SSS 2 Scheme of Work

(Third/Summer Term)

Week 1:	Modelling Applications, Applications of ICT in Manufacturing Industries (I)
Week 2:	Booking Systems, Banking applications (I)
Week 3:	Computers in medicine, Expert systems (I)
Week 4:	Computers in the retail industry, Recognition systems (I)
Week 5:	Monitoring and tracking systems, Satellite systems (I)
Week 6 - 7:	The Systems Life Cycle (I), System Development Cycle (W) and Program Development Cycle (W)
Week 8:	Safety and Security (I)
Week 9:	Computer Ethics and Human Issues - Security And Ethics (W)
Week 10:	Revision

Week 3

Computers in medicine and Expert systems (I)

Lesson Outlines:

Computers in Medicine

Students should be able to:

- Describe the contents of information systems in medicine (including patient records, pharmacy records, monitoring and expert systems for diagnosis)
- Describe how 3D printers can be used in producing medical aids (e.g. surgical and diagnostic aids, development of prosthetics and medical products, tissue engineering, artificial blood vessels and the design of medical tools and equipment)

Computers in medicine

Computer systems are used in several quite different ways within doctor's surgeries and hospitals…

- **Managing Patient Records -** the **medical details** of every patient is **accurately** recorded (using a computerised database) so that the correct diagnosis can be made, and the correct treatment can be given.
- Databases also allow for a quick and easy search of patient records. This is especially important during an emergency. It also means that medication can be prescribed without issuing paper prescriptions – an email could be sent to the pharmacy.
- The sort of data which would be required on a patient database would be as follows:
  - ✓ a unique identification number
  - ✓ name and address
  - ✓ gender (male or female)
  - ✓ blood group
  - ✓ medical history (e.g. recent medicines taken, treatment given)
  - ✓ date of birth
  - ✓ any known allergies
  - ✓ details of doctors the patient might have consulted
  - ✓ important additional information such as CT scans, X-rays, blood reports, etc
  - ✓ any current diagnosis.

Computers in medicine

Computer systems are used in several quite different ways within doctor's surgeries and hospitals...

- **Monitoring of Patients –** connecting a patient to a computer system sensors are used to monitor a condition continuously**: Pulse rate** (heart beats per minute), blood/body **temperature, Breathing rate** (breathes per minute), **Blood oxygen** levels, **Blood pressure,** brain activity, oxygen levels in the blood, blood sugar levels, blood pressure.

- **Diagnosis for illness** - Body Scanners, CT scanners and MRI scanners allow doctors to investigate what is happening inside a patient's body without intrusive surgery. These data collected by **sensors** are **processed** and then outputs **full-colour images,** sometimes in **3D,** for the doctor, giving views of the patient's body.

- **Expert Systems -** allow medical staff with limited medical knowledge (e.g. nurses) to get advice from a computer 'expert'.

How it works?

✓ Medical staff **inputs** patient's **symptoms** (or answers questions about them)
✓ The expert system's search engine **searches** the **knowledge base**(a collection of medical knowledge) to find possible diagnoses
✓ The system **outputs** a list of **possible diagnoses,** and treatments

How 3D Printers Are Used in Producing Medical Aids

- surgical and diagnostic aids
- development of prosthetics and medical products
- tissue engineering
- artificial blood vessels and
- design of medical tools and equipment)

One of the most innovative use of 3-D printers is in the field of medicine.

- **Surgical and Diagnostic Aids -** It is possible to print out anatomical parts using 3-D printers. These are used as an aid towards diagnosis and surgical procedures.
  - A 3-D printer can then reproduce a solid object showing the exact internal organs of the patient. The doctor or surgeon can then show the patient exactly what is wrong and then show them what procedures are required. They also help the surgeons in planning surgical procedures since they can see exactly what is required well in advance of the operation.
  - 3-D printing systems enable blood vessels, major arteries, tumours and so on to be part of the diagnostic, pre-surgical aids. This also allows for patient engagement which would be missing from the more traditional consultation methods.
  - Some 3-D printers produce hard nylon objects which are used in certain pre-surgical planning. If a patient has suffered, say, a bone fracture, then the surgeon can physically test and position screws and plates in the '3-D bone nylon image' prior to the surgery. This reduces the chance of any errors when the actual procedure is carried out.

