1. **Title:** How deep is your learning?

3. **Module Description:** Neuroscience helped inspire the deep learning and reinforcement learning advances that led to an AI renaissance. This course introduces the links between cortical architecture and deep learning artificial neural networks, between dopamine neuron activity and reinforcement learning algorithms; the links between simple statistical models and deep learning, between control theory and reinforcement learning algorithms; and potential vulnerabilities of AI usage. Differences between biological and machine learning are explored. Workshops provide introductory coding experience in machine learning and computational neuroscience. We discuss potential medical applications of the algorithms to aiding diagnosis, decoding neural activity for brain-machine interfaces, and crafting patient-management plans.

4. **Learning outcomes:** Students should be able to gain some appreciation of AI’s links with neuroscience, statistics, and control theory; potential vulnerabilities of the technology’s usage, and its potential applications in medicine.

12. **Workload hours:**

   (i) **Lecture:** 10 hours

   (ii) **Tutorial:**

   (iii) **Computer laboratory:** 10 hours

   (iv) **Fieldwork, projects, assignments, etc.:**

   (v) **Preparatory work:**

   **Total:** 20 hours

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**Part B**

*(Please provide operational details which may vary every time the module is taught, subject to the approval of the Department)*

1. **Module Lecturer(s):**
   (Indicate Name and Department.)

   (i) **Principal lecturer(s):** Andrew Tan, Ngiam Kee Yuan, Dean Ho

   (ii) **Alternative lecturer(s):**

2. **Maximum Class Size:** 20

3. **Syllabus (Outline)**

   Day 1
Day 1
Lecture: Visual object recognition, cortical architecture, and deep learning; potential medical applications of deep learning: analysis of medical images, decoding speech for a brain-machine interface
Workshop: Introductory coding of simple statistical models, and deep learning models with MNIST

Day 2
Lecture: Fooling and being fooled by AI; vulnerability to noise, distortion, and adversarial examples; interpretability, correlation and causation; generative adversarial networks
Workshop: Adversarial deep learning with MNIST

Day 3
Lecture: Biological learning; potential medical application: stroke rehabilitation
Workshop: Introductory coding of computational neuroscience models; Hodgkin-Huxley neuron, integrate-and-fire neuron, Morris water maze learning

Day 4
Lecture: Prediction-error-driven learning and reinforcement learning algorithms; control theory and reinforcement learning; potential medical application: q-learning for sepsis treatment
Workshop: Introductory coding of reinforcement learning models; cartpole balancing with q-learning and DQN algorithms

Day 5
Lecture: Clinical Applications of Neural Networks
Transforming the Practice of Medicine (Dr. Ngiam Kee Yuan)
Lecture: AI for personalized medicine at The N.1 Institute for Health (Prof Dean Ho)

5. Modes of Teaching and Learning:
(E.g., lectures, regular tests, Q&A, IVLE, problem-based learning, blended learning.)
Lectures, computer laboratories

7. Illustrative Reading List
(optional)