**VMW Edu**

**Scientific thinking, Mathematics, and Logic**

*12 Lessons, x3 Series*

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**Overview**

***Stage 1:***

- **Lesson 1** - Scientific thinking 1: Introduction
- **Lesson 2** - Logic 1: Introduction
- **Lesson 3** - Math fundamentals 1: Introduction
- **Lesson 4** - Scientific thinking 2: Structure
- **Lesson 5** - Logic 2: The rational detective
- **Lesson 6** - Math fundamentals 2: Numerical Reasoning
- **Lesson 7** - Scientific thinking 3: Flow
- **Lesson 8** - Logic 3: Puzzles and riddles
- **Lesson 9** - Math fundamentals 3: Logical reasoning
- **Lesson 10** - Computer science 1: Tools of computer science
- **Lesson 11** - Computer science 2: Computational Problem Solving
- **Lesson 12** - Applying logic - Scratch programming project (NON BRILLIANT)

***Stage 2:***

- **Lesson 1** - Scientific thinking 4: Light
- **Lesson 2** - Logic 4: Multi-level thinking
- **Lesson 3** - Math fundamentals 4: Visually Understanding Algebra
- **Lesson 4** - Scientific thinking 5: Relativity
- **Lesson 5** - Logic 5: Competitive games
- **Lesson 6** - Math fundamentals 5: Algebraic reasoning
- **Lesson 7** - Computer science 3: Algorithmic thinking
- **Lesson 8** -Logic 6: Logic machines
- **Lesson 9** - Applying logic - Scratch programming project (NON BRILLIANT)
- **Lesson 10** - Algorithm fundamentals 1: Building blocks
- **Lesson 11** - Neural networks 1: Introduction
- **Lesson 12** - Neural networks 2: Neurons

***Stage 3:***

- **Lesson 1** - Math fundamentals 6: What comes next?
- **Lesson 2** - Probability Fundamentals 1: Introduction
- **Lesson 3** - Logic 7: Advanced Knights and Knaves
- **Lesson 4** - Probability fundamentals 2: Starting with probability

- **Lesson 5** - Probability fundamentals 3: Roll the dice
- **Lesson 6** - Probability fundamentals 4: Fairness and expected value
- **Lesson 7** - Algorithm fundamentals 2: Array algorithms
- **Lesson 8** - Algorithm fundamentals 3: The Speed of algorithms
- **Lesson 9** - Artificial Neural Networks 1: Learning and the brain
- **Lesson 10** - Neural networks 3: Layers
- **Lesson 11** - Algorithm fundamentals 4: Stable Matching
- **Lesson 12 -** Applying logic - Scratch programming project (NON BRILLIANT)

**Topics covered:**

- **Scientific Thinking (5)**
  - Lessons 1.1, 1.4, 1.7, 2.1, 2.4
- **Logic (10)**
  - Lessons 1.2, 1.5, 1.8, 1.12, 2.2, 2.5, 2.8, 2.9, 3.3, 3.12
- **Mathematics (6)**
  - Lessons 1.3, 1.6, 1.9, 2.3, 2.6, 3.1
- **Probability (4)**
  - Lessons 3.2, 3.4, 3.5, 3.6
- **Computer Science (6)**
  - Lessons 1.10, 1.11, 1.12, 2.7, 2.9, 3.12
- **Artificial Intelligence and Neural Networks (8)**
  - Lessons 2.10, 2.11, 2.12, 3.7, 3.8, 3.9, 3.10, 3.11

**Agenda (Stage 1)**

| # | Title | Category | Activities (Brilliant.org) |
|---|---|---|---|
| 1 | Scientific thinking 1: Introduction | Scientific thinking | Information theory: measuring uncertainty ('Entropy', 'Information Decreases Uncertainty)<br><br>Bayesian thinking and Baye's rule ('Bayesian Thinking')<br><br>Applying bayesian logic to science<br><br>**Homework problem:** If you are given this research question and tools, which experiments would best answer it? |
| 2 | Logic 1: Introduction | Logic | Luk Tsut K'i classic boardgame problem<br><br>Introduction to logical reasoning |

