### **Research Findings on Improving Prompts for Differential Diagnosis**

After some research, I’ve found ways to help Small Language Models (SLMs) perform better in differential diagnosis tasks. Here’s a breakdown of what I learned, along with recommendations to get better outputs.

### **Two Main Approaches**

1. **Syndromic Approach (Pattern Recognition):**
   * In this method, the model looks for a pattern of symptoms that match a known condition.
   * **Example:** If a patient has symptoms like ankle arthritis, hilar lymphadenopathy, and a skin rash, this matches the pattern of **Löfgren’s syndrome**, a form of sarcoidosis.
   * **Best For:** Common or well-known conditions.
   * **Limitation:** It might miss rare or complex conditions.
2. **Checklist Approach (Step-by-Step Elimination):**
   * The model looks at each symptom individually and creates a list of possible causes for each. Then it compares and finds overlaps between the causes.
   * **Example:**
     + **For lymphadenopathy:** Could be sarcoidosis, tuberculosis, or lymphoma.
     + **For ankle swelling:** Could be arthritis, heart failure, or sarcoidosis.
     + The overlap suggests **sarcoidosis** might be a top possibility.
   * **Best For:** Rare or complex cases that require more thorough reasoning.
   * **Limitation:** Takes longer to process.

### **Hybrid Approach (What I Recommend)**

We can use both approaches together:

1. **Start with Syndromic Approach** for common conditions.
2. **Switch to the Checklist Approach** when symptoms don't fit a known pattern.

### **Example Prompts and Outputs**

#### **Andrew's Example Prompt:**

*"You are a medical expert. Consider the following patient presentation. Do a differential diagnosis."***Patient Presentation:** A 41-year-old man with ankle swelling, syncope, and lymphadenopathy.

### **Output from o3-mini Model:**

The model listed possible conditions such as sarcoidosis, Hodgkin lymphoma, and tuberculosis, but the reasoning was not well-structured. It also didn't clearly prioritize conditions or suggest tests for confirmation.

### **Refined Prompts**

#### **Option 1 – Step-by-Step Prompt**

*"You are a medical expert. The patient is a 41-year-old man presenting with ankle swelling, syncope, and bilateral lymphadenopathy. Provide the following:"*

1. **Top 3 likely diagnoses.**
2. **Short explanation** of why each diagnosis is likely.
3. **Tests** to confirm or rule out each diagnosis.

**Output Example:**

1. **Top 3 Diagnoses:**
   * Cardiac sarcoidosis
   * Hodgkin lymphoma
   * Chronic beryllium disease
2. **Explanation:**
   * **Cardiac Sarcoidosis:** Commonly causes lymphadenopathy, lung nodules, and heart-related symptoms like syncope.
   * **Hodgkin Lymphoma:** Can cause lymphadenopathy but lacks other key symptoms here.
   * **Chronic Beryllium Disease:** Rare but similar to sarcoidosis; requires exposure history.
3. **Recommended Tests:**
   * ECG, cardiac MRI, lymph node biopsy for sarcoidosis.
   * PET scan and blood tests for lymphoma.

#### **Option 2 – Syndromic + Checklist Prompt:**

*"You are a medical expert. Use both approaches to perform a diagnosis for this case:"*

1. **Identify a syndrome** that fits the pattern of symptoms.
2. **List possible causes** for each key symptom.
3. **Cross-check** the causes to find the condition that explains everything.
4. **Suggest next steps** (tests).

**Output Example:**

1. **Syndrome:** Löfgren’s syndrome (acute sarcoidosis).
2. **Possible Causes:**
   * Lymphadenopathy: Sarcoidosis, TB, lymphoma.
   * Ankle swelling: Sarcoidosis, arthritis, heart failure.
   * Syncope: Cardiac sarcoidosis, arrhythmia, or a mass.
3. **Conclusion:** Sarcoidosis explains all symptoms.
4. **Next Steps:** Cardiac MRI, PET scan, biopsy.

### **Doctor Preferences**

Doctors usually prefer **Option 1** because:

* It’s clear and concise.
* It prioritizes the most likely diagnoses.
* It includes actionable next steps.

Option 2 might work better for training or rare cases where a full breakdown is needed.

### **Key Takeaway**

We can improve SLM results by guiding the model with structured prompts that balance quick pattern recognition with thorough analysis when necessary. This hybrid approach can handle both common and complex cases efficiently.