Conceptual Map

1. Central Core: The LLM

- **LLM Core**
    - **Input:** Problem statements or user queries.
    - **Processing:** Generates internal reasoning and determines when to invoke tools.
    - **Output:** Combines reasoning output with actions (i.e., tool calls) to produce final answers.

2. Reasoning Pathways

This component encompasses the model's internal chain-of-thought and planning capabilities.

A. Explicit Chain-of-Thought Reasoning

- **ReAct Framework:**
    - **Workflow:**
        - **Step 1:** Generate "thoughts" (reasoning) →
        - **Step 2:** Decide on an "action" (tool invocation).
    - **Key Interaction:** The agent interleaves reasoning with explicit commands.
- **ReST meets ReAct:**
    - **Workflow:**
        - **Initial Reasoning:** Generate a chain-of-thought.
        - **Feedback Loop:** Revisit and self-improve by re-evaluating previous reasoning and actions.
    - **Key Interaction:** Iterative refinement enhances accuracy in both reasoning and tool use.

B. Implicit or Self-Supervised Reasoning

- **Toolformer:**
    - **Workflow:**
        - The LLM learns, during training, to recognize moments when external tools can improve its output.
        - Lacks an explicit chain-of-thought but incorporates implicit reasoning signals.
    - **Key Interaction:** The model self-discovers optimal moments for tool invocation without explicit intermediate steps.

C. Planning and Multi-Path Exploration

- **Language Agent Tree Search:**
    - **Workflow:**

        - **Tree Exploration:** The model generates a tree of potential reasoning and action pathways.
        - **Evaluation:** Each branch (which may include tool calls) is evaluated to select the optimal sequence.
    - **Key Interaction:** Integrates planning with tool decisions, allowing for forward and backward reasoning.

3. External Tool Use

This component details how the LLM interacts with external resources to augment its reasoning.

A. Direct Tool Invocation

- **ReAct & ReST meets ReAct:**
    - **Mechanism:**
        - The agent issues explicit commands to external tools (e.g., calculators, search engines) as soon as its internal reasoning identifies a gap.
    - **Interaction:**
        - The output from these tools is fed back into the chain-of-thought, aiding subsequent reasoning.

B. Self-Supervised Tool Integration

- **Toolformer:**
    - **Mechanism:**
        - During pre-training, the LLM learns the API formats and usage patterns of various tools.
        - It dynamically attaches tool outputs to enhance its answers.
    - **Interaction:**
        - The tool integration is learned rather than manually programmed, allowing the model to generalize across many tools.

C. Sequential and Modular Tool Chaining

- **Chain of Tools:**
    - **Workflow:**
        - **Step 1:** Decompose the task into sub-tasks.
        - **Step 2:** Sequentially invoke specialized tools to address each sub-task.
        - **Step 3:** Aggregate tool outputs into a cohesive final answer.
    - **Key Interaction:**
        - The modular approach ensures that each tool is used optimally in a step-by-step process, with outputs from one stage serving as inputs for the next.

4. Interactions & Feedback Loops

The conceptual map emphasizes the dynamic interplay between reasoning and tool use:

- **Feedback from Tools to Reasoning:**
    - Outputs from external tools (whether direct or via modular chains) are incorporated back into the LLM's reasoning process.
    - In the ReST meets ReAct and Tree Search frameworks, this feedback is essential for self-improvement and strategic planning.
- **Iterative Self-Improvement:**
    - The model can re-assess and refine its chain-of-thought based on tool outputs, reducing errors and optimizing the overall decision-making process.
- **Planning and Parallel Exploration:**
    - Through tree search, the LLM can simulate multiple tool usage scenarios simultaneously, ensuring that the chosen path is both efficient and robust.