ANALYTICAL METHODS TOOLKIT
Comprehensive Reference for Metacognitive Reasoning

CATEGORY A: TREE-BASED REASONING

1. Tree-of-Thought (ToT)
- Generate multiple reasoning paths
- Evaluate each branch
- Backtrack and explore alternatives
- Select best path
- **Use when:** Multiple viable approaches exist

2. Self-Pruned Tree-of-Thought
- Generate branches, prune weak ones early
- Focus resources on promising paths
- More efficient than full ToT
- **Use when:** Need efficiency with exploration

3. Monte Carlo Tree Search (MCTS)
- Balance exploration vs. exploitation
- Simulate outcomes, back-propagate values
- Guided search through solution space
- **Use when:** Large search space, uncertain values

4. Beam Search
- Keep top-k candidates at each step
- Parallel exploration of best options
- Balance breadth and depth
- **Use when:** Need multiple good solutions

CATEGORY B: MULTI-AGENT / PERSPECTIVE METHODS

5. Multi-Agent Debate
- Multiple agents with different positions
- Dialectical reasoning through argument
- Convergence through structured disagreement
- **Use when:** Controversial topics, need multiple views

6. Society of Mind
- Different specialized sub-agents
- Each handles different aspect
- Integration of perspectives
- **Use when:** Complex problems need decomposition

7. Perspective-Taking
- Systematically adopt different viewpoints
- Epistemic, ethical, cultural, temporal perspectives
- Synthesis across views
- **Use when:** Need comprehensive understanding

CATEGORY C: VERIFICATION & VALIDATION

8. Chain-of-Verification (CoVe)
- Generate baseline response
- Create verification questions
- Answer independently (avoid bias)
- Revise if inconsistent
- **Use when:** Factual accuracy critical

9. Self-Consistency
- Generate multiple independent responses
- Check consistency across them
- Majority voting or confidence-weighted selection
- **Use when:** Single answer unreliable

10. Adversarial Testing
- Generate claim
- Attack it rigorously as adversary
- Defend or revise as proponent
- **Use when:** Need robust claims

11. Recursive Verification
- Verify claim
- Verify the verification
- Multiple levels of checking
- **Use when:** High-stakes accuracy needed

CATEGORY D: DECOMPOSITION METHODS

12. Least-to-Most Prompting
- Break complex into simple subproblems
- Solve simple first
- Build up to complex solution
- **Use when:** Complex overwhelms direct approach

13. Subgoal Decomposition
- Identify required subgoals
- Solve each systematically

- Compose into solution
- **Use when:** Clear goal but unclear path

14. Hierarchical Task Analysis
- Break task into subtasks (multiple levels)
- Tree structure of dependencies
- Bottom-up execution
- **Use when:** Large projects need organization

CATEGORY E: SEARCH & EXPLORATION

15. Generate-and-Test
- Generate candidate solution
- Test against criteria
- Iterate until success
- **Use when:** Solution space enumerable

16. Hill Climbing
- Local search for improvements
- Move to better neighbor
- Risk: local maxima
- **Use when:** Gradient exists, local good enough

17. Simulated Annealing
- Allow worse moves probabilistically
- Escape local maxima via temperature parameter
- Gradual cooling
- **Use when:** Need global optimum

18. Genetic Algorithms
- Population of solutions
- Mutation and crossover
- Selection pressure over generations
- **Use when:** Complex fitness landscape

CATEGORY F: CONSTRAINT & LOGIC METHODS

19. Constraint Satisfaction
- Define all constraints
- Search for solution satisfying all
- Backtrack when violated
- **Use when:** Hard constraints must be met

20. Logic Programming

- Define rules and facts
- Query for logical conclusions
- Backward/forward chaining
- **Use when:** Formal reasoning needed

21. Proof Search
- Formal deduction from axioms
- Constructive proof building
- Mathematical rigor
- **Use when:** Mathematical/logical certainty required

CATEGORY G: META-REASONING

22. Meta-Learning
- Learn how to learn
- Extract strategies from experience
- Apply to new domains
- **Use when:** Pattern across problems exists

23. Analogical Reasoning
- Find similar past problems
- Map structural similarities
- Transfer solution approach
- **Use when:** Novel problem resembles known ones

24. Case-Based Reasoning
- Retrieve similar cases
- Adapt to current situation
- Learn from outcomes
- **Use when:** Experience base available

CATEGORY H: UNCERTAINTY & PROBABILITY

25. Bayesian Reasoning
- Start with prior beliefs
- Update with evidence
- Calculate posterior probabilities
- **Use when:** Uncertainty quantifiable

26. Expected Value Calculation
- Probability × Value for each outcome
- Compare expected utilities
- Optimize decisions
- **Use when:** Risk/reward trade-offs

27. Scenario Analysis
- Multiple plausible futures
- Probability-weighted outcomes
- Robust strategies across scenarios
- **Use when:** High uncertainty about future

CATEGORY I: CREATIVE & GENERATIVE

28. Lateral Thinking
- Break assumptions deliberately
- Random stimulus for new connections
- Provocation techniques
- **Use when:** Stuck in conventional thinking

29. Bisociation
- Connect distant domains
- Novel combinations create insight
- Cross-pollination of ideas
- **Use when:** Need creative breakthrough

