

**CS 2710 Foundations of AI**  
**Lecture 15**

**Modeling uncertainty using  
probabilities**

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**KB systems. Medical example.**

We want to build a KB system for the **diagnosis of pneumonia**.

**Problem description:**

- **Disease:** pneumonia
- **Patient symptoms (findings, lab tests):**
  - Fever, Cough, Paleness, WBC (white blood cells) count, Chest pain, etc.

**Representation of a patient case:**

- Statements that hold (are true) for the patient.

E.g:        *Fever =True*  
              *Cough =False*  
              *WBCcount=High*

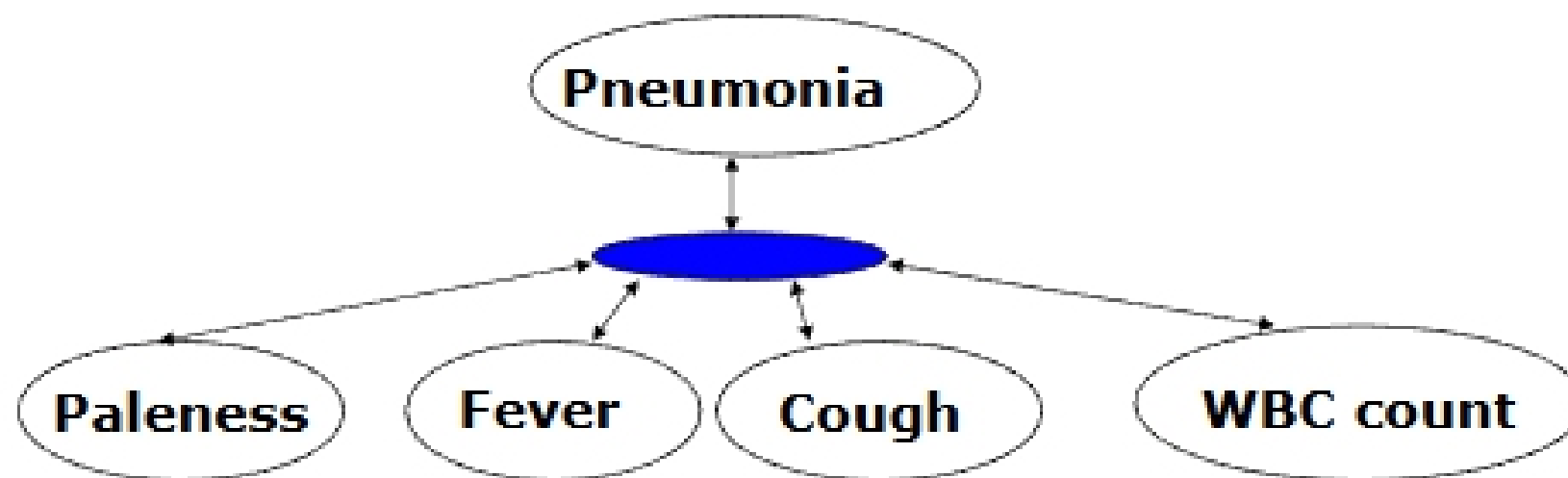
**Diagnostic task:** we want to decide whether the patient suffers from the pneumonia or not given the symptoms

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## Uncertainty

To make diagnostic inference possible we need to represent knowledge (axioms) that relate symptoms and diagnosis



**Problem:** disease/symptoms relations are not deterministic

- They are **uncertain (or stochastic)** and vary from patient to patient

## Uncertainty

**Two types of uncertainty:**

- **Disease → Symptoms uncertainty**
  - A patient suffering from pneumonia may not have fever all the times, may or may not have a cough, white blood cell test can be in a normal range.
- **Symptoms → Disease uncertainty**
  - High fever is typical for many diseases (e.g. bacterial diseases) and does not point specifically to pneumonia
  - Fever, cough, paleness, high WBC count combined do not always point to pneumonia

# Uncertainty

## Why are relations uncertain?

- **Observability**

- It is impossible to observe all relevant components of the world
- Observable components behave stochastically even if the underlying world is deterministic

- **Efficiency, capacity limits**

- It is often impossible to enumerate and model all components of the world and their relations
- abstractions can become stochastic

## Humans can reason with uncertainty !!!

- Can computer systems do the same?

# Modeling the uncertainty.

## Key challenges:

- How to represent the relations in the presence of uncertainty?
- How to manipulate such knowledge to make inferences?
  - **Humans can reason with uncertainty.**

