Plant Intelligence

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In botany, plant intelligence is the ability of plants to sense the environment and adjust their morphology, physiology and phenotype accordingly. Research draws on the fields of plant physiology, ecology and molecular biology. Intelligence is an umbrella term describing abilities such as the capacities for abstract thought, understanding, communication, reasoning, learning, learning from past experiences, planning, and problem solving. Studies indicate plants are capable of problem solving and communication.

Problem solving

Plants adapt their behaviour in a variety of ways:

Active foraging for light and nutrients. They do this by changing their architecture, physiology and phenotype.
Leaves and branches are positioned and oriented in response to light source.
Ability to detect soil volume and adapt growth accordingly independently of nutrient availability.
Adaptively defend against herbivores.

Communication

Plants respond to volatile signals produced by other plants.

Mechanisms

In plants, the mechanism responsible for adaptation is signal transduction. Plants do not have a brain or neuronal network, but reactions within signalling pathways may provide a biochemical basis for learning and memory. Controversially, the brain is used as a metaphor in plant intelligence to provide an integrated view of signalling, (see plant neurobiology).

Plant cells can be electrically excitable and can display rapid electrical responses (action potentials) to environmental stimuli. These action potentials can influence processes such as actin-based cytoplasmic streaming, plant organ movements, wound responses, respiration, photosynthesis and flowering.

Senses in plants

Plants have many strategies to fight off pests. For example, they can produce different toxins (phytoalexins) against invaders or they can induce rapid cell death in invading cells to hinder the pests from spreading out. These strategies depend on quick and reliable recognition-systems.

Smell

Wounded tomatoes are known to produce the volatile odour methyl-jasmonate as an alarm-signal.

Plants in the neighbourhood can then smell the danger and prepare for the attack by producing chemicals that defend insects or attract predators.

Light and electromagnetic waves

Many plant-organs contain photo-sensitive compounds (phototropins, cryptochromes and phytochromes) each reacting very specifically to certain wavelengths of light. These light-sensors tell the plant if it's day or night, how long the day is (photoperiodism), how much light is available and from where the light comes. Plants also can detect harmful ultraviolet B-rays and then start producing pigments which filter out these rays.

Touch

The mimosa plant (Mimosa pudica) makes its thin leaves point down at the slightest touch and carnivorous plants such as the Venus flytrap snap shut by the touch of insects. But a sense of touch is something every plant has, as Coughlin describes: "Ordinary plants need a sense of touch to respond to the buffeting of the wind, which can cause damage to foliage. They try to resist wind by strengthening tissues that are being swayed. The extra energy expended stiffening tissue can cost farmers dear, however. One experiment showed that when maize plants are shaken for 30 seconds each day, yields drop by 30 to 40% compared with unshaken plants" (New Scientist).

Hearing

Mechanical perturbation can also be detected by plants. Jasmonate levels also increase rapidly in response to mechanical perturbations such as tendril coiling. Mordecai Jaffe (Wake Forest University) used an instrument that made a loud "warble" and got a doubling in the growth of dwarf pea plants. Jaffe suspects that the plant hormone gibberellic acid, which is instrumental in shoot elongation and seed germination, is involved in the "hearing" response. When Jaffe added chemicals to the pea plants inhibiting the biosynthesis of this hormone, he was unable to reproduce the original effects. Poplar stems can detect reorientation and inclination (equilibrioception).

Criticism

It has been argued that although plants are capable of adaptation, it should not be called intelligence. "A bacterium can monitor its environment and instigate developmental processes appropriate to the prevailing circumstances, but is that intelligence? Such simple adaptation behaviour might be bacterial intelligence but is clearly not animal intelligence." However, plant intelligence fits with the definition of intelligence proposed by David Stenhouse in a book he wrote about evolution where he described it as "adaptively variable behaviour during the lifetime of the individual". It is also argued that a plant cannot have goals because operational control of the

plant's organs is devolved.

History

Charles Darwin studied the movement of plants and in 1880 published a book The Power of Movement in Plants. In the book he concludes:

It is hardly an exaggeration to say that the tip of the radicle thus endowed acts like the brain of one of the lower animals; the brain being situated within the anterior end of the body, receiving impressions from the sense-organs, and directing the several movements.

Indian scientist Sir Jagdish Chandra Bose began to conduct experiments on plants in the year 1900. He found that every plant and every part of a plant appeared to have a sensitive nervous system and responded to shock by a spasm just as an animal muscle does.

Bose's experiments stopped at this conclusion, but American polygraph expert Cleve Backster conducted research that led him to believe that plants can communicate with other lifeforms. Backster's interest in the subject began in February 1966, when Backster wondered if he could measure the rate at which water rises from a philodendron's root area into its leaves. Because a polygraph or "lie detector" can measure electrical resistance, and water would alter the resistance of the leaf, he decided that this was the correct instrument to use. After attaching a polygraph to one of the plant's leaves, Backster claimed that, to his immense surprise, "the tracing began to show a pattern typical of the response you get when you subject a human to emotional stimulation of short duration".

Artificial intelligence

Artificial intelligence (or AI) is both the intelligence of machines and the branch of computer science which aims to create it, through "the study and design of intelligent agents" or "rational agents", where an intelligent agent is a system that perceives its environment and takes actions which maximize its chances of success. Achievements in artificial intelligence include constrained and well-defined problems such as games, crossword-solving and optical character recognition. General intelligence or strong AI has not yet been achieved and is a long-term goal of AI research.

Among the traits that researchers hope machines will exhibit are reasoning, knowledge, planning, learning, communication, perception, and the ability to move and manipulate objects. In the field of artificial intelligence there is no consensus on how closely the brain should be simulated.