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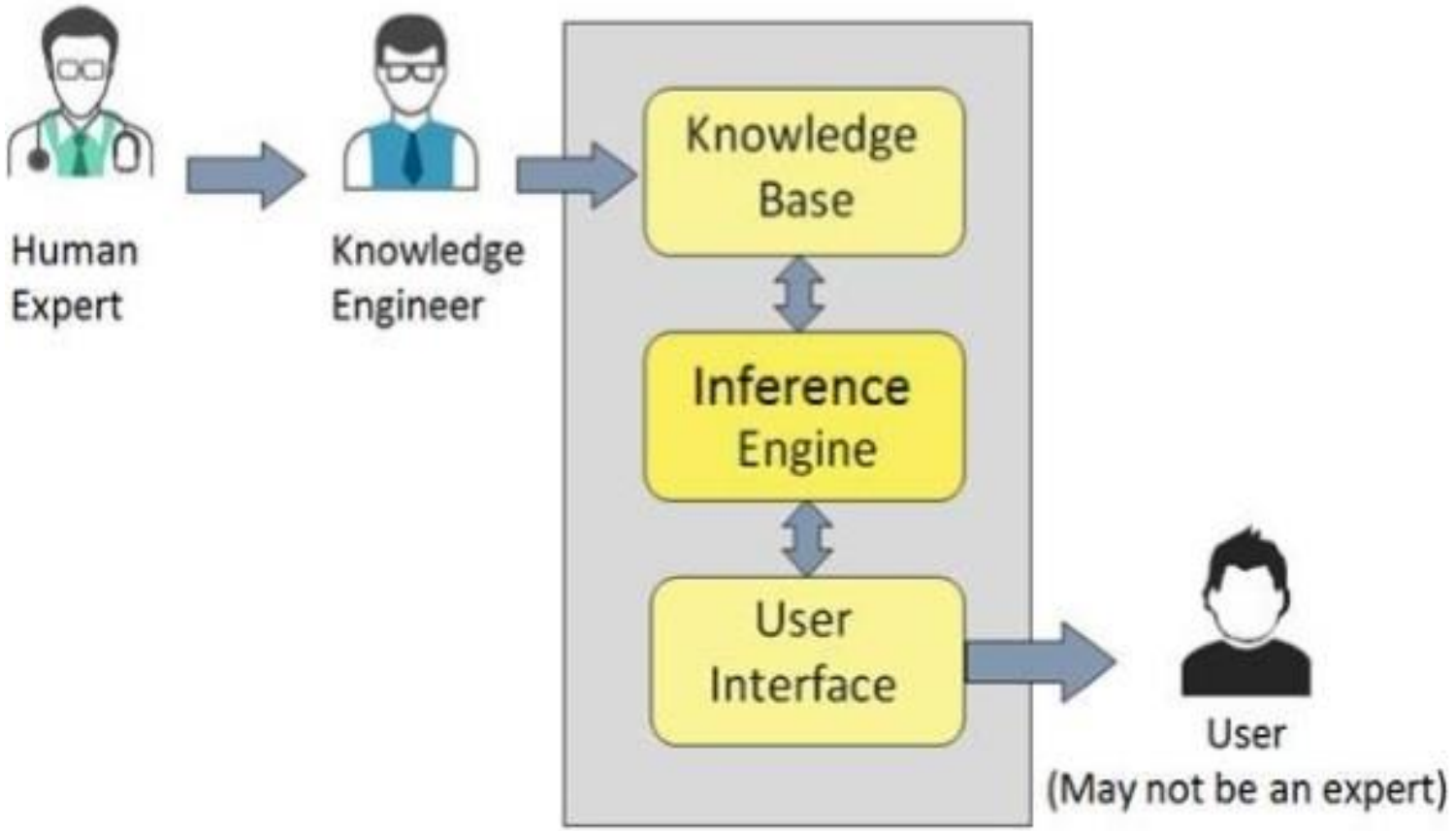
- **Prosthetics** - 3-D printers are used to print out prosthetics i.e. artificial arms, hands and legs. The results to date are very encouraging with many more people from poorer countries now having a chance to replace missing limbs at a fraction of the cost compared to existing methods.
- **Tissue Engineering** - Recent advances have allowed the 3-D printing of bio-compatible materials, cells and supporting structures. This has improved the viability of the function of cells within a 3-D printed object. 3-D bio-printing is a very complex process and requires the input from biologists, medical engineers, physicists and other engineers. It has already been used successfully to produce multilayered skin tissue, bone tissue, heart/artery grafts and tracheal splints.
- The procedure involves making biological materials by diffusing cells into a bio-compatible scaffold. The bio-printed tissue is then put into an incubator and the cell structure held within the scaffold grows to form actual cellular tissue.
- **Design of medical tools and equipment** - 3-D printers are now being used as part of the product development cycle for medical tools. This allows new medical equipment/tools to be made ready for the market much faster. Traditional methods of producing new equipment/tools are very time consuming and very expensive. 3-D printers create injection moulding tools which allow several prototypes to be made within a short period of time. Traditional methods require aluminium moulds to be made which is slow and expensive process. Development time is reduced, on average, by up to 90% and development cost is reduced, on average, by up to 70%. This is important in the field of medicine where it is essential that development time and costs are reduced to a minimum.

