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# FIT5047 Fundamentals of Artificial Intelligence

## Exam and Study Topics

Southeast University-Monash University
Joint Graduate School
Suzhou, China
2021

# Agenda

- **Topics**
- **Practice questions and Mock exam**
- **About the exam**
- **Staff consultation**

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# FIT5047 Fundamentals of Artificial Intelligence

## Topics

# Topics

- **LN1: Introduction to AI**
- **LN2: Intelligent Agents**
- **LN3: Problem solving as search, Game playing**
- **LN4: Knowledge representation: propositional and predicate calculus**
- **LN5: Probability**
- **LN6: Bayesian networks**
- **LN7: Machine learning: supervised and unsupervised**

# LN1 and LN2

- **LN1: Introduction to Artificial Intelligence**
  - Definition
  - Problems attacked in AI
  - Turing test
  - History and state of the art
- **LN2: Agents**
  - Rationality
  - PEAS (Performance measure, Environment, Actuators, Sensors)
  - Environment types
  - Agent types

# LN3 – Problem solving as search

- **Problem formulation: state description (with initial state), goal test, operators, cost function**
- **Search: Control strategies**
  - Tentative
    - > Backtrack
    - > Graphsearch (BFS, UCS, DFS, DLS, ID-DFS, Greedy BestFS, A and A*) 年年考
    - > Properties
  - ~~Irrevocable~~
    - ~~> Hill climbing, simulated annealing~~
    - ~~> Genetic algorithms – fitness function, crossover and mutation~~
- **Game playing**
  - Minimax, $\alpha$-$\beta$ algorithm

# LN4 – Knowledge representation (I)

- **Propositional logic**
  - Syntax and semantics
    - > Example: (HUNGRY ∨ ¬PASS_EXAM) ⇒ SAD
  - Logical equivalence
  - Validity and Satisfiability
  - Resolution-refutation
  - Inference: Forward and backward reasoning

# LN4 – Knowledge representation (II)

- **First-order logic**
  - Syntax and semantics
    - > Example:
      - » *Not every Bayesian Network (BN) can represent (CR) every joint distribution (JD) of the same variables (SV).*
        $\neg\{\forall x\ \forall y\ JD(y) \wedge BN(x) \wedge SV(x,y) \Rightarrow CR(x,y)\}$ OR
        $\exists x\ \exists y\ JD(y) \wedge BN(x) \wedge SV(x,y) \wedge \neg CR(x,y)$
      - » *Jim's spouse is female*:
        $\forall x\ SPOUSE(Jim,x) \Rightarrow FEMALE(x)$
  - Well formed formulas
  - Logical equivalence

# LN4 – Knowledge representation (III)

- **Inference: resolution refutation systems**
  - Unification and substitution
    - > Unify takes two atomic sentences p and q and returns a substitution that makes them look the same
      - » unify(p,q)= θ where subst(θ,p)=subst(θ,q)
  - Converting wffs to clauses
  - Resolution refutation
    - > Provides a complete, algorithmic FOL proof procedure
      - » Unify the complementary literals and apply the mgu to the rest of the resolvent

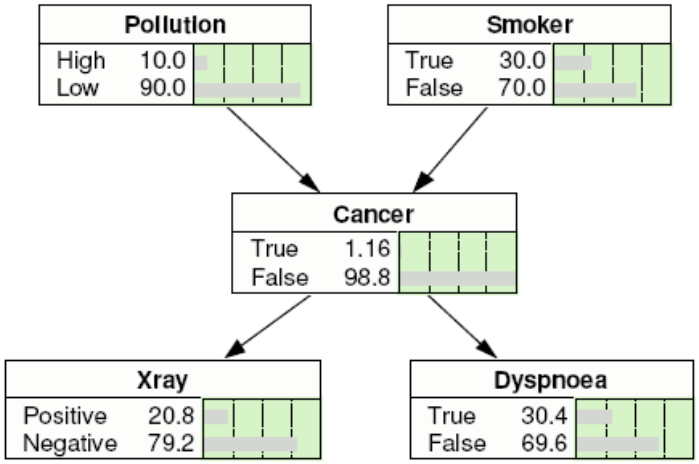
$$\frac{p_1 \vee \ldots \vee \underline{\mathbf{p_j}} \vee \ldots \vee p_n \qquad\qquad q_1 \vee \ldots \vee \underline{\mathbf{q_k}} \vee \ldots \vee q_m}{\text{subst}(\theta, p_1 \vee \ldots \vee p_{j-1} \vee p_{j+1} \vee \ldots \vee p_n \vee q_1 \vee \ldots \vee q_{k-1} \vee q_{k+1} \vee \ldots \vee q_m)}$$

