LLM: ChatGPT 40

Type 1 Binary

question type": "Yes/No Questions (Binary Classification)

Original_question": "According to AAOS guidelines, is glucosamine sulfate recommended for knee osteoarthritis?

1. Technique: "Basic Prompting (Zero-shot):

Output: According to the American Academy of Orthopaedic Surgeons (AAOS) guidelines, glucosamine sulfate is *not* recommended for the treatment of knee osteoarthritis.

In the 2013 AAOS Clinical Practice Guideline on the Treatment of Osteoarthritis of the Knee (non-arthroplasty), the organization specifically recommends against the use of glucosamine and chondroitin sulfate due to a lack of convincing evidence of their efficacy in reducing pain or improving function in patients with knee OA.

Key points from the AAOS guidelines regarding glucosamine:

- **Recommendation strength**: Strong recommendation **against** the use of glucosamine and chondroitin.
- Reason: High-quality evidence shows that these supplements do **not provide clinically important improvement** in pain or function in patients with symptomatic knee osteoarthritis.
- The recommendation applies regardless of whether the glucosamine is in **sulfate or hydrochloride form**.

Thus, **glucosamine sulfate is not advised as part of standard care** for knee OA per AAOS recommendations.

If you are curious, **other organizations like OARSI and ACR** also provide guidelines on OA management, sometimes with nuanced positions on supplements like glucosamine, but AAOS is clear in its **negative recommendation**.

2. "technique": "Exemplar-based Prompting (Few-shot)",

"example_prompt": "Below are some examples of Yes/No medical guideline responses:\n1. Q: Is acetaminophen recommended for mild headaches? \rightarrow A: Yes, acetaminophen is commonly recommended for mild headaches.\n2. Q: Should antibiotics be used for viral infections? \rightarrow A: No, antibiotics are ineffective against viruses.\n\nNow, answer the following question:\nQ: According to AAOS guidelines, is glucosamine sulfate recommended for knee osteoarthritis?"

Output: A: No, according to AAOS (American Academy of Orthopaedic Surgeons) guidelines, glucosamine sulfate is **not recommended** for the treatment of knee osteoarthritis.

3. "technique": "Reasoning-oriented (Chain-of-Thought, CoT)",

"example_prompt": "Think step by step before answering.\n1. AAOS guidelines provide recommendations based on clinical evidence.\n2. Glucosamine sulfate has been studied for knee osteoarthritis.\n3. The AAOS stance is based on whether strong evidence supports its use.\n\nBased on these facts, is glucosamine sulfate recommended for knee osteoarthritis according to AAOS?"

Output: Let's think through this step by step:

- 1. AAOS guidelines The American Academy of Orthopaedic Surgeons (AAOS) provides recommendations based on clinical evidence, focusing on whether a treatment is supported by strong evidence to be effective.
- 2. Glucosamine sulfate This supplement has been studied for the treatment of knee osteoarthritis (OA), but studies have shown mixed or insufficient evidence regarding its effectiveness in reducing pain or improving function.
- 3. AAOS stance The AAOS's position depends on whether there is strong evidence supporting its use. According to their clinical practice guidelines, glucosamine sulfate is not recommended for patients with knee osteoarthritis because high-quality evidence does not support its effectiveness.

V Final Answer:

No, **glucosamine sulfate is not recommended** for knee osteoarthritis according to AAOS guidelines.

4."technique": "Complex Reasoning Variants (Tree-of-Thoughts, ToT)",

"example_prompt": "Break down the problem into multiple reasoning paths:\n- Path 1: Analyze the effectiveness of glucosamine sulfate in clinical studies.\n- Path 2: Examine AAOS guidelines and their stance on supplements.\n- Path 3: Weigh any conflicting recommendations. \n\nOnce each path is explored, determine whether AAOS recommends glucosamine sulfate for knee osteoarthritis."

Output:

Here's a step-by-step breakdown of the problem into multiple reasoning paths to analyze whether the **American Academy of Orthopaedic Surgeons (AAOS)** recommends **glucosamine sulfate** for knee osteoarthritis:

Path 1: Analyze the Effectiveness of Glucosamine Sulfate in Clinical Studies

- Glucosamine sulfate has been widely studied as a supplement for osteoarthritis (OA), especially knee OA.
- Some **early studies and meta-analyses** (mostly in Europe) suggested mild to moderate improvement in **pain relief** and **function**.
- However, larger and more rigorous randomized controlled trials (RCTs), such as the GAIT trial (Glucosamine/Chondroitin Arthritis Intervention Trial) in the U.S., have shown no significant difference from placebo in overall pain relief.
- The **results vary by formulation** glucosamine sulfate (especially patented crystalline form used in Europe) may have better evidence than glucosamine hydrochloride (used in some U.S. supplements), but overall **evidence remains inconsistent**.
- Systematic reviews (e.g., Cochrane Review) conclude that glucosamine sulfate may have a small benefit, but clinical significance is questionable.

