Artificial Intelligence, Simulations and Modelling

Outcomes - on completing this topic, a student should be able to -
1. describe and apply problem solving processes when creating solutions
2. design, produce and evaluate appropriate solutions to a range of challenging problems
3. critically analyse decision making processes in a range of information and software solutions

Throughout our whole lives, each of us is faced with a wide range of situations, some of which we have experienced before, while some others will be totally new to us. How we proceed in a new situation may be determined by a wide range of things, but these will include our past experiences and the things we have done and seen done. Faced with a difficult or life threatening situation, the immediate response will often be very different from the one we might come up with if the threat were removed and we were given time to think the problem through. We term this Problem Solving, and we all do this every day.

Problem Solving examples -
(i) a savage dog faced you and your baby brother in a narrow alley, what would you do?

You have all seen such situations on television, where the hero simply deals with this life threatening scenario with hardly a hair out of place - the dog knocked out or run off, and everyone safe.

But would you attempt that in real life? You would probably think through a whole range of possibilities to judge your options. (run, try to calm down the dog, get a weapon to protect yourself, put the baby behind you).

Indicate your immediate response to the following situations -
(ii) the car you and a friend are travelling in, on a cold wet night on a quiet country road suddenly stops running and all power (including to the car phone) ceases
....................................................................................................................................................................
....................................................................................................................................................................

(iii) you are scuba diving alone near a wreck off the Great Barrier reef and find another diver partially trapped under a rock fall and he is almost out of air
....................................................................................................................................................................
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How might your solutions to these problems alter if you had plenty of time to consider all of the
Problem solving software
Since you cannot practice every situation that could possibly occur, you cannot be totally prepared for each different possibility - but you can build up a series of problem solving strategies and skills. Computer programs can be of great help in allowing us to model real or imagined situations - from the past, present or even the future. Millions of dollars may have to be spent to produce fast and high capacity computers (super computers) with highly complex programs running on them to simulate the varied situations scientists need to study.

Most computer programs follow simple algorithms and use mathematical equations, and simply do not have the capabilities of people to be creative and solve problems at anywhere near the complexity of the human brain. Having computers store data which can be processed to form knowledge, leads us into the area of artificial intelligence.

Artificial Intelligence (AI)
This is the area of computer science concerned with the ways of designing and programming computers to simulate human intelligent thought.

AI programs may allow many simulation and modelling scenarios to be calculated quite accurately and allow scientists to predict the likely outcomes or range of possibilities over periods of time. This aids in the solving of real-world problems.

For example, Delta Airlines used AI to assist in creating an airport resource system to efficiently allocate the 70 gates at an airport to the flights arriving and taking off from that airport. The system was designed to track arrivals and departures, distinguish between aircraft size and gate requirements, take into account connecting flights and avoid traffic jams while planes move between gates. Other features of the system include an interface with human decision makers, the exchange of information with other databases, recovery from system failure, baggage-handling, crew-scheduling and aircraft maintenance.
Computers are used to help people solve problems, and one method for helping to solve problems is in the use of Simulation programs. This is where the user of the computer is able to go through many of the situations and problems which would or could be connected with a particular task.

Examples of activities where simulations are used include -

- driving a car
- flying a plane
- playing golf
- learning to become an astronaut

**To Do** - find and list below 4 other good use areas for simulations -

1. ............................................................................................................................................
2. ............................................................................................................................................
3. ............................................................................................................................................
4. ............................................................................................................................................

We have all heard of, seen or even played with **virtual reality type simulations**, which make you feel as if you are in some other place - even out in space, or fighting creatures, etc. We do not have the hundreds of thousands of dollars worth of high powered computers, helmets, gloves, etc. needed for this level of simulation, but it is not hard to ‘get into’ a game type simulation.

You may have quite sophisticated games at home - name any of these would you class as a simulation type program.

**Answers** - ..................................................................................................................................
........................................................................................................................................................
........................................................................................................................................................

Of course, game type simulations are only one type that you may have come across, and others such as flight simulators have been used for years to train pilots of jets and helicopters - so that -

(a) in the early stages of training they do not damage valuable equipment and hurt themselves and others.

(b) pilots can experience flying into many airports around the world without actually leaving the city where they are based.
THE SEARCH FOR SANCHEZ

The object of Search For Sanchez is to follow clues received from OFFICE computer or from field agent 13, and track down the R.U.N.T. agents to the location suggested by the clue. You must capture the agents, obtain the pieces of code, and then attempt to capture Sanchez.

PLAYING THE GAME

After the program has loaded, an introductory screen will appear. Click the mouse button and a short animated sequence will play, after which the OFFICE screen will appear.

THE OFFICE

The OFFICE is where most instructions are given for performing your Search For Sanchez. Read the instructions and clues carefully. Also, there are several MENU options available for LOADING, SAVING, RESTARTING and leaving a game. The MENU options are explained in detail below.

When the OFFICE screen first appears, you will be prompted to load an existing game, if any games have been previously saved. Select a game and then click on "YES" to continue an old game, or select "NO" to begin a new game. If you are loading an old game, you will begin from the point at which you saved the game.

STARTING A NEW GAME

When starting a new game, you will be prompted to enter your name. You can enter your full name, up to a maximum of 20 characters. Press RETURN after entering your name. Read the instructions, clicking on "NEXT PAGE" or pressing "RETURN" to see the next page. Examine the first clue carefully. All clues give details on a city in the country you are searching.

IT IS RECOMMENDED YOU USE AN ATLAS TO HELP SOLVE SOME OF THE CLUES. ALSO WRITE DOWN THE CLUES, AS YOU MAY FORGET CERTAIN IMPORTANT INFORMATION. An example could be:

"This city has a bridge that looks like a coat hanger."

The answer is Sydney as Sydney Harbour Bridge resembles a coat hanger.

Click on "TRAVEL" or press "RETURN" to go to the TRAVEL PAGE.