# LN5 – Probability

- **Probability Theory**
  - ~~Random variables~~
  - ~~Joint and marginal probabilities~~
  - ~~Conditional probability~~
  - ~~Normalization~~
  - ~~Product rule, Chain rule, Bayes rule~~
  - ~~Independence, Conditional independence~~

# LN6 – Bayesian Networks (I)

- **Representation and inference**
  - Encode dependency structure between random variables
  - Allow us to easily update our beliefs given new evidence

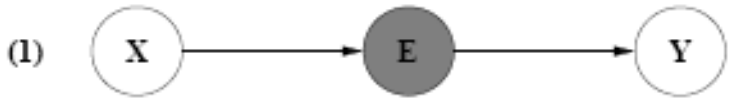



  - Definitions
  - Joint probability distributions
  - Conditional Probability Tables (CPTs)

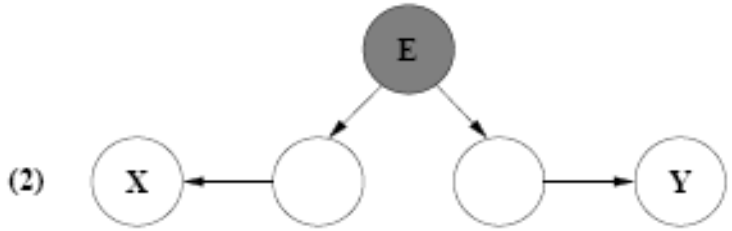
# LN6 – Bayesian Networks (II)

- **Conditional independence and D-separation**

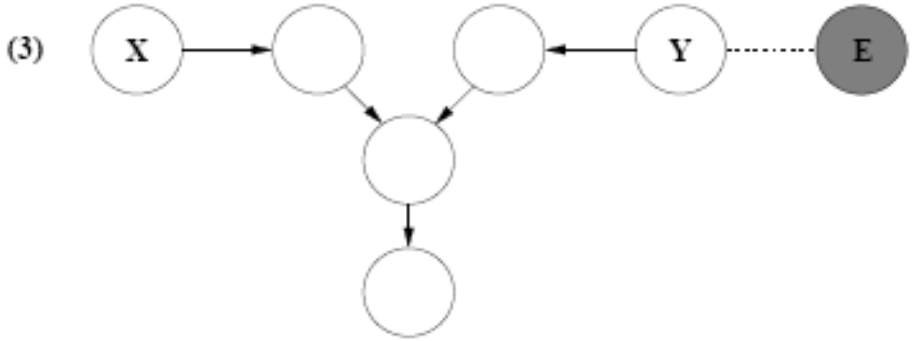
Chain




Common cause




Common effect



# LN6 – Bayesian Networks (III)

- **Decision Networks**
  - Select the action that maximizes expected utility

$$EU(A \mid E) = \sum_i \Pr(O_i \mid E, A) U(O_i \mid A)$$

- **Exact inference**
  - Inference by enumeration
  - Variable elimination

# LN7 – Machine learning

- **Principles and concepts**
- **Supervised Learning**
  - Determining classifier performance
  - Decision Trees
    > Entropy and Information Gain
  - Naïve Bayes classifier
    > MLE, ELE
  - ~~K Nearest Neighbour~~
  - Regression
  - ~~Classification with thresholds~~
    ~~> Regression, Logistic regression~~
- **Unsupervised Learning**
  - ~~K means algorithm~~

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## Practice Questions and Mock Exam

