Carnap's Early Systems: \( m^i \) and \( m^s \)

Here is the \( m^i \) distribution, for the 2 prediate, 2 object case:

\[
\text{Symbolize}[m^i_{2,2}];
\]

\[
m^i_{2,2} = \text{PrSAT}\{\Pr[\text{Ea} \land \text{Ga} \land \text{Eb} \land \text{Gb}] = \frac{1}{16}, \Pr[\text{Ea} \land \text{Ga} \land \text{Eb} \land \lnot \text{Gb}] = \frac{1}{16},
\Pr[\text{Ea} \land \lnot \text{Ga} \land \text{Eb} \land \text{Gb}] = \frac{1}{16}, \Pr[\text{Ea} \land \lnot \text{Ga} \land \text{Eb} \land \lnot \text{Gb}] = \frac{1}{16},
\Pr[\lnot \text{Ea} \land \text{Ga} \land \text{Eb} \land \text{Gb}] = \frac{1}{16}, \Pr[\lnot \text{Ea} \land \text{Ga} \land \text{Eb} \land \lnot \text{Gb}] = \frac{1}{16},
\Pr[\lnot \text{Ea} \land \lnot \text{Ga} \land \text{Eb} \land \text{Gb}] = \frac{1}{16}, \Pr[\lnot \text{Ea} \land \lnot \text{Ga} \land \text{Eb} \land \lnot \text{Gb}] = \frac{1}{16}\}\}
\]

\[
\text{Out}[3]= \{\{\text{Ea} \to \{a_2, a_6, a_7, a_8, a_{12}, a_{13}, a_{14}, a_{16}\}, \text{Ga} \to \{a_4, a_7, a_9, a_{11}, a_{12}, a_{14}, a_{15}, a_{16}\}, \text{Gb} \to \{a_5, a_8, a_{10}, a_{11}, a_{13}, a_{14}, a_{15}, a_{16}\}\},
\{a_1 \to \frac{1}{16}, a_2 \to \frac{1}{16}, a_3 \to \frac{1}{16}, a_4 \to \frac{1}{16}, a_5 \to \frac{1}{16}, a_6 \to \frac{1}{16}, a_7 \to \frac{1}{16}, a_8 \to \frac{1}{16}, a_9 \to \frac{1}{16}, a_{10} \to \frac{1}{16}, a_{11} \to \frac{1}{16}, a_{12} \to \frac{1}{16}, a_{13} \to \frac{1}{16}, a_{14} \to \frac{1}{16}, a_{15} \to \frac{1}{16}, a_{16} \to \frac{1}{16}\}\}
\]
In[4]:= TruthTable[m',2 ,2]

Out[4]/DisplayForm=

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</table>

Here are some salient facts about m':

In[5]:= x_ ⊃ y_ := ¬ x ∨ y;
   x_ ≡ y_ := (x ⊃ y) ∧ (y ⊃ x);

In[7]:= EvaluateProbability[Pr[(Ea ⊃ Ga) ∧ (Eb ⊃ Gb)], m',2 ,2] // N
   Out[7]= 0.5625

In[8]:= EvaluateProbability[Pr[Eb ∧ Gb], m',2 ,2] // N
   Out[8]= 0.25

In[9]:= EvaluateProbability[Pr[Gb | Ea ∧ Ga], m',2 ,2] // N
   Out[9]= 0.5

In[10]:= EvaluateProbability[Pr[Gb | Ea ⊃ Ga], m',2 ,2] // N
   Out[10]= 0.5

In[11]:= EvaluateProbability[Pr[Gb], m',2 ,2] // N
   Out[11]= 0.5

In[12]:= EvaluateProbability[Pr[Eb ≡ Gb], m',2 ,2] // N
   Out[12]= 0.5

In[13]:= EvaluateProbability[Pr[Eb ≡ Gb | Ea ∧ Ga], m',2 ,2] // N
   Out[13]= 0.5

In[14]:= EvaluateProbability[Pr[Eb ≡ Gb | Ea ≡ Ga], m',2 ,2] // N
   Out[14]= 0.5
In other words, $m^*$ violates instantial relevance and analogy, but it leads to all Hempelian confirmatory instances for a universal generalization being confirmatory (probabilistically relevant) instances for a universal generalization.

