

# Equivalence - Combinatorics, Algebra, Proofs

Helmut Seidl

Technische Universität München, Germany

One particular instance of reasoning about the semantic correctness of programs is to prove that two programs in fact are equivalent, where the notion of equivalence may be relativized w.r.t. the set of observations of interest to be made about the behavior of the code.

In general, proving equivalence is an intriguing problem. The tutorial gives a non-exhaustive overview over various techniques in the field. In a first lecture, the tutorial considers the most simple form of programs, namely, straight-line programs which form the basis of, e.g., grammar-based compression schemes.

The second lecture then considers document processors which transform structured input into (possibly unstructured) output. Even if these processors are finite-state, elaborate techniques from commutative algebra are required to obtain effective decision procedures.

Finally, the third lecture considers observational equivalence of programs in general. Based on a formulation as a hyper-safety property a framework is presented which allows to apply techniques from relational abstract interpretation to infer equivalences in non-trivial cases.

## References

### Straight-line programs:

- [1] W. Plandowski. *The Complexity of the Morphism Equivalence Problem for Context-Free Languages*. Ph.D. Thesis Warsaw, 1995
- [2] M. Lohrey. *Algorithmics on SLP-compressed Strings: a Survey*. Groups Complexity Cryptology, Vol. 4(2); pp. 241–299; 2012.
- [3] M. Lohrey, S. Maneth, M. Schmidt-Schauss. *Parameter Reduction and Automata Evaluation for Grammar-compressed Trees*. J. Comput. Syst. Sci., Vol. 78(5); pp. 1651–1669; 2012.

### XML Processors:

- [1] S. Staworko, G. Laurence, A. Lemay, J. Niehren. *Equivalence of Deterministic Nested Word to Word Transducers*. In: Procs. of FCT'2009; pp. 310–322; 2009.
- [2] J. Engelfriet, S. Maneth, H. Seidl. *Deciding Equivalence of Top-down XML Transformations in Polynomial Time*. J. Comput. Syst. Sci., Vol. 75(5); pp. 271–286; 2009.
- [3] S. Maneth. *Equivalence Problems for Tree Transducers: A Brief Survey*. CoRR abs/1405.5597.pdf; 2014.
- [4] H. Seidl, S. Maneth, G. Kemper. *Equivalence of Deterministic Top-Down Tree-to-String Transducers is Decidable*. CoRR abs/1503.09163; 2015.

### Equivalence as a Hyper-Safety Property:

- [1] G. Barthe, M. Gaboardi, E. J. Gallego Arias, J. Hsu, C. Kunz, P.-Y. Strub. *Proving Differential Privacy in Hoare Logic*. In: Procs. of CSF'14; pp. 411–424; 2014.
- [2] H. Seidl, M. Kovács. *Interprocedural Information Flow Analysis of XML Processors*. In: Procs. of LATA'14; pp. 34–61; 2014.
- [3] Ch. Müller, M. Kovacs, H. Seidl. *An Analysis of Universal Information Flow based on Self-Composition*. In: Procs. of CSF 2015.