ITEM #206 - SOS Ternary Mutual Inference for ACLM Gap Bridging

From Reachability to Structural Completion

Conversation: ACLM SOS 三元互算智能

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Abstract

Current ACLM implementations primarily exploit SOS primitives through **Calling Path reachability**, which only leverages a limited projection of the underlying knowledge intelligence embedded in the SOS ternary set. This ITEM formalizes and introduces the **SOS Ternary Mutual Inference** mechanisms—**SO→S, SS→O, OS→S**—and explains how they can be systematically applied to **ACLM Gap Bridging**, transforming unreachable paths into evaluable structural candidate spaces. This shift marks ACLM's transition from a path-finding system toward a structural completion and decision-oriented intelligence framework.

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1. SOS as Known-Knowledge Intelligence

ACLM is fundamentally built upon the **SOS primitive set**, representing known, historically occurred triples of the form:

(S,O,S′)(S, O, S')(S,O,S′)

These triples encode *known knowledge intelligence* rather than speculative inference. Existing ACLM Calling Graph algorithms utilize SOS primarily through **reachability analysis**, answering whether a state transition exists.

This use, however, represents only the **weakest operational form** of SOS intelligence.

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2. Limitation of Calling Path–Only Reasoning

Calling Path algorithms effectively project SOS knowledge into a Boolean reachability query:

- Input: S1S_1S1
- Output: Is S2S_2S2 reachable via some OOO?

This collapses a rich ternary knowledge tensor into a single-axis traversal problem, discarding most of the structural intelligence encoded in SOS.

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3. SOS Ternary Mutual Inference (SOS-TMI)

From a mathematical and logical standpoint, the SOS ternary set inherently supports **mutual inference**:

- **SO → S** : Given a subject and operation, infer plausible target states.
- **SS → O** : Given two states, infer plausible operations relating them.
- **OS → S** : Given an operation and resulting state, infer plausible originating states.

These inferences are not optional extensions; they are **inevitable consequences** of the SOS ternary structure once partial dimensions are fixed.

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4. Linguistic Interpretation and Generative Analogy

From a linguistic perspective:

- S, O, S correspond naturally to **subject–predicate–object** sentence structures.
- The SOS set is equivalent to all previously spoken "sentences" in a language.

A learner who has internalized such sentences can:

- Complete missing components ("three-missing-one" construction),
- Generate novel but structurally valid sentences never previously uttered.

This analogy directly explains why SOS-TMI is suitable for **Gap Bridging**, where explicit paths may not exist.

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5. Algorithmic Integration: A Practical Three-Tier Toolkit

To operationalize SOS-TMI, ACLM should prioritize broadly applicable and intuitive algorithmic strategies:

1. **LLM-style Next-Component Prediction**
   Exploratory generation of missing S or O candidates.
2. **Differential Tree + Two-Phase Search (Histogram / Decision)**
   Structural focusing on LHS with controlled evaluation of RHS candidate distributions.
3. **Differential Tree + Fast Single-Metric Prediction**
   Rapid, low-latency approximation for online or survival-oriented decisions.

SOS-TMI serves as a **shared candidate generator** for all three tiers, while scoring and selection strategies remain modular.

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6. Progressive Gap Reduction and the Long-Tail Reality

With SOS-TMI enabled, ACLM Gap Bridging becomes an iterative approximation process:

- Gaps shrink progressively.
- However, **Long-Tail Gaps remain inevitable** due to:
  - Open-world conditions,
  - Non-stationary environments,
  - Novel state and operation emergence.

This is not a failure of the algorithm but a structural property of reality.

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7. Survival Decision vs. Mathematical Absolutism

A critical distinction emerges in how unresolved Long-Tail gaps are handled:

- **Mathematical / Logical Decision Systems**
  - Demand absolute correctness.

- o Tend to stall or reject action under uncertainty.
- **Survival / Competitive Decision Systems**
  - o Accept bounded uncertainty.
  - o Favor timely decisions with compensatory mechanisms.

ACLM and DBM explicitly align with the latter, framing intelligence as **risk-aware structural decision-making**, not absolute logical proof.

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8. From Gap Filling to Decision Space Construction

The most important conceptual shift introduced by SOS-TMI is this:

Gaps are no longer treated as broken paths,
but as **constructible decision spaces** composed of structured, evaluable candidates.

This redefines ACLM from a graph traversal system into a **structural intelligence engine capable of operating beyond explicit reachability**.