Expert Systems



Students should be able to:

- identify a range of applications which use expert systems (e.g. mineral prospecting, car engine fault diagnosis, medical diagnosis, chess games)
- identify the components of an expert system (e.g. interactive user interface, inference engine, rules base, knowledge base)
- describe how an expert system is used to suggest diagnoses

Expert system

- An expert system is a computer **program** that is designed to act like a human expert (i.e. mimics the intelligence of a human expert) on a particular subject area. For example, it could be set up to give medical advice.

- They are often used to advise non-experts in situations where a human expert in unavailable (for example it may be too expensive to employ a human expert, or it might be a difficult to reach location).

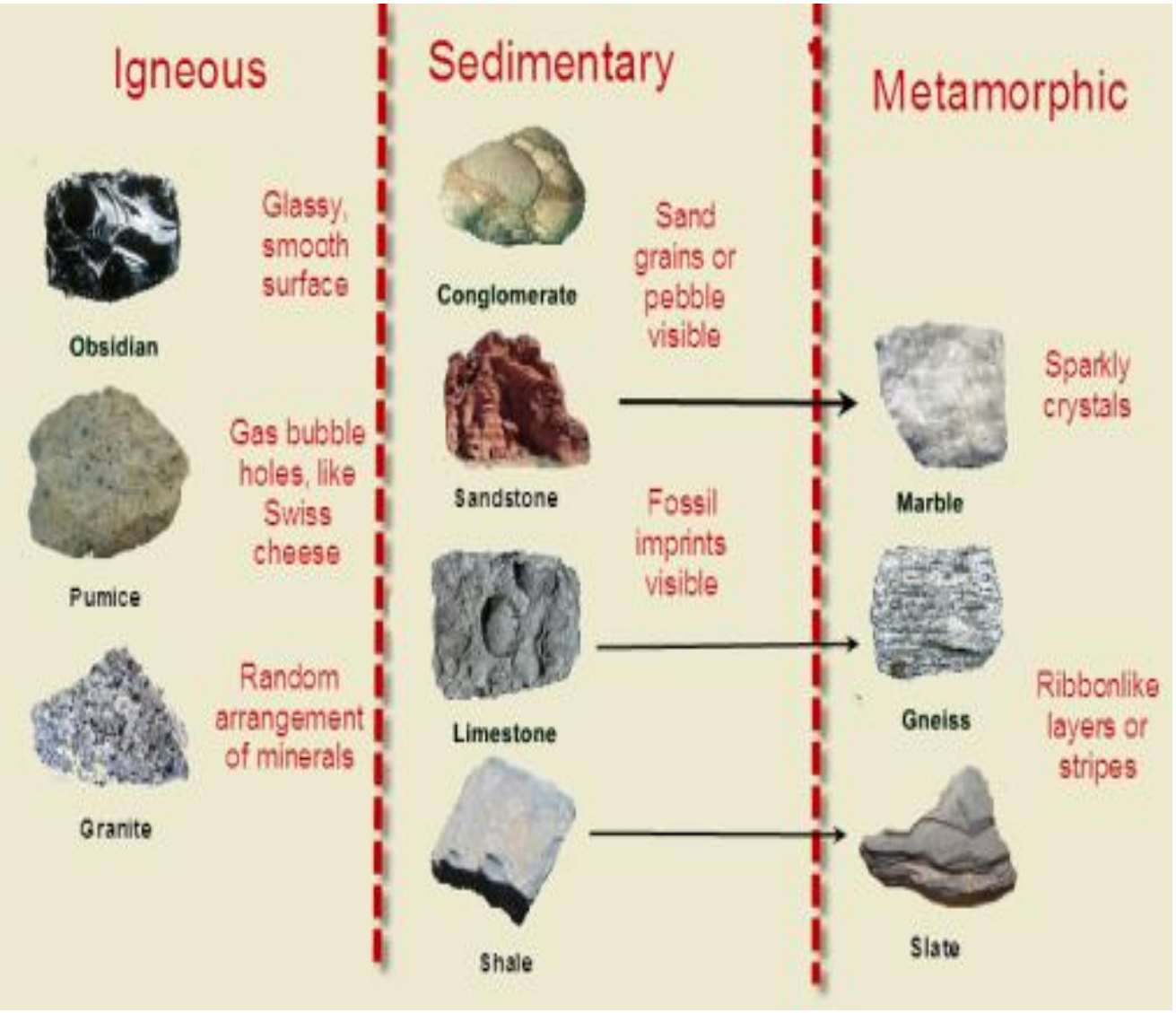
Some expert systems in action ….

- **Medical diagnosis**

To work out what is wrong with a patient. The knowledge base would contain medical information, the symptoms of the patient would be used as the query, and the advice would be a diagnosis of the patient's illness.

- **Playing strategy games-** like chess against a computer (the knowledge base would contain strategies and moves, the player's moves would be used as the query, and the output would be the computer's 'expert' moves)

- **Providing financial advice -** whether to invest in a business, etc. (the knowledge base would contain data about the performance of financial markets and businesses in the past)