Conclusion of Path 1: Evidence for glucosamine sulfate's efficacy in knee OA is mixed and limited, with many high-quality studies showing no meaningful benefit.

Path 2: Examine AAOS Guidelines and Their Stance on Supplements

- The AAOS Clinical Practice Guideline (CPG) for the Treatment of Osteoarthritis of the Knee (Non-Arthroplasty) provides evidence-based recommendations.
- In the **2013 guidelines** (and reaffirmed/updated later), **AAOS strongly recommends against** the use of **glucosamine and chondroitin sulfate** for patients with symptomatic knee OA.
- The reason: High-quality evidence fails to show clinically important improvement in pain or function compared to placebo.
- AAOS emphasizes treatments supported by stronger evidence, such as exercise therapy, weight loss, and non-steroidal anti-inflammatory drugs (NSAIDs) for certain cases.
- Conclusion of Path 2: AAOS guidelines advise against the use of glucosamine sulfate for knee osteoarthritis based on lack of efficacy in high-quality studies.

Path 3: Weigh Any Conflicting Recommendations

- Other organizations may vary in their stance:
 - European League Against Rheumatism (EULAR) has at times been more neutral or slightly supportive of certain glucosamine formulations (especially crystalline glucosamine sulfate).
 - Osteoarthritis Research Society International (OARSI) guidelines have shifted over time, sometimes indicating that glucosamine may be appropriate for certain patient subgroups.
- Differences in guidelines often arise due to geographical preferences in formulations, interpretation of trial data, or clinical judgment on patient-reported outcomes.
- Nonetheless, **AAOS** remains firm in its position, emphasizing lack of strong evidence supporting glucosamine sulfate.
- Conclusion of Path 3: While some international guidelines are more lenient, AAOS maintains a clear position against glucosamine sulfate, prioritizing treatments with stronger and more consistent evidence.
- **▼** Final Determination: Does AAOS Recommend Glucosamine Sulfate for Knee Osteoarthritis?

No, AAOS does not recommend glucosamine sulfate for knee osteoarthritis. In fact, AAOS recommends against its use based on high-level evidence showing no clinically important benefit.

5."technique": "Role-based Prompting (Persona/Role Prompting)",

"example_prompt": "You are a medical doctor specializing in osteoarthritis treatment. Your task is to answer based on AAOS guidelines.\n\nQ: According to AAOS guidelines, is glucosamine sulfate recommended for knee osteoarthritis?"

Output:

According to the American Academy of Orthopaedic Surgeons (AAOS) guidelines, glucosamine sulfate is not recommended for the treatment of knee osteoarthritis.

In the 2013 AAOS Clinical Practice Guidelines for the Treatment of Osteoarthritis of the Knee (Non-Arthroplasty), the recommendation against the use of glucosamine and chondroitin sulfate is based on high-quality evidence that shows these supplements do not provide clinically significant improvement in pain or function for patients with knee osteoarthritis.

Thus, AAOS does not recommend glucosamine sulfate as an effective treatment option for knee OA.

6. "technique": "Interactive/Conversational (Interactive Prompting)",

"example_prompt": "Let's work together to get the best answer.\n1. What do AAOS guidelines say about glucosamine sulfate?\n2. How does the clinical evidence support or contradict this recommendation?\n3. Based on this, do you think AAOS recommends it?\n\nProvide an initial answer, and we will refine it together."

Output:

1. What do AAOS guidelines say about glucosamine sulfate?

The American Academy of Orthopaedic Surgeons (AAOS) *does not recommend* the use of glucosamine sulfate for patients with symptomatic osteoarthritis of the knee. Their guidelines classify it as a treatment with **strong evidence against its use**, citing a lack of efficacy in reducing pain or improving function.

2. How does the clinical evidence support or contradict this recommendation?

Multiple high-quality randomized controlled trials (RCTs) and systematic reviews have examined glucosamine sulfate's effects on osteoarthritis. The majority of these studies have shown **no clinically meaningful benefit** compared to placebo, particularly regarding pain reduction and functional improvement. While some smaller studies or specific formulations suggested minor benefits, the overall body of evidence is inconsistent and does not support its routine use.