TRAVEL PAGE

When this screen loads you will see a map of Australia displayed on the main screen of your YAMAZUKI BAD GUY PURSUIT BIKE. You will travel all over Australia using your bike. Examine the map.
will see your current location as a GREEN circle, and destination cities as RED circles.

- At the bottom left is a list of cities that you can travel to, from your current location. Click on a city from the list, an asterisk will be displayed next to the city and the circle for that city will change to BLUE.

- You can then select TRAVEL to travel to that location on your bike, or select OFFICE to return to the OFFICE. Only use this option if you have forgotten the clue, or you wish to leave the game, as you can only leave the game from the OFFICE.

- When you reach your destination, a screen will appear showing you meeting with Field Agent 13. If you have travelled to the correct location you will be given further clues to the R.U.N.T. agent’s location. If, however, you went to the wrong location, the agent will inform you and you will have to return to your office for further instructions.

The R.U.N.T. agents move quickly from city to city and it may take several attempts to catch up to him. When you do catch up to an agent, you will be taken to the R.U.N.T. AGENT DISCOVERY screen.

**CAPTURING A R.U.N.T. AGENT**

To capture a R.U.N.T. agent you must correctly defuse the LOGIC BOMB that he /she will throw at you. There are several puzzles that must be solved. You will have to read the instructions for each puzzle and attempt to solve it yourself.

If you defuse the LOGIC BOMB you will capture the R.U.N.T. agent. If you fail to defuse the bomb it will explode, giving your brain a nasty logic scramble that may take some time to wear off.

**CAPTURING SANCHEZ**

The second stage of the program involves the capture of SANCHEZ. After you have all pieces of the code, you will be transported to SANCHEZ’ hideout. You must navigate the mazes before reaching SANCHEZ. Use the FOUR WAY DIRECTION ARROWS on your computer to navigate through the mazes. You will need to gather keys to open doors, and find the pads to turn off the protector beams. Examine each maze carefully before venturing into the maze. After negotiating through the mazes you will meet Sanchez face to face. Solve his logic puzzle to capture Sanchez and win the game.

If you scored well enough you will be added to the list of "SANCHEZ SUPER SEARCHERS".

**GAME MENU OPTIONS**

**NEW GAME**

Select this option to start a new game. The current game will be lost, so be sure you want to restart before selecting this option.

**LOAD GAME**
Select this option to load an old game from disk. Select the game from the list and then select "OK". Your game will load and you can continue from where you finished previously.

It is a good idea to save your game before venturing into the mazes as the mazes can be very difficult to negotiate.

SAVE GAME
Selecting this option will save your game as the name you entered when you logged on to the OFFICE computer. In this way you can easily find your game when you wish to load it at a later date.

LEAVE GAME
Before selecting this option make sure you have saved your game if you want to return to it at a later date.

Sanchez Results
Having gone through this simulation several times, and hopefully captured Sanchez himself, you have travelled around the country and seen many sights.

Where you have visited -
1. ........................................................................ and seen .................................................................
2. ........................................................................ and seen .................................................................
3. ........................................................................ and seen .................................................................
4. ........................................................................ and seen .................................................................
5. ........................................................................ and seen .................................................................
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9. ........................................................................ and seen .................................................................
10. ........................................................................ and seen ..............................................................

What type of problems have you solved easily to capture R.U.N.T. agents?
1. ........................................................................................................................................................................
2. ........................................................................................................................................................................
3. ........................................................................................................................................................................
What type of problems have you had difficulty solving to capture R.U.N.T. agents?
1. ..................................................................................................................................................................

2. ..................................................................................................................................................................

3. ..................................................................................................................................................................
Milky Way Cafe

Milky Way Cafe is a game for either a single or pair of players, to run a small Cafe located somewhere in Outer space. The only things sold from the Cafe are Boggle Thirst Zappers, which refresh weary space travellers.

You are the manager of the Cafe for 2 weeks, and you must -

• purchase stock at the right price for making Boggle Thirst Zappers (BTZ)
• hire alien helpers on busy days
• buy advertising when sales are down
• analyse the spaceport docking schedule
• control the quantity of BTZ made
• decide on a fair market price for your product
• keep the bank manager happy by repaying your loan via EFT
• make a good profit

Beware though, random events do occur which can cause problems - the top 10 managers go into the High Score table.

Main Menu - clicking on the Control Button allows you to -

• Begin - begin playing the game
• Scores - shows high scores
• Ships - loads a database of space ships that is expected to dock at the local spaceport

<table>
<thead>
<tr>
<th>Ship Type</th>
<th>Crew</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centauran HyperCat</td>
<td>4</td>
</tr>
<tr>
<td>Garbage Drone</td>
<td>0</td>
</tr>
<tr>
<td>Janus DayTripper</td>
<td>50</td>
</tr>
<tr>
<td>Martian Cruiser</td>
<td>100</td>
</tr>
<tr>
<td>Mining Drone</td>
<td>0</td>
</tr>
<tr>
<td>Saturn Freighter</td>
<td>10</td>
</tr>
<tr>
<td>Space Truck</td>
<td>5</td>
</tr>
<tr>
<td>Supply Vessel</td>
<td>5</td>
</tr>
<tr>
<td>Terran Cruiser</td>
<td>100</td>
</tr>
<tr>
<td>Terran Battlestar</td>
<td>150</td>
</tr>
<tr>
<td>Titan Freighter</td>
<td>10</td>
</tr>
<tr>
<td>Venusian Cruiser</td>
<td>45</td>
</tr>
</tbody>
</table>

Note - crew numbers are important as they are your only potential customers.
• BTZ - loads a database of ingredients for making the BTZ

Martian Denso Crystals - bought by the kilogram - between $10 and $20 - 1 kg makes 15 goblets
Pewter Goblets - keeps BTZ cold - between $5 and $8 - 1 box contains 5 goblets
Rusilan Fruit - for flavour - between $2 and $4 - 1 fruit makes 2 goblets
Venusian Marsh Gas - for gassy drink - between $4 and $8 - 1 tube makes 5 goblets

Note - you should try to buy these ingredients at the right market price.

