

Why the Future of Pruning is Robotic and Why That is a Good Thing

Every winter, across millions of hectares of vineyards and olive groves, a quiet but decisive act takes place. A worker walks up to a plant, looks at its shape, and makes a handful of cuts. Within seconds, the fate of that plant for the following year has effectively been influenced. Prune well, and the vine or tree can produce a balanced crop while remaining healthy and productive for years. Prune badly, and yields can suffer, disease can spread, and the plant's long-term structure can be compromised. Few agricultural tasks carry such consequence for so little time invested, and few are so poorly understood outside the communities that practice them.





The Illusion of Simplicity

On paper, pruning looks like a rules-based task. Agronomy provides guidelines for target shapes, the number of buds to retain, and which parts of a plant should be removed. In practice, every plant is a unique negotiation between theory and reality. Vigour varies from vine to vine, canopy density from tree to tree, and no two seasons of growth are exactly the same. The rules provide a framework, but the final decision is often a judgement call, made in the moment and based on experience that is rarely written down.

Vineyards: A Simple Rule with a Difficult Decision at its Core

Viticulture has developed highly structured pruning systems, including Guyot and Royat, or cordon, training. Our current work focuses on double-Royat, where two permanent cordons form the framework of the vine. Along each cordon, short fixed points called spurs are left, from which new canes grow each season. During pruning, most of these canes are removed, while the strongest and best-positioned cane is retained and cut back to leave two buds. The following season, these buds produce new growth, which is then pruned again.

The principle is straightforward. The difficult decision is repeated at every spur: when two or three canes have grown from the same point, which one should be left?

Experienced pruners consider several factors simultaneously, including vigour, diameter, direction of growth and position along the vine. No single factor determines the answer, and two experienced pruners can look at the same vine and make different decisions. The rule, therefore, is not really a checklist. It is a framework for judgement refined through years of observation and practice.

There is another important consideration: the health of the wood. Trunk diseases can remain hidden within a vine until symptoms become serious. Some wood diseases can be identified visually through signs such as necrotic wood and abnormal bark development: rather than naturally peeling as healthy growing wood does, affected areas can remain covered and visibly altered. An experienced pruner can recognise these signs and remove affected material, but developing that ability requires considerable experience.

Olive Trees: When You Cannot See the Whole Picture

Olive pruning presents a different challenge. Olive trees are evergreen and are generally pruned while they are still in full leaf. The branches that need to be managed are therefore partly hidden by the canopy. Unlike a simple inspection from one viewpoint, understanding the plant often requires the pruner to move around it, walking both outside and inside the canopy to gradually build an understanding of its structure.



The decision is also inherently a balance between competing objectives. At branch level, the grower must balance renovation and production: removing old wood encourages new productive growth, but excessive cutting can sacrifice part of the current harvest. At canopy level, the aim is to maintain enough foliage for productive growth while avoiding excessive density and ensuring adequate light reaches the appropriate parts of the tree. Removing too much, however, can expose trunks and branches to excessive sunlight.

The result is an iterative process. A pruner makes a cut, looks again at the tree, sees what has been revealed, and decides what to remove next. Much of this knowledge is difficult to describe in advance because the consequences of one decision change the context for the next.

A Vanishing Skillset

Both examples share a common thread: pruning knowledge is traditionally learned by watching and doing. It is passed between generations and developed through years of practice rather than captured in a manual. At the same time, pruning is physically demanding, repetitive work, often carried out for long hours and heavily dependent on seasonal and migrant labour. Workers may have to learn the task directly in the field, sometimes with limited time to develop the experience required for difficult decisions.

As fewer young people enter this type of agricultural work, the challenge is not simply finding enough workers.





It is preserving the expertise that those workers have accumulated. If an experienced pruner retires, much of the reasoning behind their decisions can disappear with them.

The AgRimate Approach: Digitising the "What", Exploring the "How"

This is where AgRimate takes a different approach. One obvious way to automate pruning is to describe the rules explicitly: identify the plant structure, determine where each branch or cane is located, and apply established pruning rules to decide what should be removed. This is a valuable approach, and perception combined with rule-based pruning has already been explored in agricultural robotics.

AgRimate aims to go one step further. Instead of relying only on rules that we can explicitly write down, we are developing AI models that learn from examples of good pruning performed by experienced growers. The objective is to capture part of the implicit knowledge behind their decisions: which cane should be retained, which branch should be removed, and how the overall structure of the plant influences that decision.

This does not mean replacing agronomic knowledge or human expertise. Rather, explicit knowledge and learned experience can complement each other. Rules can provide structure and constraints, while AI can help capture decisions that are difficult to express precisely.

The same approach could also help identify signs of unhealthy wood where these are visible and relevant to the pruning decision.

But deciding what should be done is only one part of the problem. The other is how that decision reaches the person or machine carrying out the work.

That does not necessarily mean a fully autonomous robot. AI-generated pruning recommendations could be presented directly to a worker, helping less experienced pruners make decisions while keeping the human in control. The technology could also assist an experienced worker by highlighting potential pruning points, identifying parts of a plant that deserve attention, or providing a second opinion. In other settings, the same knowledge could eventually be connected to a robotic system capable of carrying out the work autonomously.

One of the solutions being investigated within AgRimate is precisely this last possibility. We are developing a robotic platform for autonomous vineyard pruning that can move through vineyard rows, reach individual vines, scan their structure, determine suitable pruning points using AI, and carefully perform the required cuts with two robotic arms. The challenge is not simply making a robot cut a branch. It is enabling it to understand a living, irregular plant and interact with it gently and reliably without causing damage.



Conclusion

The future of pruning does not have to mean replacing the person with a machine. It could instead mean making the knowledge of the best pruners available to many more people.

A worker equipped with AI recommendations, an experienced pruner supported by an intelligent second opinion, or a robot capable of carrying out the entire task are different points on the same technological spectrum. The important step is to preserve the knowledge behind the decision and make it usable beyond the individual who originally developed it.

Pruning sits at an unusual intersection of tradition and precision: a task that can be described in a few simple rules, yet whose successful execution depends on judgement accumulated over years. As the skilled workforce changes, technology offers a way to preserve that expertise rather than allowing it to disappear. AgRimate's goal is not to remove people from pruning, but to explore how AI and robotics can make one of agriculture's most valuable and demanding skills more accessible, consistent and sustainable for the future.



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