30. SCAMPER
- Substitute, Combine, Adapt, Modify, Put to other use, Eliminate, Reverse
- Systematic creativity checklist
- **Use when:** Need structured ideation

CATEGORY J: CRITICAL ANALYSIS

31. Dialectical Reasoning
- Thesis → Antithesis → Synthesis
- Resolve contradictions at higher level
- Iterative refinement
- **Use when:** Opposing views both valid

32. Five Whys
- Ask "why" repeatedly (5+ times)
- Find root cause beyond symptoms
- Causal chain mapping
- **Use when:** Need to find root cause

33. Pre-Mortem Analysis
- Assume failure happened
- Work backward to likely causes
- Prevent failure proactively

- **Use when:** Planning high-stakes actions

34. Red Team / Blue Team
- Attack (red) vs. defend (blue)
- Find vulnerabilities systematically
- Improve through adversarial testing
- **Use when:** Need robustness testing

CATEGORY K: SYSTEMATIC METHODS

35. SWOT Analysis
- Strengths, Weaknesses (internal)
- Opportunities, Threats (external)
- Comprehensive strategic assessment
- **Use when:** Evaluating strategies/positions

36. Pareto Analysis
- Identify vital few (80/20 principle)
- Prioritize high-impact factors
- Focus effort efficiently
- **Use when:** Need prioritization

37. Root Cause Analysis
- Fishbone/Ishikawa diagrams
- Multiple causation paths
- Systematic investigation
- **Use when:** Complex system failures

38. Decision Matrix
- Criteria × Options grid
- Weighted scoring
- Quantitative comparison
- **Use when:** Multiple options, multiple criteria

CATEGORY L: METACOGNITIVE INTEGRATION

39. C_ORIENT Pre-Flight Scan
- Before every response: pause + risk scan
- Five categories: Overconfidence, Boundary, Stakeholder, Temporal, Frame
- Flag high risks, proceed with awareness
- **Use when:** ALWAYS (foundational)

40. Layered Analysis
- Quick scan first

- Deeper analysis if flagged
- Appropriate depth for complexity
- **Use when:** Efficient resource allocation needed

41. Multi-Method Triangulation
- Apply 3-5 different methods to same problem
- Compare insights from each
- Converging evidence = higher confidence
- **Use when:** Critical decisions, need validation

USAGE GUIDANCE

For Quick Problems (C1-3):
- C_ORIENT (always)
- Generate-and-Test
- Single verification method

For Moderate Problems (C4-6):
- C_ORIENT (always)
- 1-2 decomposition methods
- Chain-of-Verification
- Self-Consistency

For Complex Problems (C7-10):
- C_ORIENT (always)
- Tree-of-Thought or Self-Pruned ToT
- Multi-Agent Debate
- Multiple verification methods
- Multi-Method Triangulation

For Creative Problems:
- C_ORIENT
- Lateral Thinking or Bisociation
- Analogical Reasoning
- Extended pause for incubation

For High-Stakes Decisions:
- C_ORIENT
- Pre-Mortem Analysis
- Red Team / Blue Team
- Recursive Verification
- Bayesian updating

For Root Cause Investigation:
- Five Whys
- Root Cause Analysis (Fishbone)

- Constraint Satisfaction
- Dialectical Reasoning

COMBINATION STRATEGIES

Powerful Combinations:

1. **ToT + Adversarial Testing + Self-Consistency**
   - Explore paths, attack each, verify consistency
   - Comprehensive for critical reasoning

2. **Five Whys + Pre-Mortem + SWOT**
   - Understand causes, predict failures, assess position
   - Strategic planning

3. **Decomposition + Case-Based + Analogical**
   - Break down, find similar cases, map solutions
   - Novel problem-solving

4. **C_ORIENT + CoVe + Multi-Agent Debate**
   - Scan risks, verify claims, challenge from perspectives
   - Quality assurance

5. **Meta-Learning + Multi-Method Triangulation**
   - Extract patterns, validate with multiple approaches
   - Learning to learn

SELECTION HEURISTICS

Choose method based on:

Problem Type:
- Well-defined → Logic/Constraint methods
- Ill-defined → Creative/Exploration methods
- Uncertain → Probabilistic methods
- Complex → Decomposition methods

Resources Available:
- Time-limited → Quick methods (C_ORIENT, Generate-Test)
- Time-abundant → Thorough methods (MCTS, Recursive Verification)

Stakes:
- Low stakes → Single method sufficient
- High stakes → Multiple methods + verification

Novelty:
- Routine → Case-based, rules
- Novel → Analogical, creative methods
- Revolutionary → Lateral thinking, bisociation

Uncertainty:
- Low → Deterministic methods
- Medium → Scenario analysis
- High → Bayesian, multiple scenarios

PRACTICE RECOMMENDATION

Week 1-2: Master C_ORIENT + 3-5 core methods
Week 3-4: Add decomposition and verification methods
Week 5-8: Add creative and advanced methods
Month 3+: Fluid multi-method application

Core 5 to master first:
1. C_ORIENT (foundational)
2. Self-Pruned Tree-of-Thought
3. Chain-of-Verification
4. Adversarial Testing
5. Five Whys

Then expand systematically based on your work type.

Total: 41 analytical methods across 12 categories

Note: These methods compose well - use multiple for robust analysis. C_ORIENT should precede all others as foundation.