

Higher Information Systems

2006 q.23a Expert Systems Comparison and Distinction

Companies involved in extracting mineral deposits such as oil and iron ore make use of a range of computer-based information systems, including decision support systems and expert systems.

- a. Distinguish between a *decision support system* and an *expert system*. **(4)**
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2006 q.23b Expert Systems Classical Expert Systems

Companies involved in extracting mineral deposits such as oil and iron ore make use of a range of computer-based information systems, including decision support systems and expert systems.

- b. The PROSPECTOR expert system was developed for use by mining companies. Describe this expert system in terms of its *category*, *domain*, and *main characteristics*. **(4)**
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2006 q.24a Expert Systems

Drumville College has over 5000 students attending classes in 102 courses in 64 classrooms, lecture theatres and practical rooms. Every year, it takes a member of staff several weeks to plan the timetable to ensure all the classes can take place as required.

- a. Give **two** reasons why this timetabling problem may be a suitable subject on which to develop an expert system. **(2)**
- b. Describe **two** factors which the college should consider before deciding whether to develop the expert system. **(2)**

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2006 q.24c Expert Systems Logic

Drumville College has over 5000 students attending classes in 102 courses in 64 classrooms, lecture theatres and practical rooms. Every year, it takes a member of staff several weeks to plan the timetable to ensure all the classes can take place as required.

c. The predicates below represent statements about student and classes.

Represent the following statements using predicate logic.

(i) Fiona takes the Tourism course and the Leisure Management course. **(2)**

(ii) All students who take Catering] also take Food Hygiene in class 1023. **(6)**

Predicate	Statement
takes(alison, catering2)	Alison takes the Catering2 course
class(2031, 45, catering2)	Class 2031 has 45 students in the Catering2 course
In class(alison, 2031)	Alison is in class 2031

2006 q.24d Expert Systems Comparison and Distinction

Drumville College has over 5000 students attending classes in 102 courses in 64 classrooms, lecture theatres and practical rooms. Every year, it takes a member of staff several weeks to plan the timetable to ensure all the classes can take place as required.

d. Distinguish between an expert system and a relational database in terms of how data is represented and the method of querying. **(4)**

e. Explain what is meant by a deductive database. **(2)**

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2006 q.25 Expert Systems Certainty Factors

Crossandra is a type of house plant from the East Indies with green pointed leaves and spikes of bright orange flowers. Unfortunately, it is not the easiest type of house plant to look after, and a degree of expertise is required to keep a plant from one year to the next. Information about what can go wrong is shown in the following expert system rules with observed facts about a crossandra plant with appropriate certainty factors given.

a. Calculate the certainty of the conclusion that the plant is too cold.

Show your working. **(2)**

b. Which conclusion will be drawn from the given facts? Explain your answer. **(3)**

IF rot on leaves
THEN the conditions are too wet and humid (0.6).

IF the leaves are limp
THEN the plant has been over watered (0.8).

IF the leaves drop AND there is no plant growth
THEN the plant is too cold (0.8).

IF the leaves shrivel
THEN the plant is too hot and dry (0.9).

IF the plant wilts AND
the leaves drop
THEN the conditions are too draughty (0.7).

The leaves are limp	0.5
The plant wilts	0.7
The leaves drop	0.9
There is no growth	0.6

2006 q.25c Expert Systems Conflict Resolution

An expert system uses a forward chaining inferencing strategy. In a forward chaining system, explain:

(i). why conflict resolution is necessary **(2)**

(ii). the purpose of the RETE algorithm **(2)**

(iii). how the specificity conflict resolution strategy works. **(2)**

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2006 q.26 Expert Systems Knowledge Representation Rule Trees

The following paragraph outlines a limited domain of knowledge about growing azaleas in various types of garden soil. This knowledge is to be represented by an expert system using an expert system shell. A user of the expert system should be given advice about the likely success of growing an azalea in their garden given the colour of the soil.

Name an expert system shell with which you are familiar.

- Represent the knowledge contained in paragraph A above, to conclude a soil's type, given its colour. **(3)**
- In paragraphs B - D, identify **two** words which indicate uncertainty in the information. **(2)**
- Represent the knowledge in paragraphs B and C, to give the conclusion "The soil is suitable for growing azaleas". Your rules should refer to your answer to (a), and include an appropriate certainty factor. **(4)**

A	Garden soils are generally one of three types: acid, loam or clay. Acid soils are dark in colour, loams are brown and clay soils are light in colour.
B	Acid soils are most suitable for growing coniferous trees, rhododendrons and azaleas.
C	Clay soils are often lumpy and difficult to drain. They are light in colour. Few plants will grow well in clay soils.

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2006 q.27 Expert Systems Conflict Resolution

Consider a forward chaining expert system containing the following rule base, where letters P - W represent facts which are known or can be concluded.

- 1 If P and V then X.
- 2 If P and S then V.
- 3 If P and Q then V.
- 4 If P and R then T.
- 5 If P and R and T then W.
- 6 If P and Q and R then U.