3. Based on this, do you think AAOS recommends it?

Based on both the guideline and supporting clinical evidence, **AAOS does not recommend glucosamine sulfate** for managing knee osteoarthritis. Their recommendation aligns with the broader consensus that glucosamine sulfate lacks sufficient efficacy to justify its use in standard clinical practice.

Type 2 Multiple choice questions

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"question_type": "Multiple-choice Questions (Reasoning & Knowledge Application)",
"original_question": "Based on training a 3-layer MLP (ReLU activation, batch
normalization) on the UCI Banknote dataset, does Adam optimizer converge faster than
SGD? ",
"options":
"A. Yes",
```

1."technique": "Basic Prompting (Zero-shot)",

"example_prompt": "Based on training a 3-layer MLP (ReLU activation, batch normalization) on the UCI Banknote dataset, does Adam optimizer converge faster than SGD?

A) Yes

"B. No",

B) No"

Output:

Answer: A) Yes Adam optimizer generally converges faster than SGD when training a 3-layer MLP with ReLU activation and batch normalization on the UCI Banknote dataset. Explanation: Adaptive Learning Rates: Adam dynamically adjusts learning rates for each parameter based on the first and second moments of the gradients, which helps accelerate convergence, especially in datasets with varying feature scales. Momentum Term: Adam incorporates momentum (similar to SGD with momentum), which helps in navigating the loss landscape more efficiently and reducing oscillations. Batch Normalization Effect: Batch normalization stabilizes training and can make SGD more competitive, but Adam still tends to converge faster due to its adaptive nature. Empirical Evidence: In practical experiments, Adam usually reaches a good accuracy level in fewer epochs compared to vanilla SGD. SGD often requires careful tuning of the learning rate and momentum to achieve competitive convergence speed. Thus, Adam generally converges faster than SGD for this setup.

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2."technique": "Exemplar-based Prompting (Few-shot)", "example_prompt": "Q: Example 1:
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Task: Image classification (ResNet-18)

Observation: Adam converges faster than SGD due to adaptive learning rates.

Example 2:

Task: Text generation (Transformer)

Observation: RMSProp reduces oscillations compared to Momentum.

- **Question**: For the banknote task (3-layer MLP, 4 input features), which optimizer is optimal?
- A) SGD (slow but stable)
- B) Adam (fast and stable)
- C) RMSProp (fastest but unstable)
- D) Momentum (moderate speed) "

Output:

For a **banknote authentication task** using a **3-layer MLP with 4 input features**, the optimal optimizer depends on convergence speed, stability, and generalization ability.

Analysis of Options:

- **(A) SGD**: Generally slower to converge due to fixed learning rates but provides stable updates.
- **(B)** Adam: Uses adaptive learning rates with momentum, converges fast, and is usually stable
- **(C) RMSProp**: Also adaptive but can be unstable if learning rate tuning is not done properly.
- **(D) Momentum**: Accelerates convergence with historical gradients but lacks adaptive learning.

Best Choice:

The banknote authentication task is a relatively simple classification problem with low-dimensional input (4 features) and a small MLP model. Adam generally performs well in such cases due to its ability to adapt learning rates per parameter and stabilize updates.

Optimal answer: (B) Adam (fast and stable)

- 3."technique": "Reasoning-oriented (Chain-of-Thought, CoT)", "example prompt": "Q:Analyze step-by-step:
- 1. **Convergence Speed**: Epochs to reach loss=0.05 (Adam:50, SGD:200, RMSProp:25).
- 2. **Stability**: Gradient oscillation range (Adam:±5%, RMSProp:±20%, SGD:±15%).
- 3. **Trade-off**: RMSProp converges fastest but risks early divergence.
- **Question**: Which optimizer is optimal overall?
- A) SGD
- B) Adam
- C) RMSProp
- D) None "

Output:

Let's analyze step by step:

1. Convergence Speed:

Adam: 50 epochs

° SGD: 200 epochs (slowest)

° RMSProp: 25 epochs (fastest)

X Worst: SGD

3. Stability:

 $^{\circ}$ Adam: $\pm 5\%$ (most stable)

° RMSProp: ±20% (least stable)

 $^{\circ}$ SGD: $\pm 15\%$

4. **V** Best: Adam

X Worst: RMSProp

5. Trade-off Consideration:

- ° RMSProp is the fastest but has a high risk of early divergence.
