# Rationalization of layout optimization result by updating discretization of the design domain

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## Abstract

Truss layout optimization provides a means of identifying the global optimal arrangement of truss bars capable of transmitting a given load or loads to defined support points within a defined design domain [1]. However, the solutions obtained are generally complex and lead to structures with far too many members to be practical, especially when fine discretization of the design domain is employed. Others have made good progress in employing integer programming methods to address some of these issues [2], but these techniques have proven to be computationally expensive and therefore impractical for very large problems.

In this paper, heuristic approaches to the practical rationalization of optimal layouts are proposed, based on the observation that fan-like segments of bicycle-wheel structures often appear in multiple places in an optimal layout, with a central joint of high valence linking through 'spokes' to a circular-arc 'rim' [3]. The optimized layout of a given problem is first obtained, and joints which are not used in the optimal truss are removed from the design domain. Subsequently, circle/arc fitting methods are used to reduce the density of joints in areas resembling bicycle-wheel structures.

A comparison is made between statistical circle-fitting methods like RANSAK, and problem-specific heuristic methods, which identify joints with high valence as potential 'centers' and use a histogram-type assessment of the lengths of connected bars to determine one or more likely 'radius' and 'arc' angle. Joints are then selectively removed from zones close to the identified arcs, and a second layout optimization carried out using the new discretization. Using real case-studies, it is shown that more rational and buildable trusses can be quickly obtained using the proposed approach, with an acceptably small increase in structural weight compared to the global optimal.

## References

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