Suppose the working memory contains the facts P, Q and R, added in that order.

a. Which rules exist in the conflict set? **(2)**

b. (i). Which rule will fire using a first-come-first-served (also known as rule ordering) conflict resolution strategy? **(1)**

(ii). Which rule will fire using the "specificity" conflict resolution strategy? **(1)**

2007 22a Expert Systems Certainty Factors

Dragons of Discovery is a computer game with the object of attacking dragons in order to capture their magical teeth. The user is given advice from a character called Mogo. The advice is generated by an expert system. Here are some of the rules which are used to determine the advice given.

IF dragon IS sleeping
AND dragon can breathe fire
AND dragon IS hungry
THEN Advice IS Attack with magic CF 90.

IF dragon IS sleeping
AND dragon IS hungry
THEN Advice IS Attack with sword CF 80.

IF dragon IS sleeping
AND dragon can breathe fire
THEN Advice IS Attack with lance CF 70.

The following facts are known with the certainty factors given.

Dragon is sleeping 60%
Dragon can breathe fire 80%
Dragon is hungry 40%

(i). Calculate the certainty of the advice "Attack with magic". Show your working. **(2)**

What advice would Mogo give based on the rules shown? Explain your answer. **(4)**

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2007 22b Expert Systems Knowledge Representation Rule Trees

Here are the rules which are used to determine if the dragon is angry.

IF it is raining
THEN the dragon is awake.

IF the dragon is awake
AND the goblins are dancing
THEN the dragon is angry.

Draw a rule tree to show how Mogo could give the reasons for concluding "The dragon is angry". **(3)**

2007 22c Expert Systems Conflict Resolution

(c) The expert system uses *forward chaining*. In a forward chaining expert system:

- (i). explain what is meant by the *working memory*; **(2)**
- (ii). explain what is meant by a *conflict set*; **(2)**
- (iii). explain how a conflict set is identified; **(2)**
- (iv). describe how the *specificity* conflict resolution strategy works. **(2)**

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2007 23 Expert Systems Knowledge Representation

The members of a knitting group are graded by their knitting experience, as grade 1, grade 2 or grade 3. A knitting expert system advises members on suitable patterns according to the members' knitting experience. The expert system makes use of the following information.

a. Using a factor table, represent the knowledge contained in paragraph B below. The factor table should show the pattern types and whether there are one or many colours or stitches. **(4)**

b. The following rule indicates whether a member can knit a complex scarf pattern:

IF garment IS scarf

AND pattern IS complex

AND grading IS > 1

THEN member can knit garment.

Represent the knowledge contained in paragraph C above to provide advice on the suitability of patterns for knitting scarves, jumpers, gloves and socks, given a member's knitting experience. The rules should be of the form IF <conditions> THEN <conclusions> as shown above. **(4)**

A	A grade 1 member is one who has never knitted anything before. Members who have knitted a scarf are classed as grade 2. Members are classed as grade 3 if they have knitted a jumper, gloves or socks.
B	The art of knitting involves following a pattern which describes the stitches to be used and colours and types of wool. Simple patterns involve using a single colour of wool and a single type of stitch. Complex patterns involve using a mix of colours of wool or a combination of different stitches or both.
C	Grade 1 members are only able to attempt a simple pattern. Grade 2 members can tackle complex patterns for scarves and simple patterns for socks and jumpers. Grade 3 members can tackle all knitting patterns.

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2007 23c Expert Systems Logic

The knitting experience of the group can also be represented as a series of predicates, as shown below.

Represent the following statements in predicate logic:

- (i). Ailsa is Grade 3 and has knitted a complex jumper; **(2)**
- (ii). anyone who has knitted simple socks is graded grade 2. **(3)**

Predicate	Statement
has_knitted(janet, scarf, complex)	Janet has knitted a complex scarf
grade(calum, grade_1)	Calum is graded Grade 1.

2007 24 Expert Systems Classical Expert Systems

Expert systems are used in a wide range of subject domains. Describe the *domain*, *category* and main *characteristics* of the DENDRAL expert system. **(4)**

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2007 q. 25 Expert Systems

Alison uses a route planning website to help her plan a journey from her home in Dundee to see her aunt and uncle who live in Kington.

She enters the postcodes of her starting point and destination, and can also specify whether she wants the fastest route, shortest route, or a route that avoids motorways or toll roads and bridges.

a. When Alison clicks on the Check Details button, the bottom screen is displayed in which she is asked to confirm the address of the start and end points of her journey, as shown. Explain how a database could be used to provide the additional information.

b. The route planner makes use of an expert system to produce the route plan. Describe **two** reasons why route planning is a suitable domain for an expert system. **(4)**

c. The expert system provides a detailed route which includes a total distance and estimated time.

(i). Alison decides to check an alternative route planning website which also uses an expert system. She finds that the recommended route from this website is longer than the route from the first website.

Describe **three** reasons why the routes may be different. **(6)**

(ii). When Alison makes her journey, she finds that it takes her 1 hour longer than indicated on the route plan. Describe **two** limitations of a route planning expert system which may have contributed to this result. **(4)**

2007P q.24 Expert Systems Development Stages

www.camerasforu.co.uk is Web site that advertises and sells digital cameras and digital video cameras from a number of different manufacturers. The site provides an on-line expert system that provides customers with advice on the camera that best suits their needs. The expert system was developed using an expert system shell.

