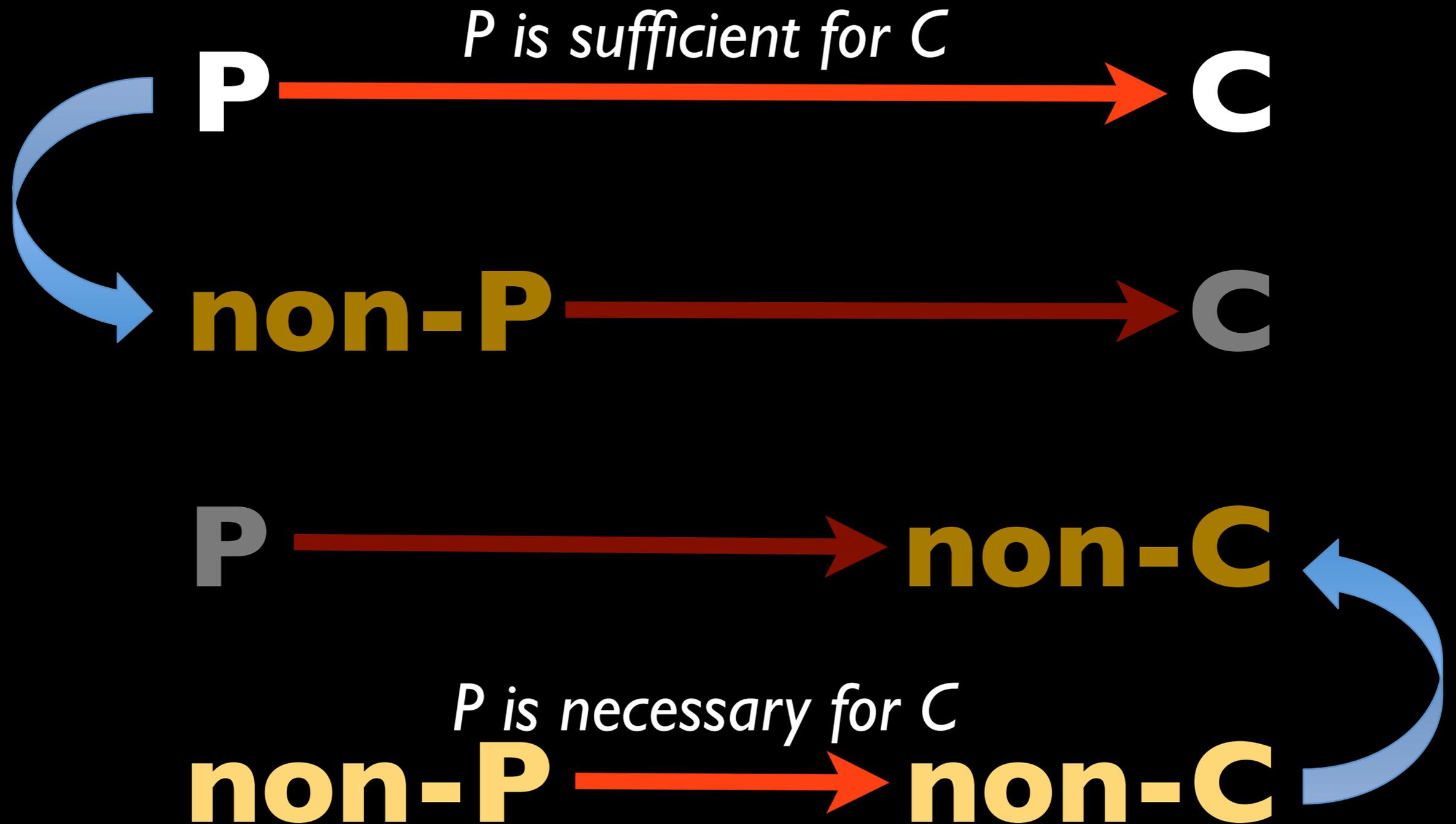
If P, then C

**Sufficient  
condition**

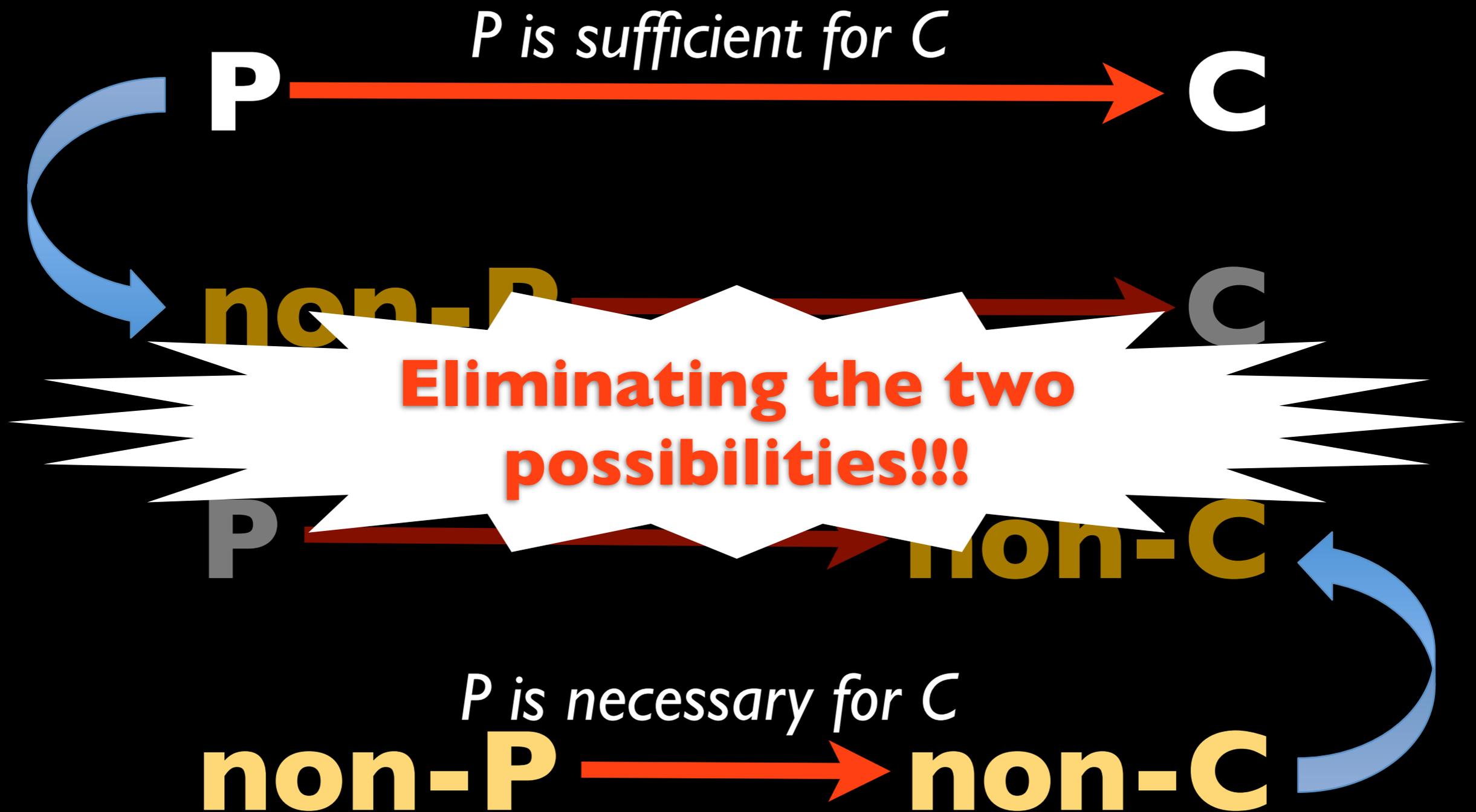
**Necessary  
condition**

