ZX Sketch: A Web-Based Interactive Editor for the ZX Calculus (software demonstration)

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ZX Sketch[1] is a free, browser-based graphical editor for the ZX calculus [1, 8], a graphical language whose diagrams are morphisms in a prop and whose rewrite rules provide a complete axiomatisation of qubit quantum mechanics [2]. Users draw and manipulate ZX diagrams directly in the browser at `zxsketch.com` with no installation required, applying rewrites through intuitive gestures: spider fusion is dragging two spiders together, color change is a double-tap, and the Hopf rule is cutting two parallel wires.

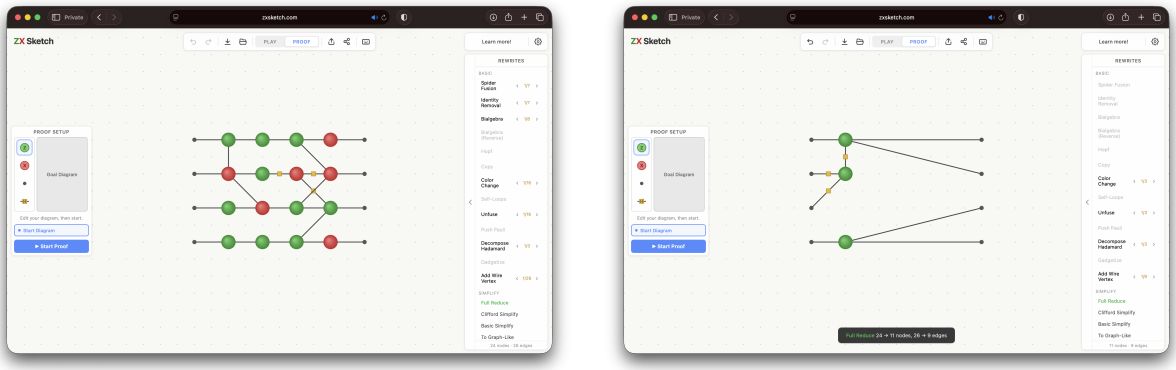

Figure 1: A ZX diagram in ZX Sketch before (left) and after (right) applying PyZX's `full_reduce` simplification, reducing from 24 nodes and 26 edges to 11 nodes and 9 edges. The rewrite panel (right sidebar) shows available rules and simplification strategies.

ZX Sketch features 19 interactive rewrite rules with pattern matching and one-click application, 18 automated simplification strategies (including `full_reduce`, Clifford simplification, and T-count optimization), and a proof mode with step-by-step timeline navigation, goal diagrams, and tensor verification. All rewrite soundness is guaranteed by delegation: the TypeScript frontend owns rendering, interaction, and graph construction, while PyZX [4] owns all ZX-calculus semantics, running in-browser via Pyodide [7] and WebAssembly in a dedicated Web Worker. The tool will never apply an unsound rewrite. Users can import quantum circuits via OpenQASM, export diagrams as TikZ, SVG, PNG, or PyZX JSON, and share diagrams via URL, with full ZXLive [9] interoperability. The application is a Progressive Web App that works offline and supports touch interaction on phones, tablets, and laptops. Fuzz testing over 25,000 random rewrite steps uncovered two previously unreported bugs in PyZX's `pauli_push`

[1] Source code: `https://github.com/hstoltz/ZX-sketch`. DOI: 10.5281/zenodo.18841742.

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implementation, which have been reported and confirmed upstream.[2]

Several excellent tools already exist for working with ZX diagrams. PyZX [4] is the canonical Python library for ZX-calculus computation, and ZXLive [9] provides a desktop graphical interface built on top of it. TikZiT [5] is the standard tool for typesetting ZX diagrams in publications. These tools serve the research community well, but they require desktop installation and a degree of technical familiarity that can be a barrier for newcomers, particularly students and educators for whom the ZX calculus could serve as an accessible entry point into quantum reasoning [1]. Taking direct inspiration from ZXLive's interactive rewriting model and the interaction design of Desmos, where users type equations and immediately see their graphs, ZX Sketch aims to make the ZX calculus accessible to this broader audience, bringing a comparable experience to the browser where it is available to anyone with a web-connected device. Since its deployment, ZX Sketch has received positive engagement from members of the PyZX development community.

We are developing a progressive tutorial mode inspired by Kontorovich's Real Analysis Game [6]. Just as the Real Analysis Game provides a mathematically rigorous environment for constructing ε-δ proofs through gameplay, ZX Sketch's tutorial will guide users through the sound rewrite rules of the ZX calculus, building toward completeness. This mirrors the structure of the ZX literature itself [8], where rules are introduced incrementally and each is proven to preserve the semantics of the underlying linear maps. We are also in discussion with the PyZX development team regarding further integration, and exploring a QuiZX [3] WebAssembly backend for improved performance.

During the demonstration, we will present ZX Sketch's core capabilities and invite attendees to follow along on their own devices at `zxsketch.com`. Because ZX Sketch runs entirely in the browser, participants need only a phone, tablet, or laptop, with no installation required.

References

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[3] Aleks Kissinger & John van de Wetering: *QuiZX*. Available at `https://github.com/zxcalc/quizx`.

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[8] John van de Wetering (2020): *ZX-calculus for the working quantum computer scientist*. *arXiv preprint arXiv:2012.13966*. arXiv:2012.13966.

[9] John van de Wetering et al.: *ZXLive*. Available at `https://github.com/zxcalc/zxlive`.

[2] `https://github.com/zxcalc/pyzx/issues/404`