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| | | | (Logical Reasoning)<br><br>Syllogisms and Sets: if X and Y are in group Z, what rules can we use to relate them? ('All, some, and none')<br><br>First-Order Logic - representing logical statement with correct notation ('Formal Symbolization')<br><br>Knights and Knaves puzzle: an introduction to advanced logic ('Knights and Formal Logic')<br><br>**Homework problem:** Worksheet of logic puzzles - to be marked in class |
| 3 | Math fundamentals 1: Introduction | Mathematics | Introduction to AND, OR, and NOT gates.<br><br>Arithmetic with logic gates ('Creating a Binary Comparator')<br><br>Multi-level logic contingencies and generality ('Multiple Generality')<br><br>Basis of logic in ordinary differential equations (ODEs) example ('Challenge: Higher-Order Equations')<br><br>**Homework problem:** Worksheet of math puzzles and basic algebra |
| 4 | Scientific thinking 2: Structure | Scientific Thinking | The laws of nature and devising a scientific question ('Nature is a Puzzle', 'Science Rules', 'House of Mirrors')<br><br>Integrating logic, mathematics, and algorithms to solve scientific questions<br><br>**Homework problem:** Prepare for next class one scientific experiment from history and how they employed the process discussed today |
| 5 | Logic 2: The rational | Logic | Riddles of order |

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| | detective | | Crafty counting<br><br>Mystery Containers<br><br>Futoshiki<br><br>Shuffles<br><br>False information<br><br>**Homework problem:** Worksheet of logic puzzles - to be marked in class |
| 6 | Math fundamentals 2: Numerical Reasoning | Math | Identifying equations and variables from everyday life (‘Equations and Variables’)<br><br>Combination locks - how much information is needed to fully describe a system? (‘Combination locks’)<br><br>Permutations - how to organise information (‘Permutations’)<br><br>**Homework problem:** Calculating the minima of curves to determine minimum cost/time in word problems (to be applied to computer science) |
| 7 | Scientific thinking 3: Flow | Scientific Thinking | Vectors, Matrices, and mathematics for neural networks (‘Optimization for Neural Networks’)<br><br>Introduction to perceptrons (‘Perceptrons as linear classifiers’)<br><br>The universal approximator, an artificial neural network for any challenge (‘The Universal Approximator’)<br><br>(‘Paradox and the Limits of AI’)<br><br>**Homework problem:** Take-home quiz, 3 long-form answers to flow questions |
| 8 | Logic 3: Puzzles and | Logic | Brilliant activities - Werewolves |

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| | riddles | | Logical language<br><br>If A then B<br><br>Elimination grids<br><br>Jigsaw map<br><br>**Homework problem:** Find the correct solution to this Jigsaw map, like the one discussed in class |
| 9 | Math fundamentals 3: Logical reasoning | Mathematics, Logic | Thinking probabilistically ('Intro to Probability')<br><br>Baye's Theorem and conditional probability ('Applying Conditional Probability')<br><br>Real-world probability puzzle ('Problem Solving')<br><br>Probability in scientific problems ('Probability in Science')<br><br>**Homework problem:** Math and logic problem set |
| 10 | Computer science 1: Tools of computer science | Computer Science | The principle of parallel processing: in which order should these tasks be done? (IBM puzzle)('Parallelism')<br><br>Introduction to Algorithms: breaking challenges into step-by-step processes ('Algorithms and Implementations', 'Divide and Conquer')<br><br>**Homework problem:** Watch the youtube video of the binary calculator made from marbles - https://youtu.be/i1e0T7IAELQ |
| 11 | Computer science 2: Computational Problem Solving | Computer Science | Conditional algorithms: the application of logic gates ('Conditional Algorithms') |

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| | | | Counting operations, multi-level logic in programming (‘Counting Operations’)<br><br>**Homework problem:** Build your own basic calculator in PyCharm |
| 12 | Applying logic - Scratch programming project (NON BRILLIANT) | Computer Science, AI | The computer vision problem: pixel processing vs human intelligence example (‘The Computer Vision Problem’)<br><br>Artificial neurons - encoding simple logical operations (‘The Decision Box’)<br><br>Building an XOR gate: Escaping the limitations of neurons by stacking them in layers (‘XOR Gates’)<br><br>**Final lesson, no homework!** |