Types of Clones

Software Evolution — L5T2

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Exact Clones (“Type 1”)

```
_client = new HttpClient();
_client.BaseAddress = new Uri(ApiUrl);
_client.DefaultRequestHeaders.Authorization
  = new AuthenticationHeaderValue("Bearer", Token);
_client.DefaultRequestHeaders.Accept.Add(
  new MediaTypeWithQualityHeaderValue(@"application/json"));
```

```
_client = new HttpClient(); // from System.Net.Http
_client.BaseAddress = new Uri(ApiUrl); // just to make sure
_client.DefaultRequestHeaders.Authorization = new
        AuthenticationHeaderValue("Bearer", Token);
_client.DefaultRequestHeaders.Accept.Add(new
        MediaTypeWithQualityHeaderValue(@"application/json"));
```

Hamid, Zaytsev, *Detecting Refactorable Clones…*, SATToSE 2014

Parameterised Clones (“Type 2”)

```
for (String string : startProg) {
  fileWriter.println(string);
}
for (String string : prog) {
  fileWriter.println(string);
}
for (String string : endProg) {
  fileWriter.println(string);
}
```

Hamid, Zaytsev, *Detecting Refactorable Clones…*, SATToSE 2014

Near Miss Clones (“Type 3”)

```
if (a.getClass().toString().contains("StringLiteral")) {
    message += (a.getText() + " “);
}
if (a.getClass().toString().contains("IntLiteral")) {
    number = Integer.parseInt(a.getText());
    itsNumber = true;
} else if (a.getClass().toString().contains("Identifier")) {
    // …
}
```

Hamid, Zaytsev, *Detecting Refactorable Clones…*, SATToSE 2014

Semantic Clones (“Type 4”)

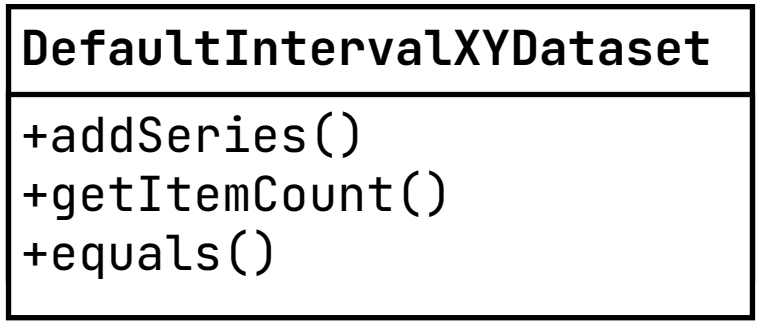
```
for x in values:
  print(x + ', ', end='')
print()
```

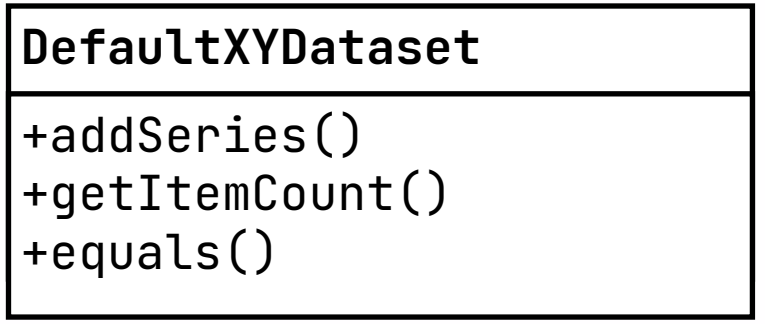
```
if values:
  print(', '.join(values) + ', ')
```

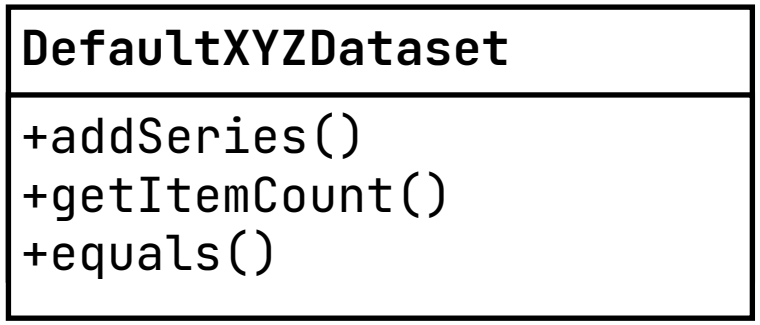
```
print(*values, sep=', ', end='')
print(', ')
```