# Types of Questions

- **Tutorials**
  - Solutions to tutorials are on Moodle
  - *Warning:* Avoid being dependent on the sample solutions
- **Labs**
- **Practice questions and mock exam (will be posted on Moodle)**
- **No multiple-choice questions!**

# About the Exam

- **Exam time: 10 June (Thursday), 7:30 AM (Suzhou Time)**
- **10 minutes reading time**
- **2 hours duration**
- **You will need a calculator**
- **eExam: closed-book and invigilated**
- **Handwritten answers only**
- **100 total marks**
- **Marks are roughly proportional to time in lectures**
  - But we can't represent everything in a 2-hour exam

# FIT5047 eExam Instructions I

## Instructions

- **This exam accounts for 60% of the total assessment in FIT5047.**
- **Total marks for the exam: 100.**
- **You must answer all 11 questions.**
- **To submit an answer, photograph your handwritten work (using a phone or tablet) and follow the instructions at the end of each question.**
- **In your handwritten work, indicate which part of the question you are answering to; for instance, "Q1.a" for part (a) of question 1.**
- **In your handwritten work, answer all parts of a question in order. For instance, first "Q3.a", then "Q3.b", then "Q3.c", and so on and so forth.**

## Authorised Materials

- **Closed Book**
- **Calculator**
- **Working Sheets (Blank A4 papers): 4**
- **Answer Sheets (Blank A4 papers): 11**

For each question:
No. of answer sheets: 1

# FIT5047 eExam Instructions II

## Instructions

**Once your exam finishes, you will be given time to scan a QR code and upload your answers using your smartphone and laptop.**

## How to upload your answer sheets?

**When you are ready, click "Upload answer sheets" to start the process**

- **STEP 1**
  **Arrange your answer sheets in the correct order**
- **STEP 2**
  **Scan QR code and take photos as instructed**
- **STEP 3**
  **Confirm photo clarity**

# eExams Information

- **The final exam uses Monash's eAssessment platform – this online assessment is called eExam.**
- **Please check the Monash eExams website to familiarize yourself with the eExam.**

**https://www.monash.edu/exams/electronic-exams**

# Exam Technique

- **Use your reading time to plan your attack!**
- **Maximize your expected utility by**
  - doing easy, high mark questions first
  - followed by easy, low mark questions
  - then hard, high mark questions
  - finally hard, low mark questions
  - If you finish early, review

# Staff Consultation Week 13

| | | |
|---|---|---|
| **Tuesday** (1 June) **2pm-5pm** (China time) | https://monash.zoom.us/j/88322486348?pwd=TzY3Wmtjb2NVQU9DdFpyc09KRnhPQT09 | **Bruce Chen** |
| **Thursday** (3 June) **1pm-5pm** (China time) | https://monash.zoom.us/j/89690093300?pwd=MFdZMWpEQkpxZ0VFQ2VFZUhZZXdNUT09 | **Murray Mount** |
| **Friday** (4 June) **3pm-6pm** (China time) | https://monash.zoom.us/j/88322486348?pwd=TzY3Wmtjb2NVQU9DdFpyc09KRnhPQT09 | **Bruce Chen** |

Consultation times are also available in FIT5047 Moodle (Scheduled Final Assessments) and (Consultation Times): Suzhou Campus (Consultations for Final Exam)

# Staff Consultation Week 14

| | | |
|---|---|---|
| **Tuesday** (8 June) **12pm-4pm** (China time) | https://monash.zoom.us/j/89690093300?pwd=MFdZMWpEQkpxZ0VFQ2VFZUhZZXdNUT09 | **Murray Mount** |
| **Tuesday** (8 June) **4pm-6pm** (China time) | https://monash.zoom.us/j/81156759332?pwd=YzY5THR2Zk5ZVHNUaS9FK2cvZ1lTUT09 | **Bruce Chen** |

Consultation times are also available in FIT5047 Moodle (Scheduled Final Assessments) and (Consultation Times): Suzhou Campus (Consultations for Final Exam)

**Please DO NOT ask questions regarding the final exam via Moodle Forums** (due to possible breaches of academic integrity)**.**
**Please ask Bruce during his consultation times or via email.**

# Good Luck!

All the best for the Exam