

Control Systems and Neural Networks

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Open-Loop and Closed-Loop Control Systems

- *Open-loop* control systems do **not** use *feedback* (i.e., information about the changes that occur as the system is operating). They run in pre-determined ways.
- *Closed-loop* control systems use feedback to adjust their actions. **How?**

Using Feedback

1. What is the desired state (the *goal*)?
2. What is the difference between the current state and the desired state (the *error*)?
3. What actions will reduce the difference between the current state and the goal state (the *response*)?

Control systems can be analog or digital.

Example: Thermostat

- A thermostat is a simple *negative-feedback* control.
- *Measured Variable*: Temperature
- When the value of the measured variable drops below a *threshold* (or *Set Point*), the heater is switched on.
- If the temperature becomes too hot and the heater is on, then the response is to turn it off.

Proportional Control

- *Proportional negative-feedback* systems have their response based on the difference between the required and measured value of the controlled variable (i.e., on the error).
- If the system is too sensitive, it may overcorrect, as there are delays. *Oscillation* may occur as a result.

Fuzzy Logic

- *Fuzzy logic* is an attempt to get the easy design of logic controllers and yet control continuously-varying systems. A measurement in a fuzzy logic system can be partly true, that is if yes is 1 and no is 0, a fuzzy measurement can be between 0 and 1.
- The rules of the system are written in natural language and translated into fuzzy logic. For example, the design for a furnace would start with: "If the temperature is too high, reduce the fuel to the furnace. If the temperature is too low, increase the fuel to the furnace."
- The last step is to "*defuzzify*" an output.

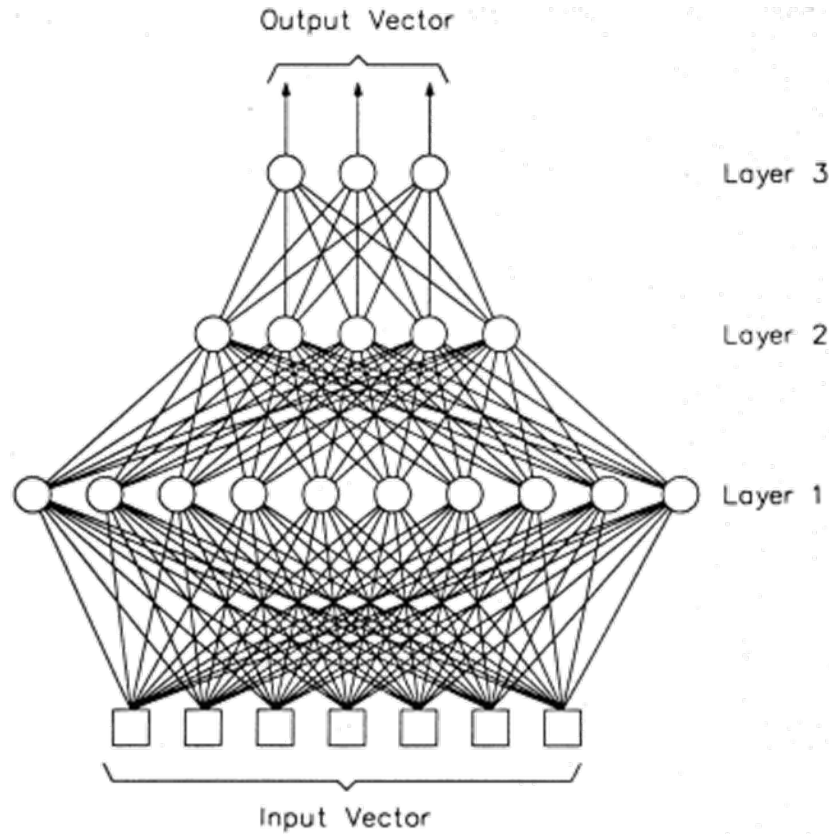
Artificial Intelligence (AI)

- Artificial Intelligence (AI) programs can be *trained* with the help of examples. Such training is a special form of providing feedback.

Neural Networks

- *Neural networks* are structures analogous to connected nets of biological *neurons* that occur in the brain.

Example: Perceptron



Frank Rosenblatt, Cornell Aeronautical Laboratory (1957)

Perceptron Spiral