**Fire Heat**

# Sufficient & Necessary Conditions



# Sufficient & Necessary Conditions

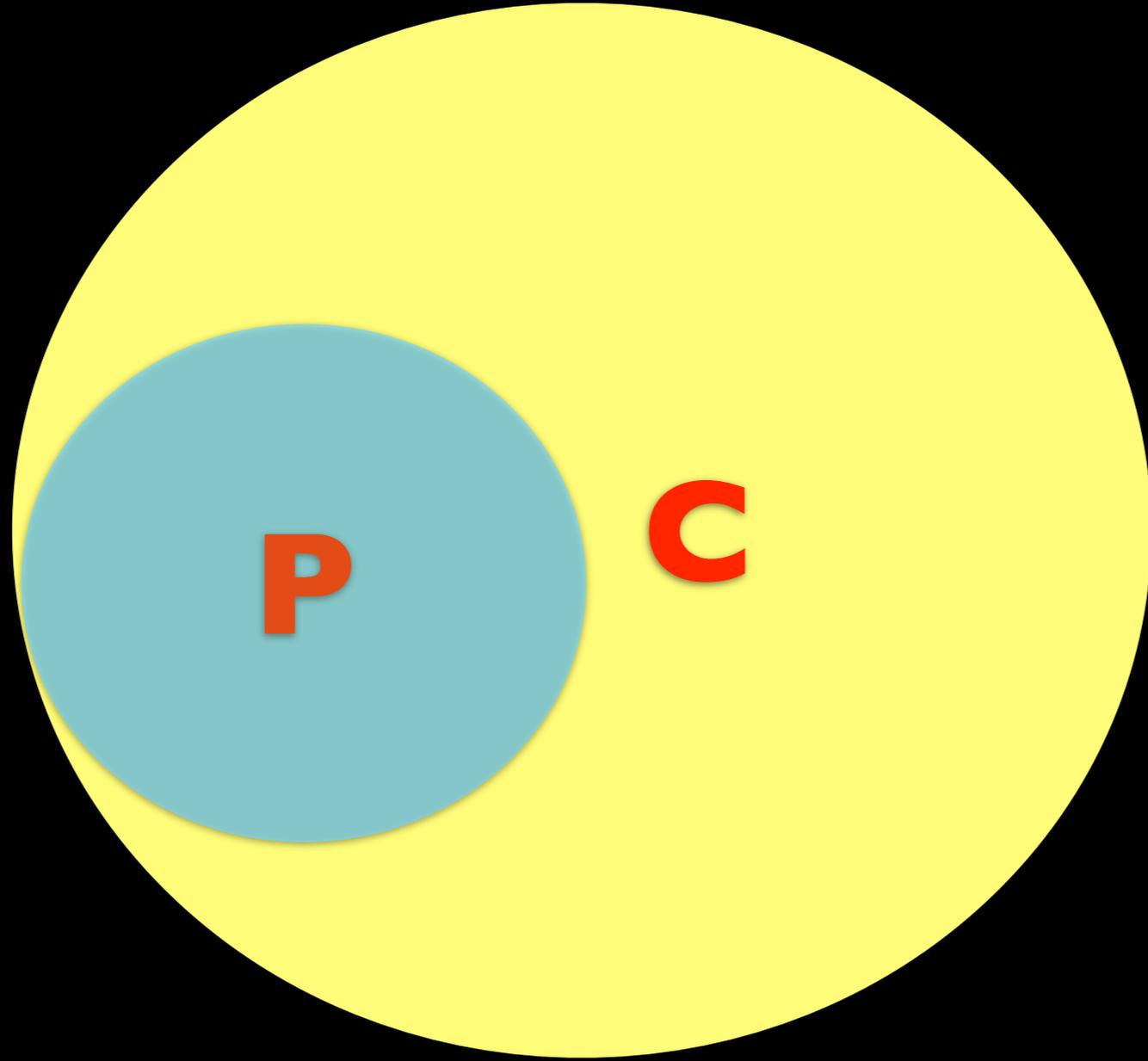


# Sufficient & Necessary Conditions



**Eliminating the two possibilities!!!**





Classwork:

Try building the premises for the following conclusion:

**Peter cannot come to school on Tuesday.**