Improve crop root architecture by resolving self-intersections of individual roots

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Branching patterns in plant roots are associated with complex traits such as stress-tolerance, yield, and the ability for carbon sequestration. The capability of the root system to branch allows the plant to search the soil for water and nutrients. For example, a reduction of higher order roots may determine how well a crop plant tolerates drought, whereas the ability to develop more higher order roots determines how well a crop plant tolerates a nutrient deficient soil. Measurements of traits such as rooting depth, root width or specific root length, however, often fail to capture the complex morphological arrangement of the root system. Therefore, a more rigorous analysis of root branching patterns is highly relevant as they are linked to the ability of plants to respond to abiotic stresses, such as drought and nutrient deficiency. Despite the need, it remains a challenge to extract information about branching patterns due to intersecting and overlapping roots in 2D and 3D imaging data. Such occlusion problems add ambiguity and outliers to root trait measurements. We present an algorithm to resolve such intersections in a globally optimal way based on simple heuristics such as straightness of roots – thus being dimension independent. This will enable quantitative analysis of how root branching patterns change in response to abiotic stress using shape descriptors. The possibility to computationally measure very dense branching structures with thousands of intersections will support the breeding of plants that withstand increasing areas of drought and nutrient deficiencies in the world.