Marks

a. Describe two limitations of the camerasforu expert system described above. **(2)**

b. The components of any expert system include a knowledge base, inference engine and user interface.

(i). Explain the purpose of the inference engine.

(ii). Explain the use made of a knowledge representation language during the development of the camerasforu expert system. **(2)**

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2007P q.25 Expert Systems Classical Expert Systems

Research into the use of expert systems in medicine started in the early 1970's and produced a number of 'classical' expert systems, including INTERNIST, MYCIN and ONCOCIN.

a. Explain how the INTERNIST and MYCIN expert systems differ from ONCOCIN in terms of their classification. **(1)**

b. The ONCOCIN expert system was developed to be a clinical decision support system. Distinguish between an expert system and a decision support system in terms of their purpose within the field of medicine. **(2)**

2007P q.25c Expert Systems Social, Legal, Ethical Issues

c. The increased use of expert systems in the field of medicine has brought about many concerns regarding the social, legal and ethical implications associated with their use. For example, many people are concerned about the implications for an experienced doctor who decides to take a particular course of action without consulting an expert system when it is later shown that the expert system may have been able to provide a preferable alternative.

(i). Describe one legal implication that could arise from this situation.

(ii). Describe one ethical implication that could arise from this situation. **(2)**

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2007P q.26 Expert Systems Conflict Resolution

GlasgowDine is an expert system that recommends restaurants in Glasgow based on occasion, atmosphere and food preferences. It uses information provided by the user to decide what restaurant characteristics would be preferred for the event. The expert system uses forward chaining rules. Part of the expert system is shown below.

a. Maisie Mo is hosting a business lunch for clients in the centre of Glasgow. The lunch is to be a relaxed event for clients who enjoy European food.

Given the facts above, state the rules that would exist in the conflict set. **(2)**

b. What advice would be given to Maisie Mo by the GlasgowDine expert system if:

(i). a rule ordering algorithm was used to resolve the conflict? Justify your answer.

(ii). a specificity algorithm was used to resolve the conflict? Justify your answer. **(4)**

c. Evaluate the GlasgowDine expert system in terms of:

- its domain
- the range and coverage of the rules shown. **(2)**

R1	IF Occasion is family meal	R2	IF Occasion is family meal
AND	Atmosphere is lively	AND	Atmosphere is lively
AND	Food preference is European	AND	Food preference is European
AND	Cost is moderate	THEN	Suitable restaurant is Gr8@Gordos.
THEN	Suitable restaurant is CharleyCool.		
R3	IF Occasion is business lunch	R4	IF Occasion is business lunch
AND	Atmosphere is relaxed	AND	Atmosphere is relaxed
AND	Food preference is European	AND	Food preference is European
AND	Location is city centre	THEN	Suitable restaurant is ChisCo.
THEN	Suitable restaurant is Uropa.		
R5	IF Occasion is business lunch		
AND	Atmosphere is relaxed		
AND	Food preference is Asian		

2007P q.28 Expert Systems Development Stages

REHAB is a rule-based expert system that is being developed for use in social security offices. The expert system will be used to refer recipients of social security disability allowance to employment rehabilitation services.

a. Identify a suitable domain expert for the development of the REHAB expert system and describe their role during system validation. **(2)**

b. Errors could occur at any stage of the development of the REHAB expert system.

(i). Describe an error that could be attributed to inferencing.

(ii). Describe one other source of error. **(2)**

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2007P q.28c Expert Systems Component Parts

REHAB is a rule-based expert system that is being developed for use in social security offices. The expert system will be used to refer recipients of social security disability allowance to employment rehabilitation services.

c. The knowledge engineer must decide whether to represent the domain knowledge as backward chaining or forward chaining rules.

(i). Suggest **two** factors would be used to determine the type of inference engine suitable for the REHAB expert system. Justify your answer by explaining the relevance of each factor you suggest.

(ii). Give **one** reason why the developers of the REHAB expert system may decide to incorporate both backward and forward chaining. **(3)**

2007P q.28d Expert Systems

REHAB is a rule-based expert system that is being developed for use in social security offices. The expert system will be used to refer recipients of social security disability allowance to employment rehabilitation services.

Due to the pressure of work faced by experienced caseworkers responsible for the assessment and review of recipients, the current situation of many recipients cannot be reviewed for several months. As a result, recipients miss out on the benefits offered by the rehabilitation services.

By developing REHAB, it is hoped that unqualified administration staff will be able to use the expert system to reach unbiased and consistent assessment decisions regarding referral of the recipients of disability allowance to employment rehabilitation services. Eventually, it is hoped that administration staff using the expert system will be able to make assessments in less time and with a level of accuracy superior to the experienced caseworkers using manual methods.

d. Compare the quality of information provided by the REHAB expert system with the quality of similar information provided by experienced caseworkers in terms of:

- timing
- availability **(2)**

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2007P q.29 Expert Systems Knowledge Representation

a. An expert system is being developed to identify and classify animals. The following knowledge is to be stored in the knowledge base of the expert system:

A mammal is an animal that has hair and provides milk for its young. A carnivore is a meat-eating mammal with claws and pointed teeth whereas an ungulate is a mammal that chews cud and has hooves. A cheetah is a carnivore with black spots and a tiger is a carnivore with black stripes. A giraffe is an ungulate with a long neck and a zebra is an ungulate with black stripes.