• Quit - to leave the game
• About - details of the designers of this program

To Do -
1. select BEGIN - gets you to the Space Fax Machine - read the instructions
2. click on NEXT PAGE - continue reading - turn off the Power when finished.
3. SPACEPORT DOCKING SCHEDULE - shown for that day - note carefully the type of craft landing, as these are your potential customers
4. click on CONTINUE when ready
5. STOCK PURCHASING SECTION - at the start of each day you must purchase stock needed to make BTZ’s
   - STARTING BALANCE - the amount of money you have available at the start of each day
   - CURRENT BALANCE - the amount you have left after purchases are deducted from the starting balance
   - check the CURRENT MARKET PRICES for each ingredient - try to buy more when prices are lower
6. purchase ingredients from your plan of the needs of the arrivals - then click on EXIT

7. PRODUCTION SECTION - where you decide how many goblets of BTZ will be produced to meet the needs of that day. The maximum number by each ingredient is displayed on the screen - and is the equal to whichever ingredient is lowest.
   Set HOW MANY GOBLETs WILL YOU MAKE.
   Set HOW MUCH ARE YOU CHARGING PER GOBLET, then click on EXIT

8. HIRING AND ADVERTISING SECTION - where you decide -
   - if you want to hire additional alien helpers (if you can afford it)
   - if you want to buy advertising, and select number, then click OK

9. receive the DAILY REPORT, then click EXIT

10. TRADING SHEET SECTION - the Sales, cost of Ingredients Profit or Loss, are shown, then click on NEXT PAGE to continue. Next you see the Balance Sheet Section.

11. BANK MANAGERS REPORT SECTION - if you are trading poorly, the First Galactic Bank will finance you to a certain extent to enable you to continue trading. However, if you require too much funding you will be declared bankrupt (this will adversely affect your credit rating).
    If you are trading profitably, you will be able to repay your overdraft - using the up arrow to set the amount to repay, and then clicking on SEND EFT to have that amount deducted from your overdraft. Turn the POWER off before continuing.

12. Continue this for 14 days - after which time (if you have not gone bankrupt) you will be assessed on your performance. If good enough you will go into the top 10 scores. After entering your name, you will be returned to the Main Menu, where you can select from the various Options available.

   Complete the Results sheet on the next page as you go.
Results - complete the following results from the Daily report in detail for the first 2 attempts at this simulation, then the final results for several more -

**Attempt 1** - fill in your results for each day -

<table>
<thead>
<tr>
<th></th>
<th>$ Profit or Loss (- sign)</th>
<th>Total $</th>
<th></th>
<th>$ Profit or Loss (- sign)</th>
<th>Total $</th>
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</thead>
<tbody>
<tr>
<td>DAY 1</td>
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<td>DAY 8</td>
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<tr>
<td>DAY 2</td>
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<td>..........</td>
<td>DAY 9</td>
<td>.................</td>
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<td>DAY 3</td>
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<td>..........</td>
<td>DAY 10</td>
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<tr>
<td>DAY 4</td>
<td>.................</td>
<td>..........</td>
<td>DAY 11</td>
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<td>DAY 5</td>
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<td>DAY 12</td>
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<td>DAY 6</td>
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<td>..........</td>
<td>DAY 13</td>
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<tr>
<td>DAY 7</td>
<td>.................</td>
<td>..........</td>
<td>DAY 14</td>
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</tr>
</tbody>
</table>

**Attempt 2** - fill in your results for each day -

<table>
<thead>
<tr>
<th></th>
<th>$ Profit or Loss (- sign)</th>
<th>Total $</th>
<th></th>
<th>$ Profit or Loss (- sign)</th>
<th>Total $</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAY 1</td>
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<td>DAY 7</td>
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<td>DAY 14</td>
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</tr>
</tbody>
</table>

Attempt 3 - your final Total = .........................

Attempt 4 - your final Total = .........................

Attempt 5 - your final Total = .........................

Questions -

1. How difficult is it to make a profit in the running of a Galactic Cafe? ........................................
   Why is this? ........................................................................................................................................
   ..........................................................................................................................................................

2. What are the critical aspects you have to worry about to make a profit? .................................
   ..........................................................................................................................................................

3. “This is quite a realistic simulation for running a small business”. Comment on this statement.
   ..........................................................................................................................................................
   ..........................................................................................................................................................

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Real World Use of Simulators

Simulations are often used to model real-life situations that could be dangerous, expensive or impractical. They are also used to provide a simple model of a complex situation.

Flight simulators
The most common, and best known, use of simulations is to simulate vehicles of various types, such as aircraft, spacecraft, boats and ships, cars, trucks or tanks. Flight simulators are commonly used by airlines and air forces around the world to train pilots and air crew.

Astronauts are trained to operate spacecraft in large simulators designed to imitate the space shuttle, or other craft. Realistic pictures and graphical images, coupled with full size models of the craft, sound and motion, are used to create realistic experiences for the people being trained.

For flight simulators, air crew sit in a full size model of a cockpit of an aircraft. Large, high-resolution monitors situated around the windows provide images similar to what crews would expect when flying in an actual aeroplane. The whole cockpit can be moved to provide the sensation of movement, while the instruments and displays provide realistic information to the crew.

By using simulators, air crew aircraft without leaving the ground. Their reactions to emergencies can be assessed and developed, without placing lives and planes at risk. Air crews can be trained to react to normal flight operations and emergencies without risk and at less expense than in an actual plane.
Project - part 1 Simulations

In groups of 2 - 3 students you are to -

1. Plan the use of THREE simulators to be used within Westfields Sports. Describe each of these in a paragraph of text.

2. For ONE of these 3, provide details on - (paragraph per part)
   - the purpose of the simulator
   - why it would be of use
   - who would use it
   - how it would actually operate
   - what range of things the simulator would allow its user to do
   - how it would be an improvement over whatever the simulator replaced

3. Complete a sketch (hand drawn in pencil) of the simulator and its important parts - controls, screens, etc. Label these main parts.

