COGS 152 / The Cognitive Science of Mathematics

Homework 1
(due in class on Thursday, April 29)

1) In Lakoff’s *The Contemporary Theory of Metaphor* (1993) – available on the course website – there is an analysis of a general and fundamental conceptual metaphor: The Event Structure Metaphor. This metaphor gives an account of hundreds of expressions dealing with the way in which we conceptualize events and their dynamics. The following is a summary of the mapping of this conceptual metaphor.

The Event Structure Metaphor

<table>
<thead>
<tr>
<th>Source Domain</th>
<th>→</th>
<th>Target Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location: A Bounded Region</td>
<td>→</td>
<td>A State</td>
</tr>
<tr>
<td>Motion from Location to Location</td>
<td>→</td>
<td>Change From State to State</td>
</tr>
<tr>
<td>A Path</td>
<td>→</td>
<td>A Course of change or action</td>
</tr>
<tr>
<td>A Destination</td>
<td>→</td>
<td>A Purpose</td>
</tr>
<tr>
<td>A Force</td>
<td>→</td>
<td>A Cause</td>
</tr>
<tr>
<td>A Forced Motion To a New Location</td>
<td>→</td>
<td>A Caused Change To a New State</td>
</tr>
<tr>
<td>A self-propelled motion</td>
<td>→</td>
<td>An Action</td>
</tr>
<tr>
<td>An Impediment To Self-propelled Motion</td>
<td>→</td>
<td>A Difficulty In Acting</td>
</tr>
</tbody>
</table>

Answer the following questions:

a) What does Self-propelled Motion Toward Reaching a Destination map onto in the target domain? **An action performed with a particular purpose.**

b) Consider a Bounded Region of a Container Schema (the interior of the container). Suppose that in the source domain an Entity moves out of a Bounded Region and into another Bounded Region. What does this map into in the target domain? **A change from one distinct state to another, following a particular course of action.**
c) Imagine that in the source domain there is an Entity moving trying to Reach a Destination. What does “being stuck” entail in the source domain? In the target domain? In the source domain, “being stuck” entails some sort of impediment that blocks the motion towards the destination. In the target domain, it entails some sort of obstacle that prohibits the attainment of the intended state.

d) In the target domain, Entity1 Causes Entity 2 to Change from State1 to State2. What in the source domain give meaning to this situation under the given metaphorical mapping? In the source domain, this corresponds to “Entity1 produces a force that moves Entity2 from Location1 to Location2.”

e) Suppose that in the Source Domain, the moving entities are two persons. Person 1 is trying to reach a Destination and Person 2 is holding him/her back. What is entailed in the target domain? Person1 is trying to achieve a certain goal (or intended state), and Person2 is interfering with Person1's course of action.

f) What in the source domain maps onto Progress in the target domain? Unobstructed movement towards a destination.

g) Suppose that in the source domain you are travelling along a route towards a destination and you reach a dead end. What is entailed about the target domain? You are following a course of action in the hope of achieving a certain goal, but reach an insurmountable obstacle.

h) Give an example of a metaphorical expression for each case defined by questions (a) to (g).
   (a) “I've almost reached the end of this assignment.”
   (b) “All my hard work in the gym has brought me from weakling to Atlas.”
   (c) “I was moving along well on my assignment, but then I got stuck trying to give an example of a metaphorical expression for 1 (c).”
   (d) “My boyfriend forced me to go from omnivore to militant vegetarian.”
   (e) “I want to build a new fence in my backyard, but my neighbour keeps getting in the way.”
   (f) “This assignment is moving along well.”
   (g) “Our negotiations have reached an impasse; if we want to make progress, we'll need to turn back and try a new tack.”
2) Below you’ll find a piece of a newspaper article and a cartoon, published some time ago in the New York Times and in the CityBEAT, respectively. Study them carefully keeping in mind that conceptual metaphors are inference-preserving cross-domain mappings. Then answer the following questions:
a) Identify at least three **metaphorical expressions** in these texts.
   “So you see, my tax plan will help defeat terrorism!”
   “She never made the connection with an outbreak of atypical pneumonia.”
   “Finally, while no cure exists at this time, risk of exposure can be minimized by avoiding infected media sources.”
   “...raising taxes...”

b) Identify a **conceptual metaphor** that is used in both texts.
   **Sickness IS a moving entity.**

c) Identify two **metaphorical expressions** in these texts that establish the presence of the conceptual metaphor you identified in (b).
   “The disease has spread to less developed regions...”
   “Ms. Meng also passed SARS to Li Ling....”
   “A mysterious epidemic sweeps the nation...”

d) Give two examples of other **metaphorical expressions** that are linguistic manifestations of the conceptual metaphor you mentioned in (b). (You can take the examples from everyday language, from written material, from illustrations, etc.).
   Ms. Meng also passed SARS to Li Ling,
   “That flu has been passed along from friend to friend.”
   “First I gave Jim my cold, and from there it moved to Susan.”
   “The chicken pox has been circulating at my son’s school.”

e) State the **mappings** of the conceptual metaphor in (b), that give an account of the inferential structure observed in the expressions in (c) and (d).

