One if by Land, Two if by Sea

Ontological Modeling of Geographical Relationships for Map Generalization
One if by land, two if by sea;
And I on the opposite shore will be,
Ready to ride and spread the alarm
Through every Middlesex, village and farm,
For the country folk to be up and to arm.

-- Henry Wadsworth Longfellow,
"Paul Revere's Ride"
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Noncontextual Generalization Is Dead

(Long live noncontextual generalization)

<table>
<thead>
<tr>
<th>Nantucket MA from NOAA 1:80K data</th>
<th>Scale 1:500 000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both figures have 142 points (16%)</td>
<td>Insets at 1:1 200 000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RDP Algorithm</th>
<th>Default QTM Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>119.3 km, S = 3.62</td>
<td>104.3 km, S = 2.48</td>
</tr>
</tbody>
</table>

T = 100 m, LVL = 16
In generalizing features, one may need to…

1. Discover and convey how portions of them differ in character
2. Assess their intrinsic importance at presentation scale
3. Collapse or combine them in order to maintain their presence
4. Communicate their status to their neighbors
5. Adapt certain ones to changes in their neighbors
6. Consider the roles that they have in landscapes and maps
7. Switch context according to the purpose of the map
Generalization Is Abstraction

You can’t intelligently generalize shapes that represent features without abstracting their conceptualizations.

The first abstraction involves mapping identified features into geometric shapes and symbols with sizes, styles, and colors.
Generalization Is Abstraction

The next abstraction involves simplifying, culling, and coalescing graphic objects into smaller versions of the things they represent.

Much of the generalization literature is stuck at this level.
Generalization Is Abstraction

The third abstraction is to generalize the concepts that the symbols represent, and then depict those.

Here is where ontologies can make a difference.
Often ignored is the role that *perception* has in specifying abstractions of *reality*.


How you generalize maps depends on how you perceive the world and how you specify it.
What’s Out There?
Why Is Some of it Ignored?

Its concern with authoritatively delineating public and private property has made cartography reluctant to deal with fluid boundaries, such as intertidal zones and subdivisions of waterbodies.

Yet, because the boundaries are fuzzy, we can define them almost at will, based on local knowledge.
Missing Roles

What’s the difference between a **waterbody**, a **sea**, a **gulf**, a **strait**, a **sound**, a **bay**, and a **cove**?

Or for that matter, a **point**, a **neck**, a **headland**, and a **cape**?

In what sense does do roles in a landscape matter?

How can a cartographic data base portray them?

Or is “capes and bays” geography irrelevant?
In what body of water is point $X$?
Establishing Context

We say $x$ is in Nantucket Sound
Two Generalization Contexts

24K Topo Quads (left more recent)

40K Navigation Chart
## Two Generalization Contexts

<table>
<thead>
<tr>
<th><strong>Topographic Map</strong></th>
<th><strong>Nautical Chart</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplify shapes of coastlines and clusters of islands</td>
<td>Simplify coastlines and islands to preserve their importance to mariners</td>
</tr>
<tr>
<td>Depict geomorphologic features fairly uniformly</td>
<td>Depict geomorphologic features visible from offshore</td>
</tr>
<tr>
<td>Delete minor roads or those that dead-end</td>
<td>Preserve main roads and those accessing shorelines</td>
</tr>
<tr>
<td>Remove solitary buildings and structures</td>
<td>Depict buildings and structures useful to navigation</td>
</tr>
</tbody>
</table>
Two Generalization Contexts
The Context from Land

- Massachusetts
  - Southeastern Massachusetts
    - Barnstable County
      - Fairhaven
      - Upper Cape
    - Bristol County
      - Marion
        - S. Marion
        - Converse Pt
        - Next Pt
      - Butler Pt
      - Sippican
        - Woods Hole
      - Piney Pt
      - Great Hill Pt
      - Lower Cape
The Context from Water

- Nantucket Sound
- Nantucket Harbor
- Aucoot Cove
- Vinyard Harbor
- Buzzards Bay
- Vinyard Sound
- Woods Hole
- Nantucket Sound
- Sippican Harbor
- Planting Cove
- Provincetown Harbor
- Cape Cod Bay
- Hammet Cove
- Wings Cove
- Atlantic Ocean
Two if by Land, One if by Sea
An Environmental Ontology

ISO/IEC 18025:2005(E)

- **Waterbody**: A particular, designated body of <WATER> forming a physiographic <OBJECT> [SOED, "waterbody"].
  - EXAMPLES <LAKE>, <OCEAN>, <SEA>, <RIVER>.
- **Lake**: <INLAND WATER> without significant flow that is surrounded by <LAND>; a lake.
- **Ocean**: One of the major divisions of an expanse of salt <WATER> covering a <PLANETARY_SURFACE>; an ocean.
- **Sea**: A salty <WATERBODY> more or less confined by continuous <LAND> or chains of <ISLAND>s and forming a distinct <REGION>; a sea.
- **River**: A natural flowing <WATERCOURSE>; a river or stream.
- **Estuary**: An arm of a <WATERBODY> that extends inland to meet the mouth of a <RIVER> and includes a mixture of fresh and salt <WATER>.
- **Watercourse**: An artificial or natural channel for the conveyance of <WATER>; a watercourse.
- **Waterbody Region**: A <REGION> of a <WATERBODY>.
- **Waterbody Basin**: A delimited, principal division of a <WATERBODY>; a waterbody basin.
  - EXAMPLE <OCEAN BASIN>.

Let’s try to structure that...
One way to enrich cartographic data records without completely recompiling them is to build associated ontologies conveying the meaning of data items, their properties, and relationships for operational purposes.

Can we itemize their qualities in ways that inform their graphic representations?
Ontology concerns the nature of being; computationally, specifying one boils down to compiling systematic inventories of what is known about a domain of knowledge.

Are we talking about knowledge of maps or of the realities they represent? And what kinds of knowledge?
Every mapmaker has a “worldview” used to choose, scale, and position graphic shapes on maps. Based on mapping standards and without a lot of thought, s/he sets down spatial semiotics to depict the real world with a host of tacit semantics.