the form of a reinforcement function to label states of the world as more or less desirable with respect to some goal. Consider, for example, a robot attempting to move from one location to another. If the robot's sensors provide feedback telling it its distance from a goal location, then the reinforcement function is simply a reflection of the sensor's readings. As the robot moves through the world it arrives at different locations which can be described as states of the world. Some world states are more rewarding than others. Being close to the goal location is more desirable than being further away or behind an obstacle. Reinforcement learning learns a policy, which is a mapping from the robot's action to expected rewards. Hence, the policy tells the system how to act in order to achieve the reward.

2.3 What Is a Robot?

Typically, an artificially intelligent agent is software that operates online or in a simulated world, often generating perceptions and/or acting within this artificial world. A robot, on the other hand, is situated in the real world, meaning that its existence and operation occur in the real world. Robots are also embodied, meaning that they have a physical body. The process of a robot making intelligent decisions is often described as "sense-plan-act" meaning that the robot must first sense the environment, plan what to do, and then act in the world.

2.3.1 Sense-Plan-Act

A robot's embodiment offers some advantages in that its experiences tend to be with real objects, but it also poses a number of challenges. Sensing in the real world is extremely challenging. Sensors such as cameras, laser scanners, and sonar all have limitations. Cameras, for example, suffer from colour shifts whenever the amount of light changes. Laser scanners have difficulty perceiving transparent objects. Converting sensor data into a usable representation is challenging and can depend on the nature and limitations of the sensor. Humans use a wide array of integrated sensors to generate perceptions. Moreover, the number of these sensors is (at least currently) much higher than the number of sensors of any robot. The vast amount of sensors available to a human is advantageous in terms of uncertainty reduction of perception. Humans also use a number different brain structures to encode information, to perform experience-based learning, and to relate this learning to other knowledge and experiences. Machines typically cannot achieve this type of learning.

Planning is the process by which the robot makes use of its perceptions and knowledge to decide what to do next. Typically, robot planning includes some type of goal that the robot is attempting to achieve. Uncertainty about the world must be dealt with at the planning stage. Moreover, any background or historical knowledge that the system has can be applied at this stage.