Derive attribute pairs from this information about all the animals provided above. The attribute pairs should be in the form:

ungulate (mammal, chews_cud, has_hooves)

cheetah (carnivore, has_black_spots) (5)

b. The developers of the expert system decide to represent knowledge about birds as factor tables. The factor tables are shown below.

(i). Represent the factor tables as a decision tree.

(ii). Compare the use of factor tables and a decision tree to represent the knowledge about birds. **(6)**

Lays eggs	Has feathers	Classification
Yes	Yes	Bird

Bird	Can fly	Can swim	Classification
Yes	Yes	Yes	Duck
Yes	No	No	Ostrich
Yes	No	Yes	Penguin

2007P q.29c Expert Systems Logic

Additional knowledge about elephants is to be represented using first order predicate logic. Use the information from below to represent the following statements in first order predicate logic:

(i). All elephants are grey.

(ii). African elephants have large ears. **(5)**

d. The knowledge about animals could have been stored in a relational database system rather than an expert system. Compare the two types of system in terms of the methods used to extract information and knowledge. **(2)**

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2007P q.30 Expert Systems Certainty Factors

SPOT-OUT is an expert system that provides users with advice about stain removal. SPOT-OUT is a rule based expert system that makes use of certainty factors.

a. Give two uses made of certainty factors in an expert system. **(2)**

b. The rule shown below is included in the SPOT-OUT expert system:

ADVICE Spray with hair-spray and wash as normal (80%)

IF Stain is due to ink

AND Stain is on fabric.

Haymon uses the expert system to get advice about how to deal with an ink stain on his shirt.

He provides the expert system with the information below:

Calculate the certainty of the conclusion:

Spray with hair-spray and wash as normal.

You should show all working. **(2)**

Users of the SPOT-OUT expert system can ask for justification of any advice that is suggested.

Explain how the expert system would justify any advice that it suggests. **(2)**

The stain is due to ink:

Certainty Factor: 50% 60% 70% 80% 90% 100%

The stain is due to grease:

Certainty Factor: 50% 60% 70% 80% 90% 100%

The stain is on fabric:

Certainty Factor: 50% 60% 70% 80% 90% 100%

The stain is on upholstery:

Certainty Factor: 50% 60% 70% 80% 90% 100%

2008 21 Expert Systems Social, Legal, Ethical Issues

MBV Car Repairs operates a number of garages in the UK. The company uses a car fault diagnostic expert system to identify faults with car engines.

a. Describe **two** benefits to MBV Car Repairs of the use of this expert system. **(4)**

b. Describe **one** social implication of using this expert system. **(2)**

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2008 21c Expert Systems Development Stages

MBV Car Repairs operates a number of garages in the UK. The company uses a car fault diagnostic expert system to identify faults with car engines.

A customer brought in his sports car for repair. The engineers used the expert system to diagnose the problem with the car and, based on the advice given, they carried out the repair. However, the customer brought the car back the next day complaining that the car was still not operating correctly.

(i). State **two** stages of the development process of this expert system where an error could have occurred. **(2)**

(ii). For each stage in c. (i) describe how the error could have occurred in this situation. **(4)**

2008 22 Expert Systems Comparison and Distinction

Expert systems are widely used in organisations along with other information systems.

a. Compare the use of expert systems within an organisation with that of a *management information system*, with reference to decision making. **(4)**

b. Distinguish between an expert system and a relational database in terms of how data is represented. **(4)**

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2008 23 Expert Systems Knowledge Representation

Colin and Sofie are fashion image consultants. They have been commissioned by an international jeans retailer to help construct an expert system. The expert system will advise customers on the style of jeans to buy.

The following rules represent advice on what type of jeans to buy if you have long legs:

IF legs are long
AND build IS regular
AND wearing boots IS yes
THEN advice IS to buy bootcut jeans.

IF legs are long
AND build IS regular
AND wearing boots IS no
THEN advice IS to buy square cut jeans.

IF legs are long
AND build IS slim
AND wearing boots IS yes
THEN advice IS to buy bootcut jeans.

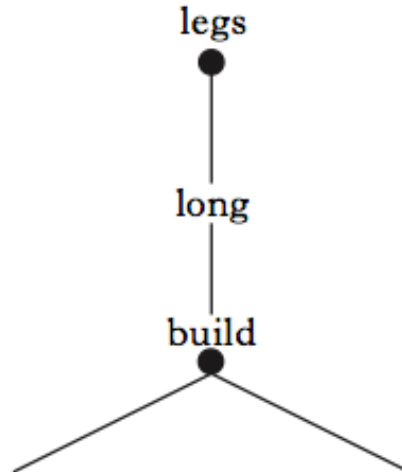
IF legs are long
AND build IS slim
AND wearing boots IS no
THEN advice IS to buy slimfit jeans.