4. (a) List and describe the hardware requirements to run the simulator - how powerful a computer, other devices needed, etc.
   (b) Describe the software required (and the option it would need ) to run the simulator.

   Place all of your answers to 1-4 in a display folder (with around 20 plastic sleeves) to hand in for marking by ....................... .................

   NOTE - you will be adding additional sections to this folder later in this topic.
Part 2
Artificial Intelligence

That computers "cannot think" is often stated these days, but is this statement really accurate?

We can all come up with characteristics which demonstrate intelligence, however, defining intelligence itself is somewhat difficult. Therefore if we compare our abilities (a human intelligence system) to those of a computer system - then we can appreciate some of the difficulties in developing a computer system that exhibits intelligence.

"People are able to communicate by written and oral language. They can reason about the world about them, they can learn, they can introspect, and they can be aware of the limits of their knowledge. These are attributes that make people consider a system to be intelligent, and computers can perform these functions only in simplistic ways, if at all."

(Computing Studies Syllabus)

Question - How much of this quotation do you agree with? Give reasons.

....................................................................................................................................................................
....................................................................................................................................................................
....................................................................................................................................................................
....................................................................................................................................................................

Some people seem to think that if a process is understandable for them, then it is not intelligent.

However, many human abilities such as walking and responding to the environment are not easily achieved by computers.

Fast processing and computing numbers, not easily done by humans, is easily done by machine - but not seen as intelligent.

Artificial intelligence is the science which seeks to provide a machine with the intelligence of a human.

A definition of intelligence should include 2 features -
- whether or not the behaviour appears to be appropriate to the situation
- whether or not the behaviour is totally predictable.

Indicators of Intelligence
As stated previously, we should all be able to come up with a list of things which indicate intelligence. Make a list now (though you may want to add to it or even alter it later) of the abilities of an intelligent machine. It would have to be able to -

1. ................................................................................................................................................................
2. ................................................................................................................................................................
3. ................................................................................................................................................................
4. ................................................................................................................................................................
5. ................................................................................................................................................................
6. ................................................................................................................................................................
7. ................................................................................................................................................................
8. ................................................................................................................................................................
9. ................................................................................................................................................................
10. ..............................................................................................................................................................

Research Project

From BOTH books in libraries, etc. AND the Internet, you are to research the areas of - INTELLIGENT SYSTEMS and ARTIFICIAL INTELLIGENCE to prepare a report printed out for handing in - on -

1. Investigate the work of the pioneers of the study and use of AI, including the work of Alan Turing.

2. (i) Define intelligent systems.
   (ii) What are intelligent systems used for?

3. (i) What are expert systems?
   (ii) What are expert systems used for?

4. Describe each of the following in terms of what they do and how it is achieved -
   • demons (or daemons)
   • agents
   • neural networks
   • knowledge bases

   Due by - .................................................................
EXERCISE 1

Read the sections on this page and then answer the questions -

Inference Engine - is part of an expert system that tries to match the data entered by the user to possible facts within the knowledge base of the system. The inference engine uses rules, assumptions and theories (termed deductive reasoning) to work (deduce) out what appears to the user as intelligent responses.

Questions -
1. What is the purpose of an inference engine? .................................................................
   ..............................................................................................................................................

2. What is a knowledge base? ..............................................................................................
   ..............................................................................................................................................

   Most computers contain a knowledge base of such things as - legal moves, relationships between moves or consequences of the move if played. Algorithms are used to evaluate all possible moves at any point in the game, and the move or action with the highest probability of success is the one played.

3. Why do computer programs give the appearance of being so clever at playing these games?
   ..............................................................................................................................................

   Fuzzy logic uses variables between true and false (the normal way a computer works) so that values can be given to rate possibilities. These 'rules of thumb', as used by people, allow the programs to derive a best solution.

4. Give an example of a situation when a computer might need to use fuzzy logic.
   ..............................................................................................................................................

   We consider that people are intelligent because they can communicate with each other, able to reason and learn from experiences. An intelligent system though, is one that receives data from sensors, processes the data and produces a response (that we would consider to be intelligent). Furbies are a type of robotised toy which use a range of sensors to react to the outside world.

5. What is the purpose of a sensor?
   ..............................................................................................................................................
This question and others like it, has been asked for over 40 years. However the answer to all of them is very simple, in that we speak and write in 'natural language' - that is, the words we use in everyday life.

The English language is a complex one, with few consistent rules as well as continual changes and additions of jargon terms. Ambiguity, contextual meaning and the complexity and characteristics of our Australian language, all present enormous difficulties for a computer to overcome to understand us.

Examples to illustrate these include -

1. Jokes which depend on plays on words taking on different meanings in different contexts -

   Hear the joke about the bed?
   Hasn't been made up yet.

   Why do cows wear bells?
   Because their horns don't work.

2. Ambiguity often occurs because many words have different meanings -

   e.g. bow, match, post, etc.

Even short sentences can have multiple meanings - e.g. "Time flies like an arrow"

Can be interpreted as -
These possibilities (and others you may think of) occur because, in this sentence -

- 'time' can be a noun, verb or adjective
- 'flies' can be a verb or noun
- 'like' can be - for affection or comparison

Which one of the above pictures do you agree with the most? ........................................................

How would a computer know what is meant? ...................................................................................
......................................................................................................................................................................

If we go further than simple words and short sentences, the complexity of getting across the real meaning - to another person, let alone a computer, increases dramatically.

"INTELLIGENT" COMPUTER PROGRAMS

Many of us will have played a computer game (cards, chess, etc.) and won against the computer for a while, only to lose repeatedly later on. This is because quite a number of programs take a little while to 'learn' from the way you play the game and then use your strategies against you. Therefore it becomes increasingly difficult to keep on changing how you play to enable you to beat the computer.