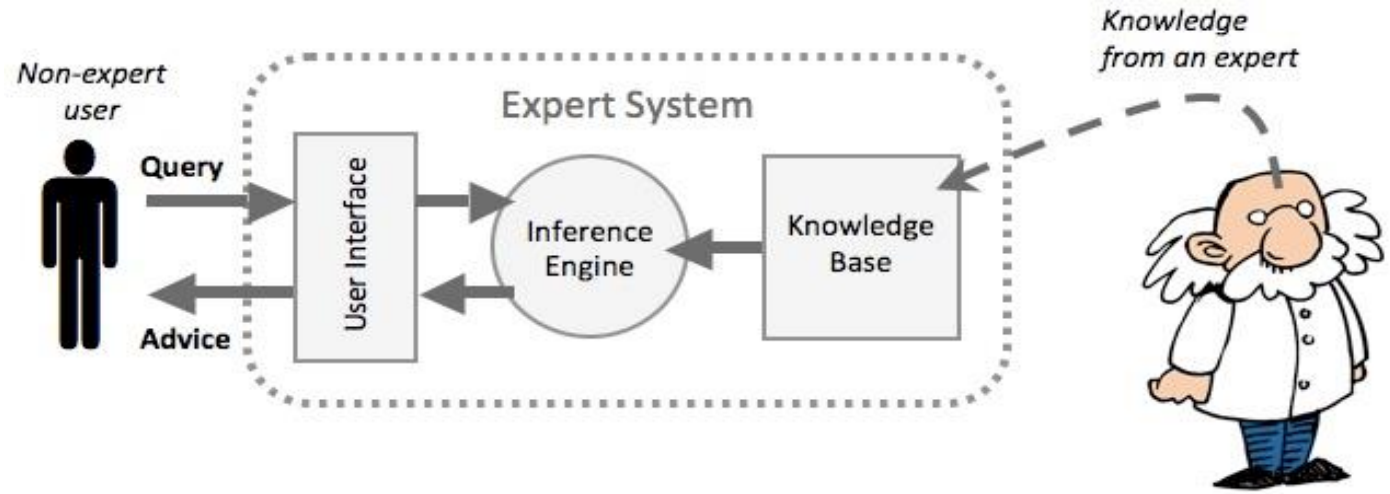


- **Helping to identify items -** such as plants / animals / rocks / etc. (the knowledge base would contain characteristics of every item, the details of an unknown item would be used as the query, and the advice would be a likely identification)

- **Helping to discover locations -** to drill for water / oil (the knowledge base would contain characteristics of likely