

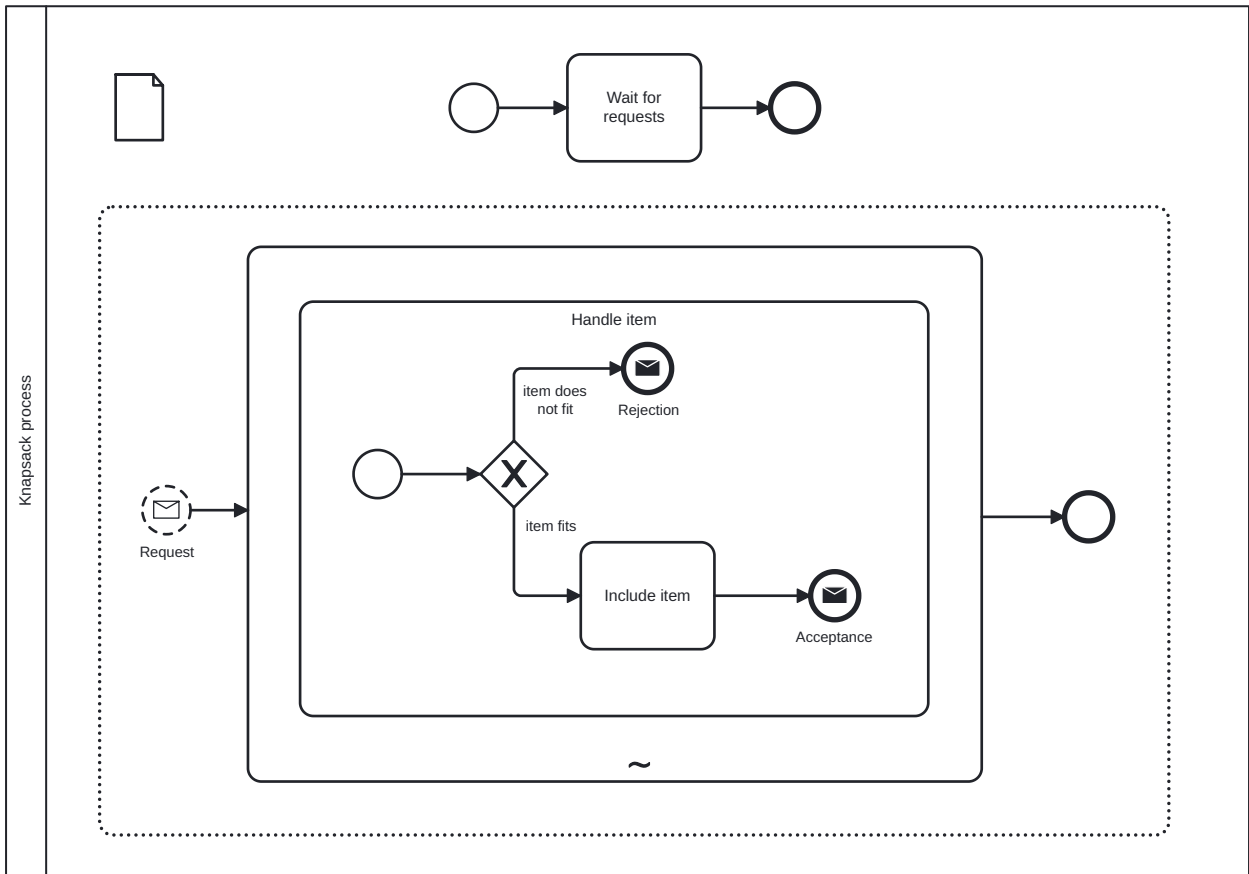
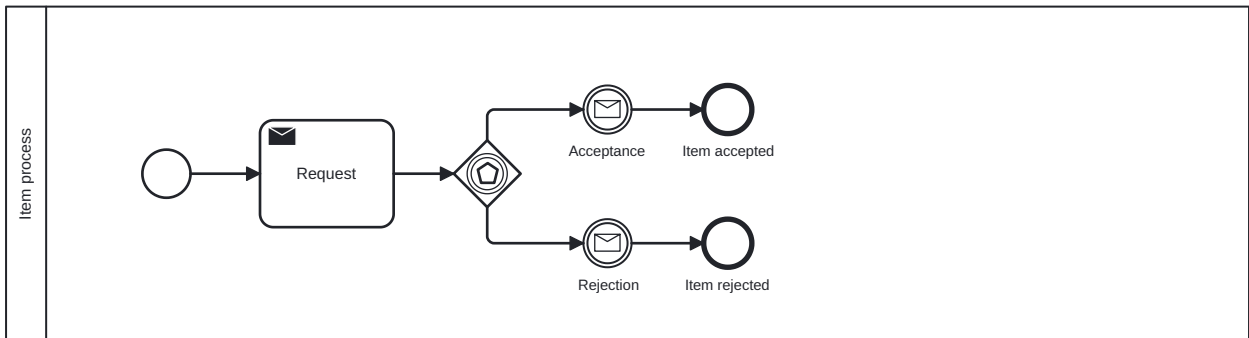
Collaboration Knapsack_problem