The start of the decision tree to represent the rules above is shown below.

Copy and complete the decision tree to represent the rules above. **(6)**

b. Describe **one** advantage of using a decision tree to represent knowledge in an expert system. **(2)**

c. The expert system has to be expanded to cater for short leg lengths. Add to the list of



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2008 24 Expert Systems Conflict Resolution

Consider a *forward chaining* expert system containing the following rule base, where the letters G to R represent facts which are known or can be concluded.

- 1 If G and H then P.**
- 2 If G then K.**
- 3 If H and J then L.**
- 4 If G and H and L then M.**
- 5 If H and N then R.**

Suppose the working memory contains facts G, H and J added in that order.

- a. (i). List the rules that exist in the conflict set. **(3)**
- (ii). Using *recency* conflict resolution strategy, state which rule would be fired first. **(2)**
- (iii). Explain why conflict resolution strategies are required. **(2)**

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2008 25 Expert Systems Certainty Factors

PHYSIO-24 is an expert system designed to diagnose sports injuries. Symptoms of the injury are requested from the user. The input is evaluated through a set of rules with certainty factors. A simplified sample of rules for an injured foot is shown below.

IF pain is on ball of foot
AND bending toes is painful
THEN patient suffers from loss of padding on sole (0.7)

IF pain is on heel
AND bending toes is painful
THEN patient has heel spur (0.7)

IF pain is on heel
AND pain is up leg
THEN patient is suffering from damaged Achilles tendon (0.9)

The following facts are known with certainty factors given:

The pain is on ball of foot	0.5
Bending toes is painful	0.8
Pain is up leg	0.5
Pain is on heel	0.8

(i). Calculate the certainty of the conclusion that the patient is suffering from loss of padding on sole. Show your working. **(2)**

(ii) Identify the conclusion drawn from the given facts. Explain your answer. **(4)**

b. "Severe pain and swelling on the ankle indicate that it is very likely that the ankle is broken."

The following rule is added to the expert system to represent the knowledge above:

IF pain is on ankle
AND swelling is yes
THEN patient is suffering from a broken ankle

State a certainty factor for this rule and explain your answer. **(2)**

†

2008 q.24 b Expert Systems Logic

b. The following rule was added to the expert system. Represent this rule using propositional logic.

If G and not L then N (3)

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2008P q. 27d Expert Systems Comparison and Distinction

Compare an expert system with a relational database management system in terms of –

- Representation of data/knowledge
- Extraction of data/knowledge

Use your comparison to justify why the IT Manager at CITYCAR decided to develop an expert system rather than develop a relational database system for a vehicle fault diagnosis system. **(4)**

2008P q.25 Expert Systems Comparison and Distinction

Computer-based information systems such as expert systems and decision support systems are often used by companies to automate the planning of business activities and events.

a. Distinguish between an expert system and a decision support system. **(4)**

2008P q.25b Expert Systems Classical Expert Systems

b. The STRIPS expert system was developed in the early 1970s. Describe this expert system in terms of category and main characteristics. **(3)**

2008P q.26 Expert Systems Knowledge Representation Production Rules

Tom is interested in sailing and has decided to make an expert system regarding pleasure boats. He has consulted an expert and received the following advice.

Expert: Pleasure boats are boats used by people for their enjoyment and leisure. A pleasure boat powered by humans using oars is a rowing boat. A pleasure boat powered by an engine is known as a powerboat. When the engine is mounted outside the stern of the boat this is an outboard engine. An engine inside the hull of the boat is an inboard engine. A pleasure boat powered by wind is a sailboat.

a. Make up design rules to represent the knowledge from the expert. The rules should be expressed in a form with which you are familiar, as shown in the first two rules below:

IF boat is used for enjoyment and leisure
THEN vessel is pleasure boat.

IF vessel is pleasure boat AND
power is by humans using oars
THEN this boat is a rowing boat. **(4)**

b. State the category of this expert system. Justify your answer. **(2)**

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2008P q.26c Expert Systems Certainty Factors

Tom is interested in sailing and has decided to make an expert system regarding pleasure boats.

Certainty factors are often features of expert systems.

- (i). Describe **two** benefits that can be claimed for an expert system that implements certainty factors. **(2)**
 - (ii). Give **two** reasons why some expert systems do not use certainty factors. **(2)**
-

2008P q.26d Expert Systems Conflict Resolution

Tom is interested in sailing and has decided to make an expert system regarding pleasure boats.

This is an example of a forward chaining rule-based expert system.

- (i). Explain why conflict resolution strategies are required in expert systems such as this. **(2)**
- (ii). What is the purpose of the RETE algorithm? **(2)**
- (iii). Describe how the refractoriness strategy for conflict resolution works. **(2)**

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2008P q.27 Expert Systems Social, Legal, Ethical Issues

CITYCAR is a small company selling small four wheel vehicles for city travellers to use throughout Scotland. Customers who purchase a vehicle are asked if they wish to purchase an extended service warranty. For the duration of its extended warranty, customers who have any problems with a vehicle purchased from CITYCAR can call out a service engineer. The service engineer will then arrange a suitable date and time to call at the customer's home to repair the vehicle.