rock formations where oil / water could be found, the details of a particular location would be used as the query, and the advice would be the likelihood of finding oil / water there).

- **Helping to diagnose car engine problems -** Like medical diagnosis, but for cars. To work out what is wrong with a car.

Parts of an expert system:



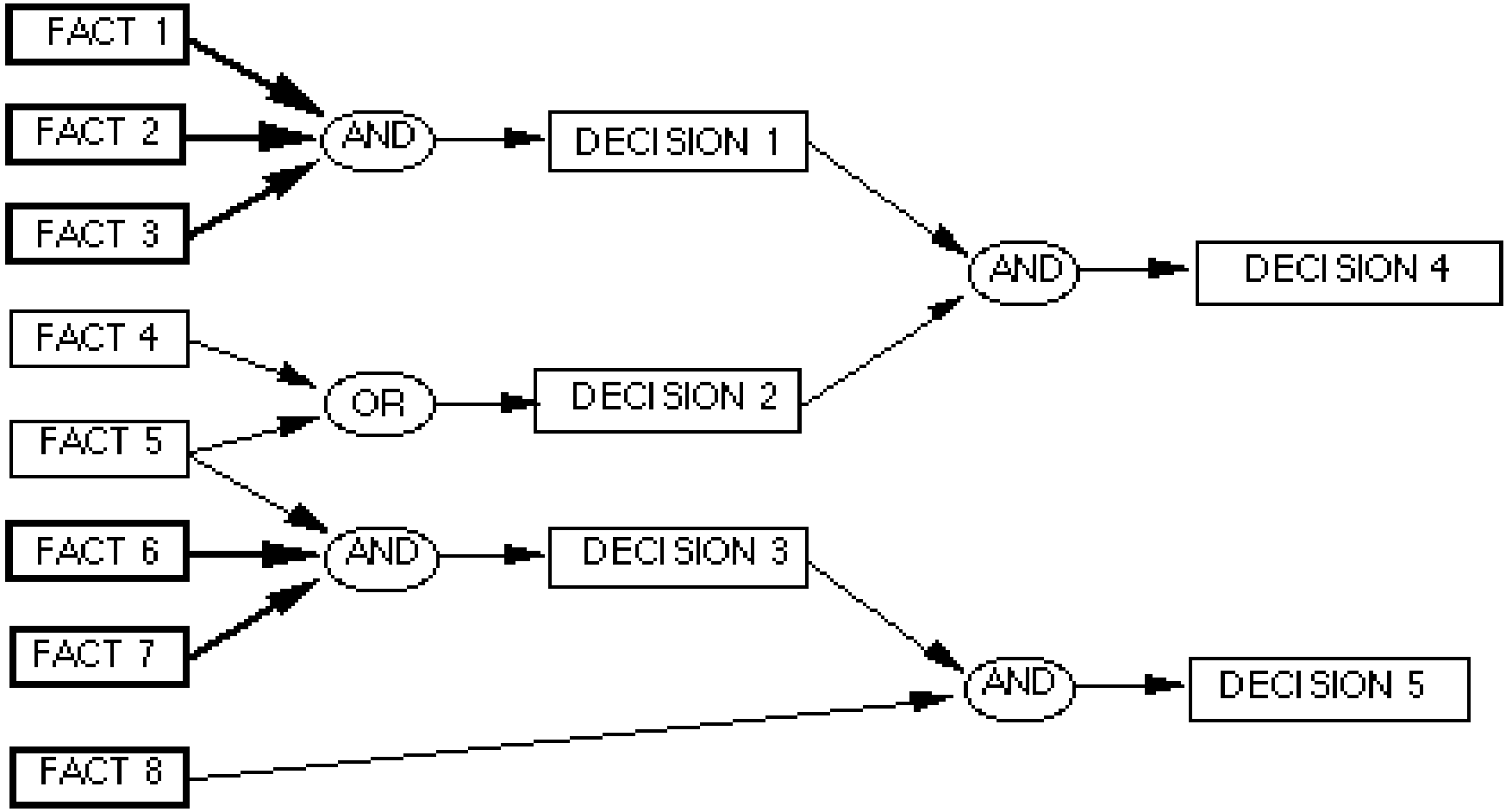
An expert system is made up of:

