**Program Analysis**

- **Classification**
  - **Syntactic analysis**: derives information about a program's structure (typically static).
  - **Semantic analysis**: derives information about the properties of dynamic computations of a program (operations, data) and determines validity of a program (e.g., type correctness).
- **Applications**
  - Understand behavior of a program for debugging, maintenance, verification, testing.
  - Transform (representation of) a program, preserving its semantics.

### Mechanisms for Semantic Analysis (1) [Srikant/Shankar, Ch. 1.2]

- **Inference systems**: set of axioms + inductive / compositional rules of inference.
- **Constraint resolution systems**: rules for solving constraints.
- **Abstract interpretation**: map concrete domain of values to abstract domain.
- **Other approaches**: formal semantics-based approaches.

#### Time of Performing Analysis (1)

<table>
<thead>
<tr>
<th>Analysis Type</th>
<th>Time of Performing Analysis</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static analysis</td>
<td>Compile time (generation time)</td>
<td>Target platform given</td>
</tr>
<tr>
<td>Static analysis</td>
<td>Load time</td>
<td>Typically, module view</td>
</tr>
<tr>
<td>Static analysis</td>
<td>Link time</td>
<td>Typically, whole program view but with less information</td>
</tr>
<tr>
<td>Dynamic analysis</td>
<td>Run time</td>
<td>Whole program given, program input known</td>
</tr>
<tr>
<td>Dynamic analysis</td>
<td>Link time</td>
<td>Profile information known</td>
</tr>
</tbody>
</table>

### Mechanisms for Semantic Analysis (2)

- **Transformation of a program (e.g., type correctness)**
- **Semantics analysis**
- **Syntactic analysis**
- **Classical Semantic Analysis**
- **Syntactic analysis**
Time of performing analysis (2)

Static vs. dynamic analysis
choice governed by
/ availability of needed information
/ required precision
/ acceptable overhead (time, space)

Hybrid forms
factor out static parts and do them at compile time
e.g., dynamic array bounds checking

Motivation

In the sequel, we focus on static analysis.

Intraprocedural analysis

Determine the flow of scalar values, build Data Flow Graph

Consider Flow Analysis

Determine the control structure of the program

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