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## Chemical robotics for outreach and autonomous laboratories

Chemistry is not only the science of constructing new molecules and materials, but also the craft of performing syntheses. The latter aspect has changed very little over the last century despite tremendous progress in robotics, automation and digitalization in other scientific domains. To overcome the challenges of the 21st century, chemistry needs to become more reproducible, time-efficient and reduce its ecological impact. Autonomous robotic chemistry systems help achieve these goals and will reshape the public perception of chemistry as a modern, precise science.

To promote our emerging autonomous chemistry platform, the Heine group at the Dresden University of Technology uses two illustrative chemical robots in our outreach activities. These are constructed from LEGO® bricks and were designed by Gerber et al. [1]. One of them can perform simple pipetting tasks such as color mixing or dilution series, allowing students to program it themselves. The second robot illustrates the automation of chemical synthesis through automatic preparation of simple cocktails. Both robots have proven effective in promoting chemistry at events such as the long night of science and Girls' day.

Aside from their success in popularizing science, these robots illustrate the potential of real robotic chemistry platforms. The system in development at the Heine group aims for the precise control of liquid-phase syntheses. This is achieved by applying several in-situ spectroscopies simultaneously and evaluating the data using machine learning models. Predictions and results are enhanced using theoretical chemistry calculations.

[1] Gerber LC, Calasanz-Kaiser A, Hyman L, Voitiuk K, Patil U, Riedel-Kruse IH (2017) Liquid-handling Lego robots and experiments for STEM education and research. PLoS Biol 15(3): e2001413. https://doi.org/10.1371/journal.pbio.2001413

## References

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