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9. Conclusion

SOS Ternary Mutual Inference elevates ACLM beyond path existence checks, enabling it to actively construct and evaluate structural hypotheses under uncertainty. This evolution is foundational for scalable Gap Bridging, long-tail handling, and real-world intelligence systems where perfect knowledge is neither available nor required.

ITEM #206 - SOS 三元互算在 ACLM Gap Bridging 中的应用

从可达性到结构补全

摘要

当前 ACLM 的实现主要通过 **Calling Path 可达性分析** 来利用 SOS 语素集，这仅使用了 SOS 已知知识智能的一个低维投影。本文正式提出并系统化 **SOS 三元互算智能** （**SO→S、SS→O、OS→S**），并论证其在 ACLM Gap Bridging 中的核心作用：将不可达路径转化为可评估的结构候选空间，推动 ACLM 从路径搜索系统进化为结构补全与决策导向的智能框架。

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1. SOS 作为"已知知识智能"

ACLM 的根基是 SOS 三元语素集：

$(S,O,S')(S, O, S')(S,O,S')$

它代表的是**历史上已发生的结构事实**，而非假设性推理。
Calling Graph 算法仅利用了这些事实中的"是否存在路径"这一极弱形式。

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2. 仅使用 Calling Path 的结构缺陷

Calling Path 实质上把 SOS 张量压缩为：

- 从 $S1S\_1S1$ 出发
- 是否存在某个 OOO 可到达 $S2S\_2S2$

这在信息论意义上是严重降维，丢失了 SOS 中大部分结构智能。

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3. SOS 三元互算智能（SOS-TMI）

在数学与逻辑上，只要 SOS 三元集存在，下列互算必然成立：

- **SO → S**：已知主体与操作，推断可能的目标状态
- **SS → O**：已知两个状态，推断可能的连接操作
- **OS → S**：已知操作与结果状态，反推可能的起始状态

它们不是附加能力，而是 SOS 结构的内在必然结果。

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4. 语言视角下的生成原理

从语言角度看：

- S、O、S 对应主—谓—宾
- SOS 集即"世界上已经说过的句子集合"

掌握这些句子后，学习者自然具备：

- 三缺一补全能力
- 新句生成能力

这正是 SOS 三元互算可用于 Gap Bridging 的直观解释。

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5. 算法落地的三件套

在工程实现上，优先采用以下通用算法组合：

1. **类 LLM 的下一成分预测**（探索型）
2. **差分树 + 两步搜索 + Histogram 决策**（结构验证型）
3. **差分树 + 单指标快速预测**（生存决策型）

SOS 三元互算负责生成候选，评估与裁剪策略保持模块化。

6. Gap 收敛与 Long-Tail 的必然性

引入 SOS-TMI 后，ACLM Gap 会持续缩小，但 **永不完全消失**。
这是开放世界、非平稳环境的必然结果，而非算法缺陷。

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7. 生存决策与数理绝对性的分野

- **数理逻辑决策**：追求真伪绝对，难以容忍 Long-Tail
- **生存竞争决策**：允许不完备，在时间与回报中取胜

DBM / ACLM 明确站在后者立场，将智能视为**结构 + 时机 + 风险分配**。

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8. 从"补路径"到"造决策空间"

SOS 三元互算带来的根本转变在于：

Gap 不再是断裂点，
而是一个可构造、可评估、可进化的决策空间。

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9. 总结

SOS 三元互算是 ACLM 走出 Calling Path 局限、迈向结构智能与现实决策能力的关键一步。它使系统在路径不存在时仍能构造合理行动方案，为真实世界中的长期进化与竞争提供基础支撑。

SOS Known-Knowledge Store
Observed triples: (S, O, S')

SOS Ternary Mutual Inference (SOS-TMI)

SO → S'
Given (S,O), infer candidate S'

SS' → O
Given (S,S'), infer candidate O

O,S' → S
Given (O,S'), infer candidate S

Gap Expansion Zone
Candidate States / Ops / Transitions

Unresolved Path Gap
(unreachable / missing segment)

Decision / Scoring Stack (Three-Tier Toolkit)

(i) LLM-style Next-Component Prediction
Exploratory generation & recall boost

(ii) Differential Tree + Two-Phase Search
LHS focusing + RHS histogram + classic decision

(iii) Differential Tree + Fast Single-Metric Prediction
Low-latency survival decision

Gap Bridging Outputs
Actionable candidates + confidence/risk profile
Rollbackable + evolvable structure