An Interface Theory for Program Verification

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Motivation

What	A compositional viewpoint of software verification
Why	Decompose software verification into parts
Example	Counterexample-guided abstraction refinement (CEGAR)

Verification Interfaces

Verification interfaces are descriptions of behavior that occurs in a program:

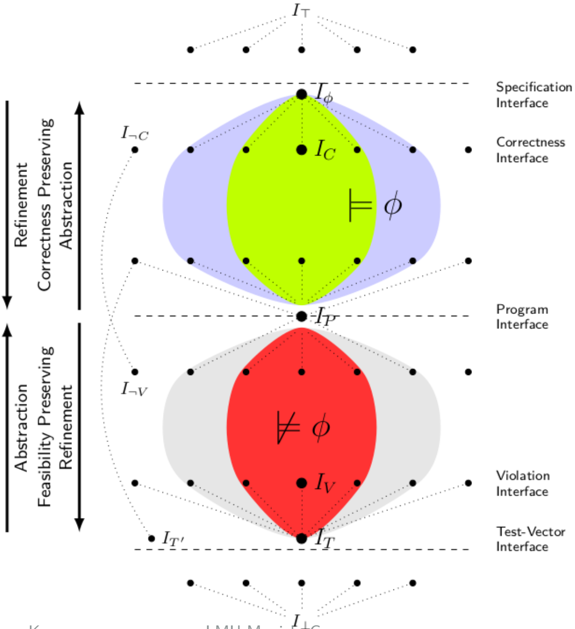
- Program Interface
- Specification Interface
- Correctness Interface
- Violation Interface

Verification Problem

Given a program P and a specification ϕ, verification is the problem of finding either a correctness proof for $I_P \preceq I_\phi$ or a violation proof for $I_P \not\preceq I_\phi$.[1]

[1] There are various ways for reasoning in order to obtain a proof, for example, strongest post-conditions [9] are traditionally used for correctness proofs and incorrectness logic [10] was proposed for violation proofs.

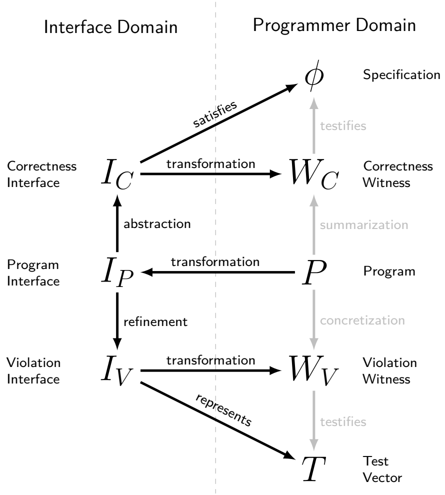
Space of Verification Interfaces (Fig. 3 in [6])



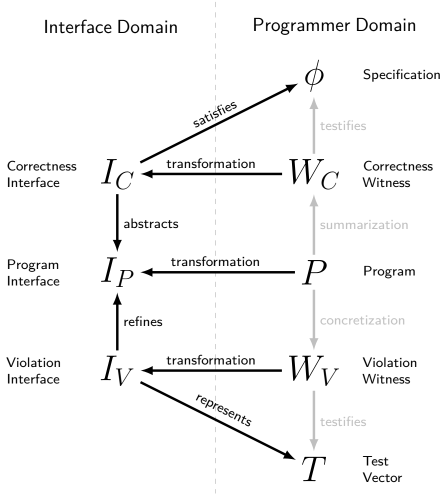
Theorems ...

- Refinement preserves correctness
- Abstraction preserves violation
- Substitutivity of interfaces

Verification



Result Validation (Fig. 10 in [6])



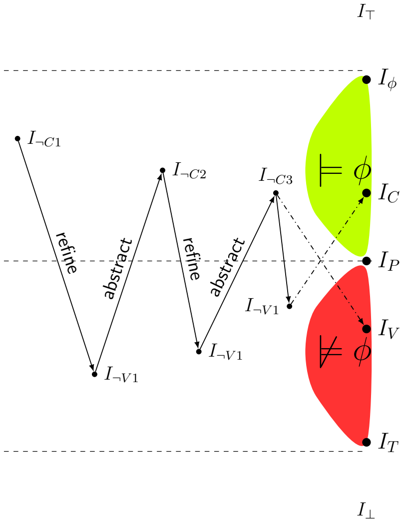
Decompose Verification Tools

- Interface synthesizers, to construct an interface
- Refinement checkers, to check $I_1 \preceq I_2$
- Specification checkers, to check $I \models \phi$

CEGAR Using Verification Interfaces

1. construct an abstract model I_0
2. check $I_0 \models \phi$; if it holds, terminate with answer $(\textsc{True}, W_C)$ (the interface I_0 corresponds to an interface I_C in Fig. 3, the correctness witness W_C in Fig. 10 is an abstraction of I_C)
3. extract counterexample interface I_1 from I_0 (interface I_0 corresponds to interface $I_{\neg C}$ in Fig. 3)
4. check $I_1 \not\models \phi$; if it holds, terminate with answer $(\textsc{False}, W_V)$ (the interface I_1 corresponds to an interface I_V in Fig. 3, the violation witness W_V in Fig. 10 is an abstraction of I_V)
5. extract new facts (derived from the infeasibility of I_1) and continue with step (1); (the interface I_1 corresponds to an interface $I_{\neg V}$ in Fig. 3)

CEGAR Using Verification Interfaces



Conclusion

- Unified viewpoint
- Decompose monolithic approaches
- Off-the-shelf combinations
- Document verification results using witnesses

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