The IT department at CITYCAR is developing a fault diagnosis expert system for use by the service engineers. The expert system will run on laptop computers that the service engineers can take to a customer's house when on a service call. The service engineer will be able to use the expert system to help identify the source of any fault. The expert system will also be able to provide guidance about any repairs that are needed.

a. Identify two benefits of developing an expert system for this purpose. **(2)**

b. Several of the service engineers who work for CITYCAR are concerned about what happens if the expert system misdiagnoses a fault in a vehicle and they then follow any inaccurate guidance that is subsequently provided by the expert system.

Who is responsible for any bad advice that is provided by an expert system? Justify your answer. **(2)**

2008P q.27c Expert Systems Development Stages

As the expert system is being developed, it is possible that errors could occur at each stage of its development. Describe one source of an error that could occur during each of the following stages of development:

(i). Knowledge acquisition **(1)**

(ii). Knowledge representation **(1)**

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2008P q.28 Expert Systems Knowledge Representation Attribute-Value Pairs

An expert system is being developed to identify and classify geographical features. The following knowledge is to be stored in the knowledge base of the expert system:

A landform is a part of the terrain and is categorised by its elevation, slope and position. A mountain is a landform that extends above the surrounding terrain and has steep cliffs. A gorge is a landform which extends beneath the surrounding terrain and has steep cliffs. A gorge is formed by erosion. A valley is a depression between two mountains. A river valley is formed by a river. A glacial valley is formed by a glacier.

a. Derive attribute pairs from this information about geographical features provided above. The attribute pairs should be in the form:

landform(part_of_terrain, has_elevation, has_slope, has_position)

mountain(landform, extends_above_terrain, has_steep_cliffs) (5)

2008P q.28b Expert Systems Knowledge Representation

An expert system is being developed to identify and classify geographical features. The developers of the expert system decide to represent knowledge about glacial moraines as factor tables. The factor tables are shown below.

(i). Represent the factor tables above as a decision tree. **(4)**

(ii). Compare the use of factor tables and a decision tree to represent the knowledge about glacial moraines. **(2)**

Formed by Glacier	From Debris	Classification
Yes	Yes	Moraine

Moraine	Subglacial	Raised Feature	Classification
Yes	No	No	Terminal Moraine
Yes	No	Yes	Lateral Moraine
Yes	Yes	No	Ground Moraine
Yes	Yes	Yes	Ribbed Moraine

2008P q.28c Expert Systems Comparison and Distinction

One developer is proposing that the system be developed as a deductive database. Explain what is meant by a deductive database. **(2)**

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2008P q.28d Expert Systems Component Parts

An expert system can be forward or backward chaining.

(i). How does the inference engine in a backward chaining expert system operate? **(2)**

(ii). The following information is used to identify some mountain features.

Produce backward rules that represent the knowledge contained in statements A and B above. **(2)**

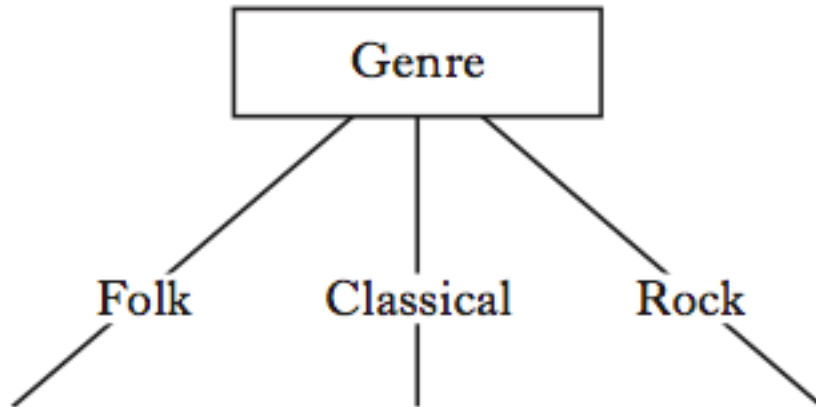
A	An arête is a thin ridge of rock between two valleys
B	A plateau is a raised area of land consisting of a flat region

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2009 23a Expert Systems Knowledge Representation Rule Trees

Strathcraig Music Centre hosts an annual Music Festival. The centre has several venues and hosts several genres of music each year. The proposed program for this year is shown below.