- An **Interactive User Interface**
- An **inference engine**
- **Rules Base**
- **A Knowledge Base**

How an expert system is used to suggest diagnoses

- The **non-expert user** queries the expert system. This is done by **asking a question,** or by **answering questions** asked by the expert system.

The **inference engine** uses the query to **search** the **knowledge base** and then provides an answer or some **advice** to the user.



Creating An Expert System:

- Gather the knowledge from experts or other expert sources (i.e. textbooks, CDs, internet, etc)
- Design the knowledge base
- Create the interface with any software and make it easy to use.
- Link the interface to the knowledge base by the use of an inference engine
- Select software to use. This may be an expert system shell (an already built inference engine) or a computer language appropriate for building the knowledge base and an inference engine
- Implement (make) the system making sure the inference is easy to use
- Test the system
- Document the system and create a user manual
- Check the system with the experts to make sure it produces sensible advice or diagnosis

Creating an expert system is very time consuming and the fact-finding stage is often very difficult because the systems consultant (the computer programmer making the system) often finds it difficult to understand the area of expertise.

Pros	Cons
Many copies can be made of an expert system, or it can be put on a website for everyone to use	It is not easy to gather the data and rules for the computer
Expert systems can contain knowledge from many people	They are inflexible, have no 'common sense' and have no human warmth (empathy)
People can be less embarrassed talking to a machine	Nobody can be sure they are programmed correctly so they might make dangerous mistakes
Computer programs do not get tired, bored or become ill	Expert systems cannot acquire and adapt to new knowledge without reprogramming
We can get expert advice anytime and anywhere	**Can't easily adapt** to new circumstances (e.g. if they are presented with totally unexpected data, they are unable to process it)
	Can be **difficult to use** (if the non-expert user makes mistakes when using the system, the resulting advice could be very wrong)
	They have **no 'common sense'** (a human user tends to notice obvious errors, whereas a computer wouldn't)

Assignment

- Download the attached file for the assignment

SS 2
SIGNMENT – WEEI