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# Empowering Robots for Swift, Smart Decision-Making

## Description

In 2018, Google DeepMind's AlphaZero program demonstrated its ability to master chess, shogi, and Go through self-directed learning and a specialized algorithm that assessed optimal moves on a defined grid. Now, researchers at Caltech have adapted this idea for autonomous robots, crafting a planning and decision-making control system that enables these robots to navigate their surroundings effectively.

Soon-Jo Chung, Caltech's Bren Professor of Control and Dynamical Systems and a senior research scientist at JPL (managed by Caltech for NASA), notes, "Our algorithm strategizes by exploring various significant motions, ultimately selecting the best one through dynamic simulation." Their innovative approach is termed Spectral Expansion Tree Search (SETS), as detailed in the December edition of *Science Robotics*.

Robots, like humanoid assistants for the elderly, must maneuver freely, adapting to obstacles and unexpected situations. John Lathrop, a graduate student and co-lead author, emphasizes the need for SETS to automate decision-making rather than relying on designers to dictate movements. The algorithm employs control theory and linear algebra to maximize a robot's physical capabilities.

SETS employs a Monte Carlo Tree Search strategy, where potential moves are represented as nodes branching from a central idea. However, in continuous systems, the number of trajectories can quickly become overwhelming. To address this, SETS strikes a balance between exploring new routes and exploiting known effective ones.

Running in just a tenth of a second, SETS can simulate thousands of trajectories to identify the optimal path. It functions across various robotic applications, evidenced by its success in diverse experiments—from drone navigation to assisting drivers and coordinating tethered spacecraft. This innovative work, supported by esteemed agencies, paves the way for future advancements in robotics.

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## Vocabulary List:

1. **Autonomous** /ɔ:'tɒnəməs/ (adjective): Having the ability to operate independently.
2. **Algorithm** /'ælgərɪðəm/ (noun): A process or set of rules to be followed in calculations or problem-solving operations.
3. **Navigate** /'nævɪgeɪt/ (verb): To plan and direct the course of a vehicle or robot.
4. **Dynamics** /daɪ'næmɪks/ (noun): The forces or processes that produce change or development in a system.
5. **Optimal** /'ɒptɪmə/ (adjective): Most conducive to a favorable outcome; best.
6. **Simulation** /,sɪmjʊ'leɪʃən/ (noun): The imitation of a situation or process.



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## Comprehension Questions

### Multiple Choice

1. What did Google DeepMind's AlphaZero program demonstrate its ability to master in 2018?  
Option: Chess, shogi, and Go  
Option: Sudoku and crossword puzzles  
Option: Tic-tac-toe and checkers  
Option: Scratch programming language
2. What is the name of the approach adapted by researchers at Caltech for autonomous robots?  
Option: Spectral Expansion Tree Search (SETS)  
Option: Binary Search Algorithm  
Option: Greedy Algorithm  
Option: Bubble Sort
3. Which professor at Caltech is mentioned in the text as a key contributor to the research on autonomous robots?  
Option: Soon-Jo Chung  
Option: John Lathrop  
Option: Larry Page  
Option: Elon Musk
4. What key concept does SETS employ to maximize a robot's physical capabilities?  
Option: Control theory and linear algebra  
Option: Quantum physics  
Option: Astrophysics principles  
Option: Biological psychology theories
5. How does SETS handle the overwhelming number of trajectories in continuous systems?  
Option: Strikes a balance between exploring new routes and exploiting known effective ones  
Option: Selects the first trajectory it encounters  
Option: Randomly chooses a trajectory  
Option: Halts the exploration process
6. Which type of simulations can SETS conduct to identify the optimal path in a tenth of a second?



- Option: Thousands of trajectories
- Option: Hundreds of trajectories
- Option: A single trajectory
- Option: No simulations

**True-False**

- 7. Soon-Jo Chung is a graduate student at Caltech.
- 8. The success of SETS has been limited to drone navigation experiments only.
- 9. SETS uses a Greedy Algorithm for decision-making.
- 10. John Lathrop is a co-lead author involved in the development of SETS.
- 11. Monte Carlo Tree Search is a strategy employed by SETS to represent potential moves.
- 12. Control theory and linear algebra are not utilized by the SETS algorithm.

**Gap-Fill**

- 13. According to the text, SETS can simulate thousands of trajectories in just a \_\_\_\_\_ of a second.
- 14. John Lathrop emphasized the need for SETS to automate decision-making rather than relying on designers to dictate \_\_\_\_\_.
- 15. Soon-Jo Chung holds the position of Bren Professor of Control and Dynamical Systems at \_\_\_\_\_.
- 16. The innovative approach of SETS for autonomous robots is termed \_\_\_\_\_.
- 17. John Lathrop is a graduate student and \_\_\_\_\_ author of the research on autonomous robots.