Use the table to complete the following rule tree using Genre as the root. **(8)**



Genre	Week	Price	Performer
Folk	1	Cheap	Paul Bennett @ Banner Hall
Folk	2	Cheap	The Purdie Family @ The Port
Classical	1	Cheap	Aiko @ The Kane Rooms
Classical	2	Cheap	Guitar Ensemble @ The Kane Rooms
Classical	1	Expensive	Warsaw Concert Orchestra @ The Auditorium
Classical	2	Expensive	Edison String Quartet @ Banner Hall
Rock	1	Cheap	China Cats @ The Port
Rock	2	Cheap	Diesel @ The Auditorium

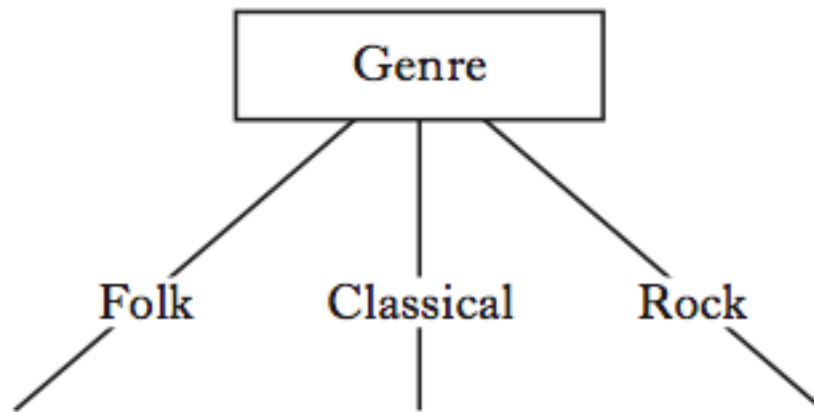
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2009 23b Expert Systems Knowledge Representation Production Rules

David has been asked to create an expert system to assist staff at the Music Centre advise customers which performance meets their needs.

Write rules to represent the knowledge for Classical music. **(8)**

Genre	Week	Price	Performer
Folk	1	Cheap	Paul Bennett @ Banner Hall
Folk	2	Cheap	The Purdie Family @ The Port
Classical	1	Cheap	Aiko @ The Kane Rooms
Classical	2	Cheap	Guitar Ensemble @ The Kane Rooms
Classical	1	Expensive	Warsaw Concert Orchestra @ The Auditorium
Classical	2	Expensive	Edison String Quartet @ Banner Hall
Rock	1	Cheap	China Cats @ The Port
Rock	2	Cheap	Diesel @ The Auditorium



2009 24 Expert Systems Conflict Resolution

a. Name and describe **two** conflict resolution strategies. **(6)**

b. Explain why conflict resolution strategies are required. **(2)**

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2009 25 Expert Systems Logic

The orders taken in a restaurant can be represented as a series of predicates, as follows. Represent the following statements in predicate logic.

- a. Martin orders steak for his main course, apple pie for dessert and is having beer to drink. **(2)**
- b. Any customer who orders chicken nuggets for a main course and a milkshake to drink is given ice cream for dessert. **(3)**

Predicate	Statement
<code>main(john, lasagne, red_wine)</code>	John orders lasagne for his main course and is having red wine to drink
<code>dessert(mary, fruit_salad)</code>	Mary orders fruit salad for dessert

2009 26 Expert Systems Comparison and Distinction

Holidays International is a members-only holiday firm. Members logging on to the company's website see a web page similar to that shown below.

- a. This web page is produced using a *deductive database* making use of an expert system and a relational database.

Describe the part played by the expert system and the relational database in producing the page shown. **(3)**

- b. Describe **one** limitation of using an expert system like this to recommend holidays. **(2)**

Holidays International

Welcome back Mr and Mrs Reid:

Your last three holidays arranged by us were:

1. Intercontinental Hotel, Sri Lanka
2. Hotel Superbe, Goa
3. Five Palms Resort, Fiji

Based on previous holidays arranged by us we would recommend:

1. Hotel Ritz, Maldives
2. Club Paradise, Mauritius
3. Excelsior Club and Resort, Seychelles

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2009 27 Expert Systems Classical Expert Systems

Describe the MYCIN expert system in terms of its *category*, *domain* and *main characteristics*.

2009 28ai Expert Systems Certainty Factors

Professor Slessor is exploring in the mountains of Crossandra. He has discovered a sack of ancient Crossandran coins. Ancient Crossandran coins:

- were made of silver or pewter, which looks very much like silver;
- had pictures of transport methods on one side;
- were inscribed with the emperor's name on the other side.

Using an expert system on his laptop the professor is trying to identify the coins. Here are some of the rules from the expert system which are used to determine the type of coin:

IF metal IS silver
AND picture IS ship
AND inscription IS "Kraax"
THEN coin IS crown CF 90.

IF metal IS silver
AND picture IS ship
THEN coin IS coronet CF 70.

IF metal IS silver
AND inscription IS "Kraax"
THEN coin IS helm CF 80.

After examining one of the coins Professor Slessor decides the following facts with the certainty factors given.

The coin is made of silver 80%

The picture is a ship 60%

The inscription is Kraax 40%

Calculate the certainty of the coin being identified as a crown. Show your working.

2009 28aii Expert Systems Certainty Factors

Based on the rules and facts above, which type of coin would the expert system conclude Professor Slessor is examining. Explain your answer.

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2009 28b Expert Systems Component Parts

The diagram below represents a screen from the expert system used to identify the coins. Text generated by the expert system is shown in normal style and user responses in bold style.

Describe the role played by each of the components of this expert system in producing the screen below.

Is the metal silver?

?? **yes 60**

Is the picture a chariot?

?? **yes 70**

Advice:

Coin is a circllet 54.

