Okay, I've analyzed the new tutorial questions along with the past papers. Here's a consolidated list of facts and key concepts, tailored for MCQ preparation, focusing on the distinctions and core ideas frequently tested.

MCQ Facts & Key Concepts (from all provided documents)

General Metaheuristics & Search:

1. **Metaheuristic Definition:** A high-level strategy that guides a search process to efficiently explore a search space to find near-optimal solutions. (2023 Paper, Q20)
2. **Exploration vs. Exploitation (in EAs):**
   - **Exploration:** Searching new, unvisited areas of the search space (e.g., driven by mutation). (2022 Memo)
   - **Exploitation:** Refining solutions in promising, already discovered areas (e.g., driven by crossover). (2022 Memo)
3. **Iterated Local Search (ILS) Operators:** Key components include an initial solution, local search, perturbation operator, acceptance criterion, and termination condition. "Offspring" and "fitness proportionate" are not ILS operators. (2023 Paper, Q12; Tutorial 3, Q2)
4. **Iterated Local Search Nature:** A stochastic global optimization algorithm. (2023 Paper, Q7)
5. **Premature Convergence (in GAs):** Can be prevented by techniques like maintaining diversity through mutation, adjusting selection pressure, or using niching methods. (Tutorial 3, Q1f)
6. **Local Optima vs. Global Optimum:** A GA might get trapped in a local optimum. Observing the fitness over generations (plateauing) can indicate this; techniques like re-initialization or changing parameters might be needed. (Tutorial 3, Q1g)

1. Genetic Algorithm (GA):

7. Core Components: Population of individuals (chromosomes), fitness function, selection mechanism, genetic operators (crossover, mutation), and a termination condition. (Tutorial 3, Q1a)

8. Search Space: GAs search in the solution space. (2022 Memo, Q1; 2024 Paper, Q10)

9. Problem Suitability: Good for optimization and search problems, especially when the search space is large, complex, or not well-understood. Can handle various types of problems if a suitable representation and fitness function can be defined. (Tutorial 3, Q1b)

10. Fitness Function: Measures the quality/goodness of an individual (solution). It's crucial as it guides the selection process towards better solutions. (Tutorial 3, Q1c)

11. Parameter Choices (Population Size, Crossover/Mutation Rates): Often problem-dependent and require empirical tuning. Larger population = more diversity but slower; higher crossover = faster convergence but risk of premature convergence; higher mutation = more exploration but can disrupt good solutions. (Tutorial 3, Q1d)

12. Selection Methods:

* Tournament Selection: Randomly picks a few individuals, the best proceeds.
* Roulette Wheel Selection: Probability of selection proportional to fitness.
* Advantages/disadvantages relate to selection pressure and diversity. (Tutorial 3, Q1e)

13. Representation (for TSP - common example): A permutation of cities/campuses. (Tutorial 3, Q2f)
14. Crossover (for TSP): Order-based crossovers (e.g., PMX, Order Crossover) are needed to maintain valid permutations. Simple single/multi-point crossover can create invalid routes. (Tutorial 3, Q2g)
15. Mutation (for TSP): Swap mutation (swapping two cities), Inversion mutation (reversing a sub-sequence). (Tutorial 3, Q2h)
16. GA vs. Stochastic Hill-Climbing: While GAs are stochastic, calling them "stochastic hill-climbing" with a large population can be debated. Hill-climbing is typically a single-point search. GAs maintain a population and use recombination. (2024 Paper, Q3 - marked "False")
2. Grammatical Evolution (GE):
17. Search Space: GE searches in the program space.
18. Representation: Uses variable-length binary strings (codons). (2022 Memo, Q5)
19. Genotype-to-Phenotype Mapping: Involves using codons to select rules from a BNF grammar via a modulus operation. This creates a derivation tree (phenotype). (2022 Memo, Q5; 2023 Paper, Q22; 2024 Paper, Q15ii)
20. Not a GP Process: "Production rule mapping" is specific to GE, not GP. (2023 Paper, Q21)
21. Selection: Based on the fitness score of the derived phenotype. (2024 Paper, Q13)
3. Genetic Programming (GP):
22. Search Space: GP searches in the program space.
23. Representation: Traditionally uses syntax trees (programs). (2022 Memo, Q2)
24. Functionality: Can evolve executable expressions and may perform feature selection. (2022 Memo, Q2)
25. Bloat: A phenomenon where GP individuals (trees) grow excessively large without a significant fitness improvement. (2023 Paper, Q5)
26. Tree Generation Methods: Full, Grow, Ramped half-and-half. "Graph tree growth" is NOT a GP method. (2023 Paper, Q15)
27. As a Classifier: When GP evolves decision trees, it is a classification algorithm. (2023 Paper, Q17)
28. Symbolic Regression (Function/Terminal Sets):
* Function Set: Mathematical operators like +, -, *, / (protected). (2024 Paper, Q15a)
* Terminal Set: Independent variables (e.g., x) and constants. The dependent variable (e.g., y) is NOT in the terminal set. (2024 Paper, Q15b)
* Fitness Function: For regression, an error metric like MSE, RMSE, or MAE. (2024 Paper, Q15c)
4. Particle Swarm Optimization (PSO):
29. Problem Suitability: Well-suited for optimization problems with continuous functions. (2024 Paper, Q2 - "Continuous and differentiable functions" was the selected answer. While differentiability isn't strictly always needed, continuous is key).
30. Solution Representation: Each candidate solution is a particle. (2024 Paper, Q11)
31. Velocity Update: Particles update their velocity based on their own personal best (pbest) and the swarm's global best (gbest) position. (2024 Paper, Q9)
5. Ant Colony Optimisation (ACO):
32. Core Idea: A probabilistic technique for solving computational problems reducible to

