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PI1 Name: Jonathan Natanian

***Scientific abstract - Solar urban blocks: A holistic generative cross-climatic method for solar-driven environmental design of dense urban fabrics***

Solar approaches to sustainable design have been with us since the dawn of civilization and have been rooted in the core of architectural practices for centuries. Computational adaptations of solar design approaches are more recent and mostly revolve around the ‘solar envelope’ (SE) concept. The SE is the calculated maximal spatial volume that ensures solar availability for a specific time of year. However, the SE concept is limited in its ability (i) to respond to the several contrasting facets of solar design in a dense urban environment (e.g., self-shading for energy efficiency vs. higher exposure for photovoltaic production and daylight), (ii) to holistically consider multiple environmental considerations (e.g., views) and (iii) to offer the designer a spatial morphology at different scales that represents these trade-offs rather than a maximal boundary. Meanwhile, recent advancements in digital analytical tools for the built environment are opening new horizons for both architectural design and research. These include parametric tools and optimization platforms that allow us to explore multiple design iterations, screen them based on reliable metrics, and allow the user to interactively visualize the results. Among other benefits, these advancements enable a new level of integration of environmental principles into architectural design.

The proposed research aims to advance the existing scientific knowledge on solar design by harnessing these technological advancements. It explores a generative approach in which a combination of solar-driven metrics drives the form-finding process of a dense district based on a multi-objective optimization process. The workflow will be applied to a real district case study in Tel Aviv and will yield a large set of spatial solar-driven building masses, rather than one SE volume, which corresponds to the different trade-offs between the environmental performance metrics applied. The project is divided into four tasks: (1) spatially establishing the generative design and analytical computation workflow, (2) the investigation of the solar metrics, (3) the optimization module, and (4) the exploration of data in different climatic contexts to ensure the robustness of the approach.

By establishing a generative approach in which performative insights directly influence the design process, the solar approach developed and employed in this project will advance our capacity to integrate environmental engineering and design. Beyond marking a new computational chapter in the field of solar-driven design, insights from this project will advance our knowledge of architectural design optimization and environmentally driven design in hot climates and provide proof of environmental design and holistic workflows for evaluating environmental performance.