Depending on the complexity of the game and the programming (with the use of fuzzy logic for example) the computer may 'learn' all of your possible strategies and you may not be able to win against it.

Other programs have been designed to ask you a series of questions and then make calculated responses - maybe to diagnose a possible illness or advise you as to which horse to bet on, or which member of the opposite sex may be your perfect match.

We will examine a range of computer programs to see how 'intelligent' they are.
EXERCISE 2

Use the Internet to briefly (30 minutes maximum each game) play each of the following games

• Miniputt  web.mit.edu/wnellie/www/miniputt.swf
• Goal Kicking  www.playtheball.com/live/conversionkings/conversionkings.asp
• Fruit Drop - Puzzles  www.ultimatearcade.com
• Hexxagon - Puzzles  www.ultimatearcade.com

Questions -

Having completed a brief run through of each of these programs, answer each of the following questions -

1. Can you work out how the programs actually make the decisions for the moves the computer makes? ........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

2. Which is the toughest game to win against? ..........................................................................................................................
Why? ..........................................................................................................................................................
Is this the most enjoyable game? .............. Why? ........................................................................................................

3. What is the name of your favourite Internet game? ..............................................................................................................
What is it's Web address - ..................................................................................................................................................
Bring up your favourite game and show it to your neighbour.

4. Do you consider that any of these programs is intelligent? .........................
If so, which one/s ........................................................................................................................................
..................................................................................................................................................
If not, why? ........................................................................................................................................
..................................................................................................................................................
Since humans are usually acknowledged to have a corner on intelligence, the subject of very smart robot computers is a little frightening. There are two human responses to such computers: accept them as geniuses, or call them idiots. A recent book has stirred up the controversy again by raising questions like these - Would anything like a "state of consciousness" arise when a system reached a certain degree of complexity? Would something like the human soul be generated in a very complex and intelligent computer—a "ghost in the machine"?

As we put it: Would an intelligent computer have a right to life?

A book was written by Douglas R. Hofstadter and Daniel C. Dennett - two people who think computers can become geniuses. But the critic John R. Searle, who is a professor of philosophy at UC Berkeley, thinks that computers will never become more than idiot savants (like Dustin Hoffman in Rainman). He wrote a scathing review arguing against the possibility of machine self-awareness. Professor Searle's article centres on the idea he calls the Chinese Room thought experiment.

It goes something like this: suppose we write a program for a computer to simulate an understanding of Chinese. We write the program so well that when we tell the computer stories in Chinese and ask questions about the stories in Chinese, the computer gives us answers in Chinese that make sense. Searle argues that this is analogous to putting me in a locked room with boxes full of Chinese ideograms, and giving me the rules in English (my "machine language") for putting them together - the basic syntax or program for combining ideograms. All I know is how to assemble strings of Chinese ideograms correctly - correctly from the standpoint of whoever puts them into the room.

Searle argues that in time I might get so good at arranging the ideograms that someone outside the room would begin to think I really understood Chinese, which in fact I do not. I am, therefore, like a computer whose program - my rules for syntax - enables me to put together answers which seem to make sense. Searle insists that something like semantics could never arise within such a computer program to give it a real "understanding" of the entire gamut of semantics of Chinese. The contrary argument of what Searle calls "strong Artificial Intelligence" (AI), is that the entire "system" does indeed have the ability to comprehend Chinese.

What follows is a conversation about these points of view.

Erik: The arguments of Searle are totally unconvincing to me. Searle keeps talking about "intentionality" and "causal properties" being unique to the human mind and not simulatable on a computer.

He says he is not talking about a soul, but I don't know. In Hofstadter and Dennett's book they
try to investigate what a soul might be; what would happen if a soul were removed from a brain. For now, I don't see why a computer could not be made to think and experience. If strong AI is successful (and I think it might be), people may assume that a computer is conscious just the way you assume that I am conscious. But the most confusing questions are: Why am I conscious? And what is consciousness?

Robert: Trying to determine the relationship between mind and body is an ancient problem. Those who have considered it fall into two classes: those who think humans are complex machines and those who think the mind is something other than just a machine - call it something spiritual. The view that animals and humans are machines in a mechanical sense was explored first in modern times by the French philosopher La Mettrie, in his book Man A Machine. Today we are replacing his viewpoint with the idea that animals and humans are electrochemical computing machines, with thousands of books and articles on the subject. Consciousness in animals and humans has always befuddled philosophers. It is at the core of our wonder about the human consciousness, soul, awareness - call it what you will. We should not expect to solve it overnight, especially since computers seem to confuse more than clarify the issue. Perhaps computers can help us sort out the problem in a very new way, simply because of their unique abilities to play as if they had their own awareness.

Erik: Do you think that "personal awareness" affects the way we act? That is, do you think the awareness has some physical effect on the brain? An effect that can be observed? If the spark has no effect (which is what Searle thinks), then a thing without the spark acts no differently from a thing with the spark - that is, it passes the Turing test. This seems rather strange, because what we have just said implies that the thing will claim that it feels everything that you and I claim - it will insist that it has an inner light, etc. The other possibility is that personal awareness does have a physical effect on us, that it modifies the way we think, maybe even causes us to claim that we have an inner light.

Some people claim that the origin of consciousness coincided with the development of language in humans. Why couldn't an inner awareness develop in a computer in the same way? On what basis do you decide whether some hunk of matter has the inner awareness or not? The mere fact that we are biological? What is intrinsic about our biology? People already hypothesise beings of different biologies. Why couldn't one of these other biologies be electronics? You can't say, it seems to me, that the particulars of our humanness cannot be duplicated in a computer, given the "total simulation argument." (Just simulate all neural sensory inputs and then all of the neurons in our brains - right down to the atomic level, if necessary.)

