From a semantic query in k.Explorer to a system of observables in k.Modeler

Example: Pollination model
A net value is the resultant amount after accounting for the sum of...
What can we observe?

Subject  Process  Relationship  Attribute
Quality  Event  Identity  Realm

Not possible to observe but existing in k.IM:
Role  Configuration

The whole system of observables available in k.Modeler
### Connecting observables through semantic operators in k.IM

<table>
<thead>
<tr>
<th>Operator prototype</th>
<th>Applies to</th>
<th>Produces</th>
</tr>
</thead>
<tbody>
<tr>
<td>presence of (&lt;O&gt;)</td>
<td>Subjects, relationships, events and processes</td>
<td>A quality concept describing the presence or absence of (O), whose states are true/false values.</td>
</tr>
<tr>
<td>count of (&lt;O&gt;)</td>
<td>Countables (subjects and events)</td>
<td>A quantity concept describing the numerosity of (O) in a context.</td>
</tr>
<tr>
<td>distance to (&lt;O&gt;)</td>
<td>Subjects and events in a spatial context</td>
<td>A length concept describing the distance to any observation of (O) in a spatial context.</td>
</tr>
<tr>
<td>probability of (&lt;O&gt;)</td>
<td>Events</td>
<td>A quality concept describing the probability of (O) happening.</td>
</tr>
<tr>
<td>uncertainty of (&lt;O&gt;)</td>
<td>Qualities</td>
<td>A quantity concept describing the uncertainty associated with an observation of (O).</td>
</tr>
<tr>
<td>proportion of (&lt;O&gt;) [in (&lt;O&gt;)]</td>
<td>Identities in quantities of more general identity</td>
<td>A quantity describing the proportion of a particular identity in a medium, e.g. salt vs. water volume.</td>
</tr>
<tr>
<td>ratio of (&lt;O1&gt;) to (&lt;O2&gt;)</td>
<td>Quantities</td>
<td>A quantity describing the ratio between two other quantities.</td>
</tr>
<tr>
<td>value of (&lt;O&gt;) [over (&lt;O2&gt;)]</td>
<td>Any concept, including non-observables, over matching concepts</td>
<td>A quantity describing the value attributed by the observer to a particular concept, possibly in comparison with another.</td>
</tr>
<tr>
<td>occurrence of (&lt;O&gt;)</td>
<td>Subjects, relationships, events and processes</td>
<td>A shorthand for &quot;probability of presence of (O)&quot;.</td>
</tr>
</tbody>
</table>

Query 2

(... for selected combinations of observables)
From a conceptual ES model to coding

Main output

- Net value of pollination
  - Pollinator occurrence
    - Landscape suitability
  - Pollinated yield
    - Insect activity
      - Flower availability
      - Inverse distance to water bodies
      - Air temperature
      - Solar radiation
    - Crop pollination dependencies
  - Crop yield

Primary input

- Nesting suitability
- Flower availability
- Inverse distance to water bodies
- Air temperature
- Solar radiation

From a conceptual ES model to coding

@documented(pollination)
namespace aries.global.pollination
  using (FLOWERING_PROBABILITY_TABLE, NESTING_PROBABILITY_TABLE)
  from aries.global.pollination.tables;

@documented(pollination.nesting-suitability)
model occurrence of agriculture:Pollinator ecology:Nest
  observing landcover:LandCoverType named landcover
  lookup (landcover) into NESTING_PROBABILITY_TABLE

@documented(pollination.flower-availability)
model probability of ecology:Flowering
  observing landcover:LandCoverType named landcover
  lookup (landcover) into FLOWERING_PROBABILITY_TABLE

@documented(pollination.insectoccurrence.landscape)
model occurrence of agriculture:Pollinator biology:Insect
  observing
distance to earth:Waterway in m named dist
distance to earth:WaterBody in m named dist
  probability of ecology:Flowering named dist
  occurrence of agriculture:Pollinator ecology

set to {
def lake_effect = nodata(distance_to_lake)
def stream_effect = nodata(distance_to_stream)
return stream_effect + lake_effect + (normal

Examples: modelled phenomena, coding and observables

@documented(pollination.nesting-suitability)
model occurrence of agriculture:Pollinator ecology:Nesting
observing landcover:LandCoverType named landcover
lookup (landcover) into NESTING_PROBABILITY_TABLE;

@documented(pollination.insectoccurrence.weather)
model occurrence of agriculture:Pollinator biology:Insect caused by earth:Weather
observing
im:Mean earth:AtmosphericTemperature in Celsius named air_temperature,
im:Mean earth:SolarRadiation in J named solar_radiation
set to [0.62 + 1.027 * air_temperature + 0.006 * solar_radiation];
Examples: modelled phenomena, coding and observables

Inverse distance to water bodies

@documented(pollination.insectoccurrence.landscape)
model occurrence of agriculture:Pollinator biology:Insect caused by ecology:Landscape named landscape_suitability
  observing
  presence of earth:WaterBody named water_body_presence,
  probability of ecology:Flowering named flowering_suitability,
  occurrence of agriculture:Pollinator ecology:Nesting named nesting_suitability
  set to [(water_body_presence)? unknown : (nesting_suitability * flowering_suitability)];