finding good paths through graphs. (2023 Paper, Q10)
33. Path Choice Influence: The primary factor is the presence and intensity of pheromones on the path. (2024 Paper, Q6)
34. Problem Suitability: Well-suited for problems like the Travelling Salesman Problem (TSP). (2024 Paper, Q12)
6. K-Nearest Neighbor (KNN):
35. Core Idea: A non-parametric method that classifies a new data point based on the majority class of its 'K' nearest neighbors in the feature space.
36. Distance Metrics: Euclidean distance is common. Manhattan distance is another. (Machine Learning PDF, p.44)
* Euclidean: $\Sigma(xi-yi)2$
* Manhattan: $\Sigma|xi-yi|$
37. Data Preprocessing: Normalization/scaling of features is often important because features with larger ranges can dominate distance calculations.
7. Hopfield Neural Network:
38. Connectivity: A fully connected recurrent neural network. (2023 Paper, Q4)
39. Function: Performs associative memory (specifically autoassociative memory, recalling stored patterns from noisy/incomplete inputs). (2023 Paper, Q4)
40. Nature: It is a recurrent ANN. (2023 Paper, Q4)
41. State Updates: Units update their state asynchronously (one at a time, typically in a random order). (2023 Paper, Q3)
42. Weight Matrix Calculation (Autoassociation):
* For bipolar patterns (-1, 1): $W=\Sigma ppT-MI$ (where M is the number of patterns, I is identity matrix) or more simply $W=\Sigma ppT$ with $wii=0$.
* For binary patterns (0, 1), convert to bipolar first (e.g., $2p-1$) before calculating W, then set $wii=0$. (Lecture_Hopfield.pdf, p.18; COS314__SemII_Memo.pdf.pdf, Q9)
General Neural Network / Machine Learning Concepts:
43. Overfitting: Indicated by a large gap between training accuracy (high) and test accuracy (low). Methods to reduce it include Dropout. (2024 Paper, Q5)
44. Perceptron & Logic Functions:
* A single McCulloch-Pitts neuron (or a simple perceptron with a step activation) can learn linearly separable functions like AND, OR.
* The XOR function is not linearly separable and requires a multi-layer perceptron or a network with hidden layers.
* 2024 Paper, Q4 ("Which of the following cannot learn the OR function?") had "None of the stated" as a correct answer, implying a linear perceptron (with appropriate activation), a single sigmoid neuron, and a network of sigmoid neurons can learn OR.
45. Classification vs. Regression:
* Predicting a continuous value (e.g., "tomorrow's exact temperature") is regression learning. (2024 Paper, Q14)
* Assigning to discrete categories (e.g., "spam" or "not spam") is classification.
46. Desirable ANN Characteristic: Generalization (performing well on unseen data) is a key goal. (2022 Memo, Q3)

47. Loss Functions in ANNs: Binary Cross-Entropy, Mean Squared Error (MSE), Cross-Entropy Loss are all valid loss functions. Be aware of which apply to regression vs. classification. (2023 Paper, Q18 - "None of the stated" implies all listed were valid).
48. Pareto Front (Multi-Objective Optimization): A set of optimal solutions where no single objective can be improved without degrading at least one other objective. (2023 Paper, Q2)

This list should cover many of the core ideas that are likely to appear in MCQs based on the provided materials. Remember to understand the *why* behind these facts, not just memorize them!