Robert: You pose quite a dilemma: I must believe either that personal awareness has a physical effect on the brain (in which case it can be simulated) or that it does not. I think that it does. You might associate language with mind, but if you say that language is the seat of human consciousness you must say that animals have no internal conscious states - unless it be a bark or a meow consciousness. And if we cannot use language, say when a certain accident hurts a part of the brain, then we lose our consciousness - which is not medically true. I think that consciousness is somehow linked with time. Consciousness is always alive at the current point in time. We can reflect on our conscious state of a moment ago, and we can will what it will do next, but it always exists as a lambent richness in the now. You cannot be sure, for example, that humans will slavishly follow all of your instructions. A person may deliberate between courses of action, but a computer cannot decide not to do a calculation because its chips are in pain or malfunctioning.

Erik: OK. I don't think that consciousness requires language. But how can you say that computers slavishly follow all instructions and can't decide not to do a calculation when we also slavishly abide by the laws of physics, for example.

Robert: I guess we must establish a set of criteria to use before we can accept computers as co-equal partners in living. How do these sound?

- We must feel that it would be morally wrong to turn off the mechanism.
- The mechanism must have a language capable of describing past intentions and suggesting
future ones, all of which need not be carried out.
• The mechanism must have a sense of the present.
• The mechanism must be aware of itself and be proud or ashamed of its actions.
• The mechanism must offer reasons why it should not perform some instruction we give it.

Because it is difficult to explain human “consciousness” - that core spark glowing somewhere at
the centre of our personal awareness - how are we aware of what seems to be an internal light or
an atmosphere of “beingness?” This sensitive, central recording device in us collects, interprets,
feels, and experiences sensual or thought states, and, unless we are asleep, brings them to our
attention to disturb, calm or amuse the self.

That core of our self which illuminates our inner experiences is indeed inexplicable. I do not see
how we can suggest that a computer could ever have a soul. I guess you are saying that it is
beside the point of AI - that if a computer satisfies Turing’s criteria, it simply does not matter. I
think you are avoiding the issue. The issue is: - what is the central thing within us, and do you
really believe that a mocking Turing computer, however clever, could really have it?

What if our computer mind claims that it thinks and feels, if we become convinced by the
computer, like Turing, that it is indeed like us because it seems to exhibit all the signs of human
intelligence, because it claims that it has a personality and its own core of consciousness because it
says it has a self, just as we do, and it demonstrates its claims in unexpected ways - say, by writing
a poem. The question then arises - and this is the beginning of the moral dilemma: Can we turn
them off at will? Such "humanoid computers" would not like it; like humans, they would begin to
cry when we reached for the off switch. Can we legitimately pull that switch? If they claim to be
as soul-like as we are, do they therefore have an inalienable "right to life"?

Erik: In response to your "moral argument", that is a confusing question. Maybe even if AIs do
feel, we should pretend that they don’t to protect ourselves. I don’t think the moral argument is
an argument about whether AIs can really feel; it is only an argument about whether we should
(morally) consider AIs to have feelings.

Robert: When a computer reaches a point of intelligence at which it objects to being switched off
or objects to having a copy made of its mind - call it a birthdisk - being erased, and gives me good
reasons why I should not do so, I will respect its wishes and withdraw all of my prejudices against
it. In fact, I will envy it enormously. Look at its virtues: Being in electronic form, it is ageless, and
it has a "body" that can be periodically renewed by transferal from clumsy old hardware into a
smaller, more beautiful, and super-miniature body. It can erase current mistakes and go back to
any point in its past life (provided a copy of its mind was saved at that point). It can be
transmitted over wires - beamed to Mars if it desires. It can reproduce itself endlessly and
effortlessly, and bask in the confidence of infinite personal friends of its identical ilk - twins who
will understand it intimately, know all of its desires and fears. It can, in fact, link up perfectly with
its brethren and form a utopian society.

So the answer to the question "Would an intelligent computer have the right to life?" is probably
that it would, but only if it could discover reasons and conditions under which it would give up its
life if called upon to do so - which would make computer intelligence as precious a thing as
human intelligence.

EXERCISE 3

Questions -
1. Considering that this article was written before you started school (1983), the degree of
computer intelligence at that time would be a fraction of that existing today. What is your opinion
of the computer's "Right to Life"?

2. What do the references to Turing actually refer to? Was he a scientist?

3. If computers of today have virtually reached the stage of development the authors are describing, what points would convince you that computers are equal to humans?

What points would worry you the most?
Project - part 2 Artificial Intelligence

Now that you have studied AI - including
- intelligent systems
- expert systems
- neural networks
- knowledge bases

you should be able to improve on your description of the software for your simulator.

To Do -
1. Research simulators (books, Internet, etc.) to see if you can find out about the types of programs that drive them. Make a reference list of all useful items and Web addresses.

2. Select one (or more) types of intelligent system to drive your simulator, and give reasons for your selection.

3. Describe how the intelligent system may be able to make the parts of the simulator perform.

4. Make suggestions about how such software could be used to improve the range of possibilities of what your simulator can do.

   Place all of your answers to 1-4 in your display folder (after your part 1 answers) to hand in for marking by ...................................................
Modelling is the computer representation of a real-life situation. Models have been used over history to depict or illustrate how something looks - either to scale or not - like model trains or cars - usually so that the object may be viewed from a variety of angles.

For example - (i) a small scale wooden model of a fortress to be attacked by an army
(ii) computer model of a tall building to see the effects of earthquakes

**EXERCISE 4**

1. List 4 other situations (different to the ones above) where models - either physically constructed or computer simulated - have been used.

2. Describe in some detail how ONE of these models was used and what was achieved by its use.

To be completed by - ..............................................

Computer modelling may be achieved in a number of ways, so long as all of the possible inputs to the situation are considered, and the rules discovered for what happens when these inputs have an effect on the model. Thus the model is a simulation of a real world situation. The more accurate the rules and their effects, the better the model and the more useful it will be.

Simple up to highly complex computer models may be created -
• as separate programs written just for that special purpose (e.g. weather prediction software) written in a programming language

• by entering formulas and data into an application program such a Spreadsheet

The hardware requirements will basically match the degree of sophistication and complexity of the program involved. Thus a personal computer will easily run most spreadsheet models, while a super computer may be needed to run climate and war simulations with hundreds of variables and scenarios.