Given a set of items, each having a specified weight and value, and a knapsack with limited capacity, the *Knapsack problem* can be described as the problem of finding a selection of items to be included in the knapsack such that

- the total weight of the selected items does not exceed the capacity of the knapsack, and
- the total value of the selected items is maximised.

Diagram

htmlonly



endhtmlonly

Process ItemProcess

The *Item* process starts with sending a request message including the item identifier, its `weight` and its `value` . Depending on whether the knapsack reject or accepts the item for inclusion, the respective end event is reached.

```
<bpmn2:extensionElements>
  <bpmnos:status>
    <bpmnos:attributes>
      <bpmnos:attribute id="Timestamp" name="timestamp" type="decimal" value="0">
    </bpmnos:attribute>
      <bpmnos:attribute id="Value" name="value" type="decimal">
    </bpmnos:attribute>
      <bpmnos:attribute id="Weight" name="weight" type="decimal">
    </bpmnos:attribute>
    </bpmnos:attributes>
  </bpmnos:status>
</bpmn2:extensionElements>
```

DataObject DataObject_1xt50y3

```
<bpmn2:extensionElements>
  <bpmnos:attributes>
    <bpmnos:attribute id="Instance" name="instance" type="string">
  </bpmnos:attribute>
  </bpmnos:attributes>
</bpmn2:extensionElements>
```

Task SendRequestTask

```
<bpmn2:extensionElements>
  <bpmnos:messages>
    <bpmnos:message name="Request">
      <bpmnos:content attribute="instance" id="Content_2uibfna" key="Item">
    </bpmnos:content>
      <bpmnos:content attribute="value" id="Content_2bfg7g9" key="Value">
    </bpmnos:content>
      <bpmnos:content attribute="weight" id="Content_3klisrm" key="Weight">
    </bpmnos:content>
    </bpmnos:message>
  </bpmnos:messages>
</bpmn2:extensionElements>
```

Event CatchAcceptanceMessage

```
<bpmn2:extensionElements>
  <bpmnos:message name="Acceptance">
</bpmnos:message>
</bpmn2:extensionElements>
```

Event CatchRejectionMessage

```
<bpmn2:extensionElements>
  <bpmnos:message name="Rejection">
</bpmnos:message>
</bpmn2:extensionElements>
```

Process KnapsackProcess

The *Knapsack process* awaits requests for inclusion and spawns an event-subprocess for each item requesting inclusion.

It has a data object containing the `capacity` as well as the `total_weight` and `total_value` of all items included.

```
<bpmn2:extensionElements>
  <bpmnos:status>
    <bpmnos:attributes>
      <bpmnos:attribute id="Timestamp" name="timestamp" type="decimal" value="0">
    </bpmnos:attribute>
    </bpmnos:attributes>
  </bpmnos:status>
</bpmn2:extensionElements>
```

DataObject DataObject_0vq7lh8

```
<bpmn2:extensionElements>
  <bpmnos:attributes>
    <bpmnos:attribute id="Capacity" name="capacity" type="decimal">
    </bpmnos:attribute>
    <bpmnos:attribute id="TotalWeight" name="total_weight" type="decimal" value="0">
    </bpmnos:attribute>
    <bpmnos:attribute id="TotalValue" name="total_value" objective="maximize" type="decimal" value="0" we.
    </bpmnos:attribute>
  </bpmnos:attributes>
</bpmn2:extensionElements>
```

DataObject DataObject_2xt50y3

```
<bpmn2:extensionElements>
  <bpmnos:attributes>
    <bpmnos:attribute id="Instance" name="instance" type="string">
    </bpmnos:attribute>
  </bpmnos:attributes>
</bpmn2:extensionElements>
```

Task waitActivity

[@attention](#) Item requests can not be received after this task is completed and the token is forwarded to the end event.