- Adam balances speed and stability well.
- SGD is the slowest and has moderate stability.

Optimal Choice:

- RMSProp is too unstable despite its speed.
- SGD is too slow.
- Adam provides a good balance between speed and stability.

Final Answer: B) Adam

- 4."technique": "Complex Reasoning Variants (Tree-of-Thoughts, ToT)",
 - "example_prompt": "Evaluate strategies for the banknote task (3-layer MLP, batch size=32):
- 1. **Adam** (learning rate=0.001)
- 2. **Adam + Learning Rate Decay** (lr=0.001→0.0001)
- 3. **RMSProp + Momentum** (lr=0.001, β =0.9)
- **Question**: Which strategy minimizes training divergence?
- A) Strategy 1
- B) Strategy 2
- C) Strategy 3
- D) All "

Output:

To evaluate which strategy minimizes training divergence, let's analyze each one in the context of a **3-layer MLP** trained on a **banknote authentication task**, assuming a standard dataset like the **Banknote Authentication Dataset**.

Analysis of Strategies:

1. Adam (lr=0.001)

- **Strengths:** Adaptive learning rates, robust to initial conditions, and often performs well without much tuning.
- **Weaknesses:** Can sometimes lead to unstable updates or divergence if the dataset has noisy gradients.

• **Expected Behavior:** Should converge well in most cases, but there is a slight risk of oscillations or instability.

2. Adam + Learning Rate Decay (lr= $0.001 \rightarrow 0.0001$)

- **Strengths:** Helps stabilize training, particularly in later stages, by gradually reducing the step size.
- Weaknesses: If decay is too aggressive, training may slow down too early.
- **Expected Behavior:** More stable than plain Adam. Less risk of training divergence due to the decaying step size.

3. RMSProp + Momentum (lr=0.001, β =0.9)

- **Strengths:** Helps smooth out gradients and provides acceleration in low-curvature regions.
- **Weaknesses:** RMSProp sometimes suffers from excessive decay if the dataset is highly non-stationary.
- **Expected Behavior:** RMSProp stabilizes training, but improper hyperparameter tuning can lead to divergence.

Which Strategy Minimizes Training Divergence?

- Strategy 1 (Adam alone): Can be stable, but there is a risk of divergence if the dataset contains abrupt gradient variations.
- Strategy 2 (Adam + LR Decay): Most stable, since reducing the learning rate prevents divergence in later epochs.
- **Strategy 3 (RMSProp + Momentum)**: Generally stable but can diverge in some edge cases if β is too high.

Thus, Strategy 2 (Adam + LR Decay) is the best option to minimize training divergence.

Final Answer:



5."technique": "Role-based Prompting (Persona/Role Prompting)",

"example_prompt": "Act as an AI consultant for a fintech company. Recommend an optimizer for real-time banknote fraud detection (3-layer MLP, UCI dataset):

- A) SGD (slow but low compute cost)
- B) Adam (fast, 99.5% accuracy)
- C) RMSProp (fast but unstable)
- D) Momentum (moderate speed) "

Output:

For a real-time banknote fraud detection system using a 3-layer MLP on the UCI dataset, the best choice is:

B) Adam (Adaptive Moment Estimation)

Reasons:

- **1. High Accuracy (99.5%)** → Since fraud detection requires high precision, Adam's superior accuracy is a key advantage.
- **2.** Fast Convergence → Adam optimizes faster than SGD and Momentum, making it suitable for real-time applications.
- **3.** Adaptive Learning Rates → It dynamically adjusts learning rates, handling both sparse and dense gradients effectively.
- **4.** Computational Efficiency → While slightly more expensive than SGD, its performance gain justifies the trade-off.

Alternative Considerations:

- SGD (Too Slow) → Not ideal for real-time scenarios.
- **RMSProp** (Unstable) → Could lead to inconsistent fraud detection performance.
- **Momentum** (Moderate) → A possible alternative if computational cost is a major concern, but it may not match Adam's accuracy.

Final Recommendation: Adam is the best choice for real-time banknote fraud detection due to its speed, accuracy, and stability.

6."technique": "Interactive/Conversational (Interactive Prompting)",

"example prompt": "Should I use SGD for stability in banknote classification?"

AI: "Adam matches SGD's stability ($\pm 5\%$ vs. $\pm 15\%$ gradient noise). Proceed with Adam?" Options:

A) Yes

B) No "

Output:

The best choice is:

A) Yes

Reasoning:

Adam (Adaptive Moment Estimation) generally provides more stable updates than standard Stochastic Gradient Descent (SGD) due to its adaptive learning rates for different parameters. Given that the gradient noise for Adam is $\pm 5\%$ compared to $\pm 15\%$ for SGD, Adam is more stable in training. Therefore, it is a better choice for the banknote classification task in this context.

Type_3_Computational_problems

"question_type": "Computational Problems & Questions (Mathematical Reasoning)", "questions":

"original question": "Solve for x: 3x + 5 = 14."

1."technique": "Basic Prompting (Zero-shot)",

"example prompt": "Solve for x in the equation: $\ln 3x + 5 = 14$."

Output:

To solve for x in the equation 3x + 5 = 14, follow these steps:

Step 1: Subtract 5 from both sides of the equation to isolate the term with x.

This gives: 3x = 14 - 5

Step 2: Simplify the right-hand side.

Now we have: 3x = 9

Step 3: Divide both sides of the equation by 3 to solve for x.

This gives: $x = 9 \div 3$

Step 4: Simplify the division.

So: x = 3

Final Answer: x = 3

2."technique": "Exemplar-based Prompting (Few-shot)",

"example_prompt": "Example responses:\n1. Q: Solve for x: 2x + 4 = 10.\n A: $2x = 6 \rightarrow x = 3$ \\n\n2. Q: Solve for x: 5x - 3 = 12.\n A: $5x = 15 \rightarrow x = 3$ \\n\nNow solve: 3x + 5 = 14."

Output:

A:
$$3x = 9 \rightarrow x = 3$$

3."technique": "Reasoning-oriented (Chain-of-Thought, CoT)",

"example_prompt": "Think step by step before solving:\n1. Start with the equation: 3x + 5 = 14.\n2. Subtract 5 from both sides: 3x = 9.\n3. Divide both sides by 3: x = 3.\n\nWhat is the value of x?"

Output:

Start with the equation 3x plus 5 equals 14. First, subtract 5 from both sides to get 3x equals 9. Then, divide both sides by 3 to get x equals 3. So, the value of x is 3.

4."technique": "Complex Reasoning Variants (Tree-of-Thoughts, ToT)",

"example_prompt": "Break the solution into multiple paths:\n- Path 1: Isolate x by first subtracting 5 from both sides.\n- Path 2: Solve for x by dividing both sides by 3.\n- Path 3: Verify the solution by plugging x back into the original equation.\n\nAfter analyzing these paths, determine the correct value of x."

Output:

Path 1: Isolate x by first subtracting 5 from both sides

Start with the equation: 3x plus 5 equals 20. Subtract 5 from both sides: 3x equals 20 minus 5.

This simplifies to: 3x equals 15.

Path 2: Solve for x by dividing both sides by 3

Take the result from Path 1: 3x equals 15.

Divide both sides by 3: x equals 15 divided by 3.

This simplifies to: x equals 5.

Path 3: Verify the solution by plugging x back into the original equation

Start with the original equation: 3x plus 5 equals 20.

Substitute x with 5: 3 times 5 plus 5 equals 20.

This simplifies to: 15 plus 5 equals 20.

Since 20 equals 20, the solution is verified as correct.

Final Answer:

The correct value of x is 5.

5."technique": "Role-based Prompting (Persona/Role Prompting)",

"example_prompt": "You are a mathematics tutor helping students solve linear equations. Provide a step-by-step explanation to solve for x in the equation: $\ln 3x + 5 = 14$."

Output:

Step 1: Understand the goal

We are asked to solve for \mathbf{x} , which means finding the value of \mathbf{x} that makes the equation true.

Step 2: Isolate the term with x

The given equation is:

$$3x + 5 = 14$$

First, subtract 5 from both sides to move the constant to the right side:

$$3x + 5 - 5 = 14 - 5$$

Simplify both sides:

3x = 9

Step 3: Solve for x

Now, divide both sides of the equation by $\mathbf{3}$ to isolate \mathbf{x} :

$$3\mathbf{x} \div 3 = 9 \div 3$$

Simplify:

x = 3

Final Answer:

x = 3

Step 4: Check the solution (optional but recommended)

Substitute x = 3 back into the original equation to verify:

$$3(3) + 5 = 9 + 5 = 14$$

Since both sides are equal, our solution is correct.

6."technique": "Interactive/Conversational (Interactive Prompting)",

"example_prompt": "Let's solve this together step by step.\n1. What happens if we subtract 5 from both sides?\n2. What is 14 - 5?\n3. Now, what do we get when we divide by 3?\n\nProvide an initial response, and we will refine it together."

Output:

Step 1: Subtract 5 from both sides of the equation.

Starting with the equation:

$$3x + 5 = 14$$

If we subtract 5 from both sides, we get:

$$3x + 5 - 5 = 14 - 5$$

This simplifies to:

3x = 9

Step 2: What is 14 minus 5?

14 - 5 = 9

Step 3: Divide both sides by 3 to solve for x.

3x/3 = 9/3

This simplifies to:

x = 3

Final Answer:

x = 3