We will begin by using spreadsheets to look at a range of models students can create and use.
The Spreadsheet

A spreadsheet is a grid made up of a series of rows and columns, with boxes called cells at their intersection.

![Spreadsheet diagram]

It is the electronic equivalent of the grid paper that accountants used in the past, so that data generally in the form of numbers may be entered and then calculations made, using formulas written for specific calculations and outcomes.

Read about spreadsheets in pages 112-114 of the textbook - Computing Studies for Australian Schools.

We will use the two scenarios based on what people need to calculate the most - loans for houses and cars - the two biggest expenses for most people.

Real Estate Spreadsheet

Using the data collected from a newspaper or a Multiple listing booklet, we can construct a spreadsheet to make useful calculations about the cost of buying any of the selected houses.

Note -
- all work is done in cells, which are located by their column and row position
  e.g. A1 is top left, C3 is across and down 3.
- arrow keys, Tab and Return are used to navigate
- a well designed SS with clear labels is much easier to use.

To Do -
1. create a new SS document - named Loan Calculator
2. fill in your SS exactly as on the following page
   - don’t worry about sizes, centring, etc.
(a) labels first - Loan Calculator, Principal, Rate, Term in Years, Months & Payments

(b) then the data - 10000, .15, 10

(c) then format the data using **Number** (under the Format menu)
- 10000 - currency, precision 2
- .15 - percent, precision 2

(d) in cell E4 type in the formula = **B6 * 12**
   (the equals sign means formula)

(e) in cell E5 type in the formula = **PMT (B5 / 12, E4, -B4)**
   - PMT stands for payment
   - the remainder comes up with the monthly payment on a reducing principal

**Note** - if your spreadsheet has the following numbers showing, you have entered everything correctly -

- **E4** - 120
- **E5** - $161.33

- if not, then you need to find and correct your mistake - sometimes spaces in formulas or dollar values will cause problems.

**Use of the Spreadsheet - Modelling**
The main uses of spreadsheets are to -
1. perform numeric calculations
2. allow ‘what if’ possibilities e.g. what if you borrow $20000? or what if the interest rate goes down to 9%?

**EXERCISE 5**

**To Do** - use your SS to answer each of the following -

1. What are the monthly repayments on -
   (a) a $55 000 loan at 9.5% over 15 yrs
   (b) a $45 500 loan at 11% over 20 yrs

**Westfields Sports Information and Software Technology J. Smith 2004 Page 27**
2. How much could you afford to borrow on a monthly repayment of -
   (a) $800 at 10% over 15 yrs ..............................................
   (b) $1 000 at 11.5% over 20 yrs ..............................................
   (c) $1 250 at 9.75% over 25 yrs ..............................................

3. Find out about your parent’s mortgage (the principal borrowed and the interest rate), then check on the monthly repayment rate (keep the amounts to yourself). Is it exactly right? ..............................................

   • Fees and charges are generally added by banks and are included in repayments.

4. If you purchased the house from the database -
   (a) (i) you thought was the best value, at 10% interest, your monthly repayments would be ..............................................

       (ii) then the interest went up to 12%, the repayment would go up by ..........................

   (b) (i) with the highest priced house, at 10% interest, your monthly repayments would be ..............................................

       (ii) then the interest went up to 12%, the repayment would go up by ..........................

If all people used the ‘what if’ possibilities of the spreadsheet before they committed themselves to high repayments, they would not find themselves unable to meet their house payments in times of economic hardship.
Used Car Spreadsheet

Just as real estate agents and house buyers could make good use of the spreadsheet, so someone wanting to buy a used car could use it to very good effect. The source of data can be the newspaper, which regularly gives details on hundreds of vehicles each week.

EXERCISE 6

Spreadsheet Use
Use your house repayments SS to work out the monthly repayments (at 14% interest) for -

1. a $10 000 car over 3 years - $..........................................
total cost (from adding all repayments) = $ .........................

2. a $15 000 car over 4 years - $................................. total cost = $ ............................

Add this feature of totalling all the repayments to your SS-
• with the label Total Payments in cell D6,
• then work out a formula to do the calculation automatically, and put the answer in cell E6.

Then save the spreadsheet - using SAVE AS - with the name Car Repayments SS

3. What would (i) the monthly repayments on a $60 000 BMW be, at 15% over 4 years - $.........................
   (ii) the total repayments be - $..............................

4. If you bought a car on Bank card (at 21% interest) for $11000 and took 3 years to pay it off, what would -
   (i) your monthly repayments be - $ .........................
   (ii) your total payments for the car be - $ .........................
   (iii) therefore the interest would be - $ .........................
Food Production in Space

We have already seen a joint US and Soviet Space Station constructed and placed in orbit around the Earth, and another is planned for the future - so that for all future space exploration, we will not need to waste valuable fuel having to escape the Earth’s gravity on each mission.

This reduces the problem of fuel and mishaps in the first few days of the space flight, however the -

• staff of the space station,
• crew of the spacecraft and
• possible colonisers of any habitable planets located

- will face the real problems of air and food supplies. If most of the food, water and oxygen could be produced ‘in house’ then supplies of all other goods could occupy virtually the entire space inside the craft.

Since in the production of food, plants take in carbon dioxide and produce oxygen in the presence of sunlight (and the space station would receive plenty of sunlight), and water is given off by plants as a byproduct of this process (photosynthesis), it is proposed that sealed transparent domed areas of land be started in sections of the space station to trial the production of food. That some oxygen would be gained and little water lost would be a bonus.

As seen on the next page, such a clear dome would have a large area which is sealed so that water recycles and both plants of many varieties and some animals may be raised to provide food for the occupants of the space station.
This is a modelling situation, where ‘what-if’ possibilities can be used to work out the amount of food value such an area of land can produce - and therefore exactly how many people can be kept fed in a range of dietary requirements.