18. Control theory and linear algebra are employed by SETS to maximize a robot's physical

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## Answer

**Multiple Choice:** 1. Chess, shogi, and Go 2. Spectral Expansion Tree Search (SETS) 3. Soon-Jo Chung 4. Control theory and linear algebra 5. Strikes a balance between exploring new routes and exploiting known effective ones 6. Thousands of trajectories

**True-False:** 7. False 8. False 9. False 10. True 11. True 12. False

**Gap-Fill:** 13. tenth 14. movements 15. Caltech 16. Spectral Expansion Tree Search 17. co-lead 18. capabilities

## Vocabulary quizzes

### Multiple Choice ( Select the Correct answer for each question. )

1. Which word describes an appetite or desire that is impossible to satisfy?

Option: Insatiable

Option: Treasure

Option: Lavish

Option: Allocate

2. Which term means to work together on a project or task?

Option: Accessibility

Option: Collaborates

Option: Enhance

Option: Competitors

3. Which word describes something that is difficult to handle or use because of its size or weight?

Option: Autonomous

Option: Cumbersome

Option: Enhance

Option: Nefarious

4. Which term refers to words or symbols that are engraved or written on a surface?

Option: Inscriptions

Option: Align

Option: Bracket



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Option: Scaffolding

5. Which word describes an imitation of a situation or process?

Option: Navigate

Option: Dynamics

Option: Optimal

Option: Simulation

6. Which term relates to one's family or cultural heritage?

Option: Postponement

Option: Aspirations

Option: Ancestral

Option: Underrated

7. Who are individuals or entities that are rivals in a particular field or competition?

Option: Accessibility

Option: Inclusive

Option: Retrospective

Option: Competitors

8. What term means the action of delaying an event or activity to a later time?

Option: Treasure

Option: Lavish

Option: Postponement

Option: Insatiable

9. Which word means to record or take possession of something using a camera or other device?

Option: Inclusive

Option: Capture

Option: Customizable

Option: Repel

10. Which term describes a support typically for a shelf or the bottom of something?

Option: Bracket

Option: Scaffolding

Option: Align

Option: Enhance

**Gap-Fill ( Fill in the blanks with the correct word from the vocabulary list. )**

11. The artist is \_\_\_\_\_ for his unique style and innovative approach to painting.

12. An \_\_\_\_\_ is a set of rules to be followed in calculations or problem-solving operations



often in computer science.

13. The captain used the stars to \_\_\_\_\_ his ship across the vast ocean.

14. The celebrity threw a \_\_\_\_\_ party to celebrate her birthday.

15. To achieve the \_\_\_\_\_ performance of your computer regular maintenance is essential.

16. Adding fresh herbs can \_\_\_\_\_ the flavor of this dish.

17. The new ramp provides \_\_\_\_\_ for wheelchair users to enter the building.

18. The software allows users to tailor the interface to their preferences; it is highly \_\_\_\_\_

19. The old map led the treasure hunters to a hidden \_\_\_\_\_ buried on the island.

20. Her career \_\_\_\_\_ include becoming a successful entrepreneur and owning her own business.

**Matching Sentences ( Match each definition to the correct word from the vocabulary list. )**

21. The strong smell of the insect repellent helped mosquitoes during the camping trip.
22. The drone flew on an mission to collect data in the remote forest.
23. The shelf was securely held up by the metal attached to the wall.
24. The construction workers used sturdy to reach the top of the building.
25. The political of the region changed rapidly after the election results were announced.
26. The club aims to be and welcomes members from all backgrounds.
27. The detective was on the trail of a criminal mastermind behind the series of bank heists.
28. The organization's goals are to with its mission of promoting sustainable practices.



29. The new lighting system will the ambiance of the dining area.

30. Her career include advancing to a leadership position within the company.

## Answer

**Multiple Choice:** 1. Insatiable 2. Collaborates 3. Cumbersome 4. Inscriptions 5. Simulation 6. Ancestral  
7. Competitors 8. Postponement 9. Capture 10. Bracket

**Gap-Fill:** 11. underrated 12. algorithm 13. navigate 14. lavish 15. optimal 16. enhance 17. accessibility  
18. customizable 19. treasure 20. aspirations

**Matching sentence:** 1. Repel 2. Autonomous 3. Bracket 4. Scaffolding 5. Dynamics 6. Inclusive 7. Nefarious  
8. Align 9. Enhance 10. Aspirations

## CATEGORY

1. Sci/Tech - LEVEL4

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