<table>
<thead>
<tr>
<th>Source domain: Moving entities</th>
<th>→</th>
<th>Target domain: Illness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity</td>
<td>→</td>
<td>Illness</td>
</tr>
<tr>
<td>Movement of the entity</td>
<td>→</td>
<td>Spread of the disease</td>
</tr>
<tr>
<td>Receiving the entity</td>
<td>→</td>
<td>Becoming infected</td>
</tr>
<tr>
<td>Passing the entity from one person to another</td>
<td>→</td>
<td>Transmitting the disease from one person to another</td>
</tr>
<tr>
<td>Interfering with the entity's motion</td>
<td>→</td>
<td>Preventing the spread of the disease</td>
</tr>
</tbody>
</table>

f) Identify two expressions in the texts that provide information about other cognitive mechanisms such as **image-schemas, analogies**, and **conceptual metonymy**.
Metonymy (Institution for People Responsible) : “I’m not convinced the administration has been completely forthcoming.”
Fictive motion: “The disease has spread to less developed regions...”
Image-schema (above schema): “While China, under international pressure, has admitted...”
3) Below you’ll find a reproduction of a few pages from *The Cartoon Guide to Statistics*.

a) Recall the conceptual metaphors of arithmetic identified in Chapters 3 and 4 of WMCF (e.g., the “4 Gs”). Identify the conceptual metaphors of arithmetic that are evident in these pages, using specific examples of expressions and representations.

- **Arithmetic IS Object Collection:** the numbers in the cartoon are shown as collections of dots:

- **The Measuring Stick Metaphor:**
  - In the cartoon to the right, the man is measuring the distance of a data point from the mean.
  - “You can think of it, roughly speaking, as the average distance of the data from the mean.”
  - "But a spread measure should have the same units as the original data."
  - “It’s often useful to know how many standard deviations a data point is from the mean.”

- **Arithmetic As Motion Along a Path:**
  - “We define z-scores as distance from the mean.”
  - In the diagram to the right, z-scores are shown as points along a line.

b) In this text, is there polysemy in the various uses of the symbol “=”? Explain the conceptual differences (if any) in the use of the “=” symbol, using examples.

Yes. Polysemy: when a single word, utterance, or symbol has different meanings.

- The symbol is used to mean “is defined as.” On page one: “Average squared distance = ...” or “We define the simple variance $s^2$ as: $s^2 = ....$” On the second page: “To define: $s = \sqrt{s} = ....$”
- On the bottom of the first page, it's used to mean “the result of the calculation is” when they write, “we calculate the variance, $s^2 = (3-12)...$”
- On the bottom of the third page, it's used to mean, “and the result of this operation is.” They write, “$(175-145.2)/23.7=1.26.$”
c) Is there any conceptual blend involved in this characterization of a z-score? If yes, describe the input spaces and the blended space, and a few of the mappings between them.

The z-score is characterized using the number-line blend. The number-line blend has two input spaces: “arithmetic” and the “line.” See below.
4) In Chapter 2 of WMCF, Lakoff and Núñez discuss Venn Diagrams – a way of visualizing sets – and identify the conceptual metaphor that supplies their logic.

   a) What is this conceptual metaphor? Specify the source domain, target domain, and the mappings between them. Tabulate this information in a table similar to the one on p. 46 for the Love IS a Partnership metaphor.

   “Sets ARE containers.”

<table>
<thead>
<tr>
<th>Source Domain: Containers</th>
<th>→</th>
<th>Target Domain: Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bounded regions in space</td>
<td>→</td>
<td>Sets</td>
</tr>
<tr>
<td>Objects inside a bounded region</td>
<td>→</td>
<td>Elements in a set</td>
</tr>
<tr>
<td>One bounded region inside another</td>
<td>→</td>
<td>A subset of another set</td>
</tr>
<tr>
<td>The totality of the interiors of two bounded regions</td>
<td>→</td>
<td>The union of two sets</td>
</tr>
<tr>
<td>The overlap of the interiors of two bounded regions</td>
<td>→</td>
<td>The intersection of two sets</td>
</tr>
</tbody>
</table>

   b) Refer to p.45 of WMCF. For each of the following, draw the appropriate Venn Diagram, identify the associated mathematical idea, and use the conceptual metaphor from (a) to explain the meaning of the idea:
   - Figure 2.4, (a): The set B is a subset of the set A. Source domain: The bounded region B is completely inside the bounded region A.
   - Figure 2.4, (b), called the “union of A and B:”, All the elements in either A or B, the union A U B. Source domain: The totality of the interiors of the bounded region A and the bounded region B.
   - Figure 2.4, (c), called the “intersection of A and B.” The elements in both A and B, the intersection A ∩ B. Source domain: The overlap of the interiors of the bounded regions A and B.