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2009P q.22a Expert Systems Certainty Factors

Northania is an island which is a popular destination for scuba divers. Around the coast there are many dive sites, each offering divers a particular attraction. One of the local dive companies has developed an expert system to try to ensure that divers get those dives which they would most enjoy.

Information about some of the dive sites is shown below as expert system rules.

A diver was asked about her preferences for dives and gave answers with the following certainty factors:

like to visit a wreck 0.5

like to see sting rays 0.7

like to see black coral 0.9

like to do a deep dive 0.6

a. (i). Calculate the certainty of the conclusion that the diver would enjoy Antonio's Canyon. **(2)**

(ii). Which conclusion will be reached for the given facts? Explain your answer. **(4)**

(iii). When asked, a diver said that he would very much like to carry out a drift dive. State a suitable certainty factor which could be allocated to this answer. **(1)**

IF you want to see sharks
THEN you will enjoy Big Tooth Bay (0.6)

IF you want to visit a wreck
THEN you will enjoy Poseidon Dive (0.8)

IF you want to see black coral AND
you would like a deep dive
THEN you will enjoy Antonio's Canyon (0.8)

IF you would like to drift with the current
THEN you will enjoy Long Reef (0.9)

IF you would like to see sting rays AND
you would like to see black coral
THEN you will enjoy Ray City (0.7)

2009P q.22b Expert Systems Conflict Resolution

An expert system uses forward chaining.

In a forward chaining expert system:

(i) explain what is meant by the working memory. **(2)**

(ii) explain what is meant by a conflict set. **(2)**

(iii) describe how the specificity conflict resolution strategy works. **(2)**

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2009P q.23 Expert Systems Knowledge Representation Production Rules

Ferve Micros is a small manufacturer of laptop computers. Features of a sample of the computers it produces are shown in the table below.

• indicates the laptop has this feature

To help customers choose which laptop may suit them best Ferve Micros has developed an expert system. Some of the rules from the expert system are shown below:

IF weight IS low AND
battery life IS long
THEN type is NM.

IF screen IS wide AND
battery life IS long AND
processor speed IS high
THEN advice is buy LF600.

IF type IS NM AND
screen IS wide
THEN advice IS buy NM200.

a. Write rules to give advice to buy LF400 and NM400 using forward chaining as above.

(4)

b. Rewrite the rule giving the advice to buy NM200 in backward chaining form. **(1)**

	Low Weight	Wide Screen	Long Battery Life	High Speed Processor
LF 600		•	•	•
LF400	•	•		
NM200	•	•	•	
NM400	•		•	•

2009P q.24 Expert Systems Component Parts

CallsforYou sell mobile telephones and call plans. The company recently introduced an expert system to assist customers in selecting the call plan to best suit their needs.

a. State **two** cost factors CallsforYou would have considered before proceeding with the development of the expert system. **(2)**

b. Describe the **three** components of an expert system. **(6)**

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2009P q.24c Expert Systems Comparison and Distinction

CallsforYou sell mobile telephones and call plans. The company recently introduced an expert system to assist customers in selecting the call plan to best suit their needs.

c. The results of a user's consultation are selected from a database. Compare a database management system and an expert system in terms of how data is represented. **(2)**

2009P q.24d Expert Systems Development Stages

CallsforYou sell mobile telephones and call plans. The company recently introduced an expert system to assist customers in selecting the call plan to best suit their needs.

d. A programmer was one of the personnel involved in the production of this expert system. Name two other personnel involved in the production of expert systems and describe the role performed by each. **(6)**

2009P q.24e Expert Systems Social, Legal, Ethical Issues

CallsforYou sell mobile telephones and call plans. The company recently introduced an expert system to assist customers in selecting the call plan to best suit their needs.

e. Anita uses the expert system and purchases the call plan recommended. After 3 months she discovers that although she does not use her phone any more than previously her bills are now consistently higher. Two of the people responsible for Anita having higher bills now may have been the programmer and/or Anita.

Describe how each of them may have caused the expert system to advise an apparently unsuitable call plan. **(6)**

2009P q.25 Expert Systems Comparison and Distinction

Doonbrae Fitness operates a chain of 5 fitness centres and gyms. The company is considering having an expert system developed to help with the organisation of fitness classes and allocating instructors to these classes.

a. State **two** factors which may make a subject suitable for the development of an expert system. **(2)**

c. Describe **one** difference in the results presented to a user from a decision support system and an expert system. **(2)**

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2009P q.25b Expert Systems Logic

Doonbrae Fitness operates a chain of 5 fitness centres and gyms. The company is considering having an expert system developed to help with the organisation of fitness classes and allocating instructors to these classes.

b. The statement that Callum is qualified to teach bodypump classes can be represented by the predicate:

qualified (callum, bodypump)

Represent the statement that Andrew is qualified to teach cyclespin and trimtome in predicate logic. **(2)**

2009P q.25d Expert Systems Development Stages

Doonbrae Fitness operates a chain of 5 fitness centres and gyms. The company is considering having an expert system developed to help with the organisation of fitness classes and allocating instructors to these classes.

d. State **four** features of an expert system which may be used to evaluate the system. **(4)**