How is programming in science changing? Scientists have been producing and sharing for decades. Code work done by scientists includes simulation, data processing, analysis, visualization, and data stewardship. Robust instrumentation generates data beyond the processing power of an individual using Excel, and instead requires more automation and/or collaboration. Sophisticated web frameworks enable more interactive web portals for displaying data or simulation results to various stakeholders. Educational initiatives that target scientists learning to program are increasingly available (and increasingly push enrollment limits).

Changes in scientific programming practice aim to improve what I refer to as effective persistent: not only longlived, but possessing longlived usefulness. I examine the dynamics of code work, in context of several oceanography groups. I interviewed 20 scientists who participated in programming workshops. I also observed with four oceanography groups over 300 hours. Out of 46 scientists observed, 21 comprise the core study participants: doing code work at graduate, postgraduate, and faculty levels. Two of the groups focus on simulation, and two on observational data analysis. All engage in the zeitgeist of novel programming paradigms.

First, I distinguish complementary aspects of daily code work: what is, and what could be. The working environment („what is“) combines cognitive, technical, and social resources. For example: iPython Notebook and Google (technical), in an office shared with frequent “hey, how do you __?” (social), looking at many small charts encoding information in a familiar and consistent way to aid quick

HOW INTERACTION BETWEEN PROGRAMMING AND SCIENTIFIC PRACTICES SHAPES MODES OF INQUIRY IN FOUR OCEANOGRAPHY TEAMS

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understanding (cognitive). Working environments are subject to continual deliberate change, in the pursuit of a collective imagination of a possible „what could be.“ Workshops, for example, embody a particular such imagination. This vision embraces inevitable (and potentially unknowable) future complexities as worthy of the necessary investment. Second, I examine the relationship between the „what is“ and „what could be.“ Using examples from observational data, I examine necessity of the former for the latter in context of: (1) version control; (2) data formats; (3) formal vs. informal testing and debugging practices. Additionally, I consider the role of reflexivity and identity in programming “best practices.” When an activity looks like „pair programming“ or „code review,“ what additional context can help explain whether the scientists involved embrace or reject the terms?

Finally, I situate the two concepts („what is“ and „what could be“) in context of a dynamic process of scientific work. I use examples from moments when a group or individual considered decided on some alternative to a current code work practice. Motivations include both painful breakdown of „what is,“ and enthusiasm about the capability of „what could be.“ Some calls to change do not persist, yet they still feed back into the cycle by way of expanding the imagination of what is possible. This work challenges assumptions about evaluation of adoption/adaptation in scientific programming. A particular tool or protocol does not need sustained use by a group to have noticeable impact on the work practices of that group. I develop several conceptual tools useful for examining alternative change mechanisms.

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