- Obviously, the crew of the space station - named Alpha (the first one) would need a balanced diet or they could become sick.

- Also, the more food value produced within the dome (measured in food units) the more people the dome can support.

**TO DO -**

Your task is for your group of TWO to use the -

- **Food Production Database** and
- **Food Selection Spreadsheet**

To plan a balanced diet for the crew, as well as the most food in the 0.12 hectares area of the dome.

You need to document all of your work by completing the attached sheets.

**EXERCISE 7**

**Group Names -**

-----------------------------------------------------------------

**From the Food Production Database**

From the database collection of 19 vegetables and 3 animal types, work out a number of each group to try to produce a balanced diet -  

**PLAN -**
Vegetables - ........................................................................................................................... 
...................................................................................................................................................... 
...................................................................................................................................................... 
Animals - ...................................................................................................................................................... 
...................................................................................................................................................... 

**Answer the following questions** -

1. What constitutes a balanced diet? ..........................................................................................
...................................................................................................................................................... 
...................................................................................................................................................... 
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2. Why do the vegetables have such different food units for the same area of land used?
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3. Why do animals have such different food units compared to the vegetables?
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**From the Food Planning Spreadsheet**

1. Enter the plants and animals from your plan on the previous page - trying about equal numbers of each to fill the land area. Fill in the Number 1 table on page 48 from your spreadsheet when you are finished.

**Result** - number of people supported = ..........................................

2. Adjust the numbers of your plants and animals from above to see the highest number of people supported by the dome. Fill in the Number 2 table page 48 from your spreadsheet when you are finished.
3. Forget your plan for a balanced diet and simply produce the greatest yield of food units. Fill in the Number 3 table on page 49 from your spreadsheet when you are finished.

Result - number of people supported = ..........................................

Answer the following questions -
1. Which of the above diets would you live on for months at a time? ..........................................
   Why? .......................................................................................................................................................

2. Which is most useful in working out the greatest yield of food units, the database or the spreadsheet? .......................................................
   Why? ......................................................................................................................................................
   .................................................................................................................................................................
   .................................................................................................................................................................
   The other is good for - ........................................................................................................................
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*Westfields Sports      Information and Software Technology      J. Smith 2004*
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<th>Yield (food units)</th>
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Number of people supported by dome =

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</tr>
<tr>
<td></td>
<td>Cow</td>
<td></td>
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</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td>(sq. m.)</td>
<td></td>
</tr>
</tbody>
</table>

Number of people supported by dome =
<table>
<thead>
<tr>
<th>Food</th>
<th>Number</th>
<th>Area Used (sq. m.)</th>
<th>Yield (food units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asparagus</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Beans</td>
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<tr>
<td>Beetroot</td>
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<tr>
<td>Broccoli</td>
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<tr>
<td>Brussel Sprouts</td>
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<tr>
<td>Cabbage</td>
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<td>Capsicum</td>
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<td>Cauliflower</td>
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<td>Corn</td>
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<tr>
<td>Lettuce</td>
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<td></td>
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<tr>
<td>Onions</td>
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<td></td>
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<tr>
<td>Parsnip</td>
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<td>Peas</td>
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<td></td>
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<tr>
<td>Potato</td>
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<td></td>
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<tr>
<td>Pumpkin</td>
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<tr>
<td>Radish</td>
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<td></td>
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<tr>
<td>Spinach</td>
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<td></td>
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<tr>
<td>Tomato</td>
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<td></td>
</tr>
<tr>
<td>Turnips</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chickens (pair)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goats (pair)</td>
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<tr>
<td>Cow</td>
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<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td><strong>(sq. m.)</strong></td>
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</tr>
</tbody>
</table>

**Conclusion -**

From my experimentation with the Food Planning Spreadsheet and from the range of data in the Food Production Database, I would grow the following plants and raise the following animals:

**Plants -**

**Animals -**

If you could not have used the 'what - if ' possibilities of the spreadsheet, how could you have attempted to solve the problem of food production on the space station?

**Advantages and Limitations of Models and Simulations**

As previously stated, the complexity of the model will generally make the simulation more realistic, and allow more predictions to be made from the model for the future. All models or simulations have limitations - in that all possible inputs may not be known or predicted, and that the size or other variables to do with these inputs may not be fully understood.

Basically, models and simulations are good for approximating a real situation, BUT will never cover ALL of the possibilities.
EXERCISE 8

1. Name - from a range of situations (remote, dangerous, etc.) FOUR examples where simulations have been used to assist man to prepare for a real situation.

2. Select ONE from your four above and research how it actually operates and what things the simulations performs in some detail. Give references for your research.

3. Discover some limitations of any of the four from 1. and discuss why they occur and what could occur due to them.

4. How has man made allowances for such limitations of simulations?

To be completed by - ...........................................................
Project - part 3 - Modelling and Simulation

Your Group (2 - 3 students) are to select from the list of possible simulation topics (or get one of your own approved by your computing teacher) for you to create a spreadsheet to perform -

1. A Canteen control system - including ordering, pricing, stock control, etc.
2. A Library borrowing system - including books, magazines, exams, videos, etc.
3. A Staff/Student Vehicle system - including all teacher, non-teaching personnel and senior student vehicle identification, parking, etc.

Involved
- organising group member tasks
- design of data collection form (and deciding which data)
- selection of people to be included
- collection of data
- design of spreadsheet
- creation of spreadsheet, formulas, etc (and debugging)
- entry of data and checking of accuracy
- presentation to the class of how the program operates (and all the things it does)

[* printout put into your display folder]

Research Questions -
1. How does the weather bureau come up with weather predictions for -
   (i) the next 24 hours
   (ii) the next 7 days
2. What are the advantages of accurate weather predictions for our area?
3. What are the limitations for weather predicting in our area?
4. Why are weather predictions frequently inaccurate? Is it the model or the data or what?

Place all of your answers to 1-4 and your printouts in your display folder (after your part 2 answers) to hand in for marking by ................................................