Event-SubProcess EventSubProcess

```
<bpmn2:extensionElements>
  <bpmnos:status>
    <bpmnos:attributes>
      <bpmnos:attribute id="Item" name="item" type="string">
      </bpmnos:attribute>
      <bpmnos:attribute id="Weight" name="weight" type="decimal">
      </bpmnos:attribute>
      <bpmnos:attribute id="Value" name="value" type="decimal">
      </bpmnos:attribute>
    </bpmnos:attributes>
  </bpmnos:status>
</bpmn2:extensionElements>
```

```
</bpmnos:attributes>
</bpmnos:status>
</bpmn2:extensionElements>
```

Ad-hoc SubProcess **AdHocSubProcess**

The adhoc-subprocess ensures that the *Handle item* activities of all event-subprocesses are executed sequentially.

SubProcess **HandleItemActivity**

This activity checks whether the item can be included in the knapsack without exceeding its capacity and rejects or accepts the item accordingly.

SequenceFlow **Flow_0y2js91**

```
<bpmn2:extensionElements>
  <bpmnos:restrictions>
    <bpmnos:restriction id="Restriction_222eo7i">
      <bpmnos:parameter name="linear" value="total_weight + weight > capacity">
      </bpmnos:parameter>
    </bpmnos:restriction>
  </bpmnos:restrictions>
</bpmn2:extensionElements>
```

SequenceFlow **Flow_1r0tr4t**

```
<bpmn2:extensionElements>
  <bpmnos:restrictions>
    <bpmnos:restriction id="Restriction_1g0l6u8">
      <bpmnos:parameter name="linear" value="total_weight + weight <= capacity">
      </bpmnos:parameter>
    </bpmnos:restriction>
  </bpmnos:restrictions>
</bpmn2:extensionElements>
```

Event **ThrowRejectionMessage**

```
<bpmn2:extensionElements>
  <bpmnos:message name="Rejection">
    <bpmnos:parameter attribute="item" name="recipient">
    </bpmnos:parameter>
  </bpmnos:message>
</bpmn2:extensionElements>
```

Task **IncludeItemActivity**

```
<bpmn2:extensionElements>
  <bpmnos:status>
    <bpmnos:operators>
      <bpmnos:operator attribute="total_value" id="Operator_30a3lhs" type="expression">
        <bpmnos:parameter name="linear" value="total_value + value">

```

```

        </bpmnos:parameter>
      </bpmnos:operator>
    <bpmnos:operator attribute="total_weight" id="Operator_33i1d3i" type="expression">
      <bpmnos:parameter name="linear" value="total_weight + weight">
        </bpmnos:parameter>
      </bpmnos:operator>
    </bpmnos:operators>
  </bpmnos:status>
</bpmn2:extensionElements>

```

Event ThrowAcceptanceMessage

```

<bpmn2:extensionElements>
  <bpmnos:message name="Acceptance">
    <bpmnos:parameter attribute="item" name="recipient">
    </bpmnos:parameter>
  </bpmnos:message>
</bpmn2:extensionElements>

```

Event CatchRequestMessage

```

<bpmn2:extensionElements>
  <bpmnos:message name="Request">
    <bpmnos:content attribute="item" id="Content_1fan2i2" key="Item">
    </bpmnos:content>
    <bpmnos:content attribute="weight" id="Content_06b5vbt" key="Weight">
    </bpmnos:content>
    <bpmnos:content attribute="value" id="Content_08oIdrv" key="Value">
    </bpmnos:content>
  </bpmnos:message>
</bpmn2:extensionElements>

```