# Barbed Bisimulations

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# Introduction

- Milner and Sangiorgi, 1980 $\sim$ 1990.
- How to compare modules ?
- Originally developed for CCS (process calculi).

# Recap & Notations

Relation:

- $\mathcal{R} \subseteq A \times B$
- Set of pairs $\langle a, b \rangle$

Transition system:

- Transition semantics: $\longrightarrow: S \times S$
- Describes the evolution of states of a system.

# String barbed simulation

Relation $\mathcal{R}$ over two languages such that:

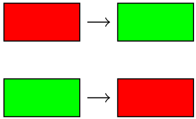
- preserves transition
- preserves observable behaviour

$$\begin{tikzcd}
S_1 \arrow[r, "\longrightarrow"] \arrow[d, "\mathcal{R}"] & S_2 \arrow[d, "\mathcal{R}"] \\
\mathcal{R}(S_1) \arrow[r, "\longrightarrow"] & \mathcal{R}(S_2)
\end{tikzcd}$$

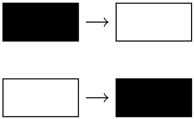
$$S \downarrow \Rightarrow \mathcal{R}(S) \downarrow$$

# Example: strong barbed (bi)simulation

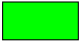
Transition:



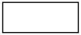
Transition:



Observable:



Observable:

$\mathcal{R} = \{\langle$  ,  $\rangle;\langle$  ,  $\rangle\}$

# Extensions

- Bisimulation: $\mathcal{R}$ and $\mathcal{R}^{-1}$ are simulations.
- Weak form: No “one-to-one” transition mapping.

# Conclusion

- Defining "observable"
- Internal behaviour vs. Observable
- Widely used in process calculi

# References

R. Milner and D. Sangiorgi.
Barbed Bisimulation.
In *Proceedings of the 19th International Colloquium on Automata, Languages and Programming*, volume 623 of *Lecture notes in computer science*, pages 685–695.
Springer-Verlag, 1992.