Hamid, Zaytsev, *Detecting Refactorable Clones…*, SATToSE 2014

Structural Clones







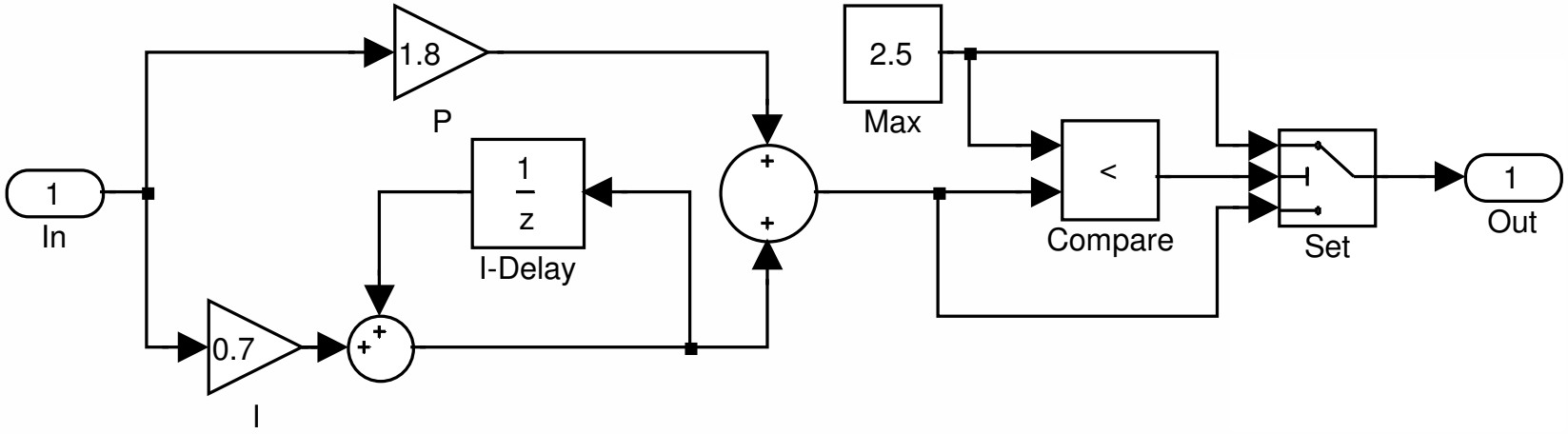
Kanwal, Basit, Maqbool, *Structural Clones: An Evolution Perspective*, 2018.

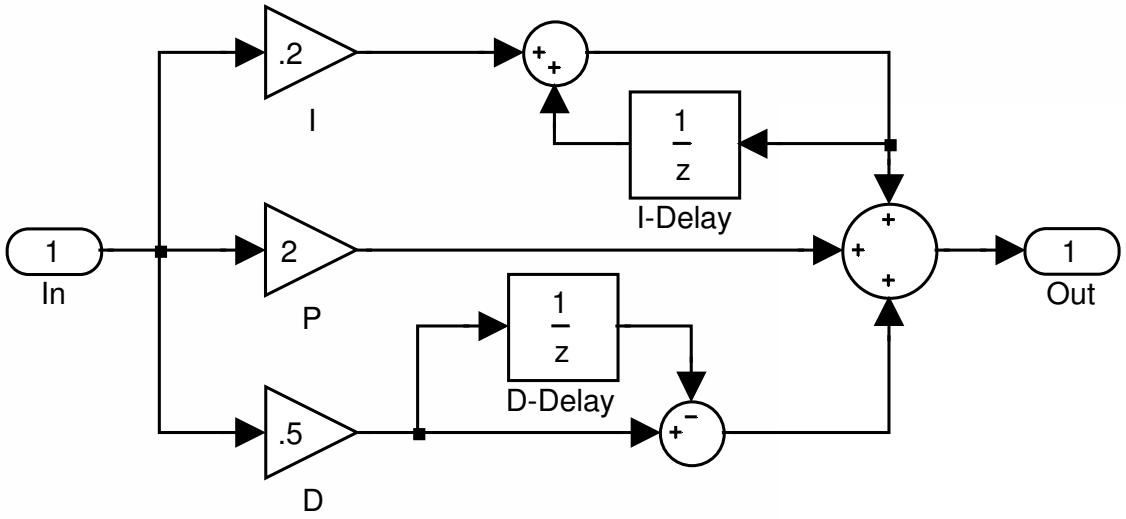
Artefact Clones

- File vs file
- Method vs method
- Library vs library
- Paragraph vs paragraph

Roy, Cordy, *Near-miss Function Clones in OSS*, JSME, 2009.

Model Clones





Deissenboeck et al, *Clone Detection in Automotive MBD*, ICSE 2008.

Contextual Clones

```
<source file="HotelReservation.wsdl" startline="81" endline="85">
  <operation name="ReserveRoom" >
    <input message="ReserveRoomRequest">
      <message name="ReserveRoomRequest">
        <part name="body" element=" ReserveRoomRequest">
          <element name="ReserveRoomRequest">
            <element name="payment" type="Payment“/>
              <element name="ccNumber" type="int"/>
              <element name="cardHolder" type="string"/>
              <element name="expiryDate" type="date"/>
            </element>
            <element name="room" type="Room">
              <element name="roomID" type="int"/>
              <element name="numBeds" type="int"/>
              <element name="isSmoking" type="boolean"/>
             </element>
          </element>
        </part>
      </message>
    </input>
    <output message="ReserveRoomResponse">
      <message name="ReserveRoomResponse">
        <part name="body" element="ReserveRoomResponse">
          <element name="ReserveRoomResponse"/>
        </part>
      </message>
    </output>
    <fault message="RoomNotAvailableException">
      <message name="RoomNotAvailableException">
        <part name="body" element="RoomNotAvailableException">
          <element name="RoomNotAvailableException"/>
        </part>
      </message>
    </fault>
  </operation>
</source>
```

Martin, Cordy, *Analyzing Web Service Similarity Using Contextual Clones*, IWSC 2011

Conclusion

- Types 1–4 are best known
- Types 2–3 are best researched
- Most tools aim at near miss / structural / artefact
- Q&A Sessions @ Canvas
  - ⇒ v.zaytsev@utwente.nl
  - ⇒ https://discord.gg/n7VQAPNBPD