

THE UNIVERSITY TIMETABLING PROBLEM IN UZBEKISTAN'S HIGHER EDUCATION SYSTEM: SCALE, COMPLEXITY, AND THE CASE FOR AUTOMATION

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DOI: <https://doi.org/10.5281/zenodo.22816690>

Uzbekistan's higher education sector has grown rapidly: the number of institutions rose from 69 (2015/2016) to 222 (2024/2025), enrolment grew more than fivefold to about 1,432,800 students, and coverage of the 18–23 age cohort rose from 6.8% to 47.7% [Davlat statistika qo'mitasi 2025]. Education is named a priority sector for digitalization under the “Digital Uzbekiston – 2030” strategy [PF-6079, 2020]. Yet most institutions still build timetables manually, department by department, in spreadsheets — a process whose administrative burden grows combinatorially, not linearly, with each additional course, room and instructor.

University timetabling assigns courses, instructors, groups and rooms to time slots so that hard constraints (no double-booking; room capacity/type match) hold and soft constraints (compactness, balanced load) are optimized as far as possible. Even a restricted version of this problem was proven NP-complete by reduction from multicommodity flow [Even, Itai, Shamir 1976: 691], a result extending to realistic timetabling instances; no algorithm is known to guarantee an optimal schedule in time that scales gracefully with institution size. The four-decade international literature [Schaerf 1999; Ceschia, Di Gaspero, Schaerf 2023] separates into three threads of uneven maturity: room/time assignment (mature, benchmark-driven), faculty–course assignment (thinner, mostly single-institution studies), and document-driven constraint extraction (the least mature, with no published work linking it directly to scheduling).

This analysis aims to establish, from verified national statistics and a structured literature review, which of these three threads offers the most defensible direction for an original, locally grounded contribution to automated timetabling in Uzbekistan.

Three results follow. First, Uzbekistan's scheduling instances have grown severalfold in a decade while the underlying problem remains intractable regardless of scale, so the burden of manual scheduling can only worsen. Second, local work already recognizes the need: To'xtasinov and Sadritdinov propose a genetic-algorithm approach for a Namangan State Technical University-scale problem [2025: 40], and a companion study models room–lesson suitability by capacity, type and department affiliation [To'xtasinov 2025: 37]. Third, the three threads are unevenly developed: Thread 1 is dense and benchmark-driven; Thread 2 is real but thin; Thread 3 is thinnest of all — no source connects document extraction directly to timetabling constraints, though an accreditation constraint encoded by Xue and colleagues shows that such a link already exists in institutional practice, handled manually [Xue et al. 2024].

In conclusion, we believe a Uzbekistan-focused system need not re-derive the room/time assignment problem, since Thread 1 already supplies validated models and algorithms to adapt directly. The most defensible original contribution lies at the intersection of Threads 2 and 3: automating the currently manual conversion of institutional and legislative documents into machine-checkable scheduling

constraints. How such a system should be designed is addressed in a companion analysis of existing solution methods.

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