Here is the $m^*$ distribution:
Here are some salient Eacts about \( m^* \):

\[
\text{TruthTable}\left[ m^* \right]
\]
EvaluateProbability[Pr[(Ea ⊃ Ga) \ (Eb ⊃ Gb)], m^2, 2] // N
Out[27]= 0.6

EvaluateProbability[Pr[Eb \ Ga], m^2, 2] // N
Out[28]= 0.25

EvaluateProbability[Pr[Gb | Ea \ Ga], m^2, 2] // N
Out[29]= 0.6

EvaluateProbability[Pr[Gb | Ea ≡ Ga], m^2, 2] // N
Out[30]= 0.5

EvaluateProbability[Pr[Gb | (Ea ≡ Ga) \ Eb], m^2, 2] // N
Out[31]= 0.6

EvaluateProbability[Pr[Gb | Eb], m^2, 2] // N
Out[32]= 0.5

EvaluateProbability[Pr[Gb], m^2, 2] // N
Out[33]= 0.5

EvaluateProbability[Pr[Eb ≡ Gb], m^2, 2] // N
Out[34]= 0.5

EvaluateProbability[Pr[Eb ≡ Gb | Ea \ Ga], m^2, 2] // N
Out[35]= 0.6

EvaluateProbability[Pr[Eb ≡ Gb | Ea ≡ Ga], m^2, 2] // N
Out[36]= 0.6

EvaluateProbability[Pr[Eb ≡ Gb], m^2, 2] // N
Out[37]= 0.5

EvaluateProbability[Pr[(Ea ⊃ Ga) \ (Eb ⊃ Gb)], m^2, 2] // N
Out[38]= 0.6

EvaluateProbability[Pr[(Ea ⊃ Ga) \ (Eb ⊃ Gb) | Ea \ Ga], m^2, 2] // N
Out[39]= 0.8

EvaluateProbability[Pr[(Ea ⊃ Ga) \ (Eb ⊃ Gb) | ~ Ea \ ~ Ga], m^2, 2] // N
Out[40]= 0.8

EvaluateProbability[Pr[(Ea ⊃ Ga) \ (Eb ⊃ Gb) | ~ Ea \ Ga], m^2, 2] // N
Out[41]= 0.8

EvaluateProbability[Pr[Ea | Eb] > Pr[Ea | Eb \ (Ga \ ~ Gb)] > Pr[Ea], m^2, 2]
Out[120]= False

EvaluateProbability[Pr[(Ea ⊃ Ga) \ (Eb ⊃ Gb) | Ea \ ~ Ga], m^2, 2] // N
Out[42]= 0.

EvaluateProbability[Pr[Ga | Gb \ (Ea \ ~ Eb)], m^2, 2] // N
Out[43]= 0.5
In other words, m' satisfies instansial relevance and “analogy by similarity”, but it also leads to all Hempelian confirmatory instances for a universal generalization being confirmatory (probabilistiscally relevant) instances for a universal generalization.

What about “Grue”? Here, the 2-object, 3-predicate case is what we’d want to look at (E, O, G, and a, b, c). It’s pretty complex. We need to be more clever now in specifying m'2,3 and m'2,3. We start with m'2,3.

```
ln[46] = Symbolize[m'2,3];

ln[47] = atoms = (Ea, Eb, Oa, Ob, Ga, Gb);
tvs = Flatten[Outer[List, Sequence @@ Table[{True, False}, {6}]], 5];
set[x_] := Table[If[x[i] == True, atoms[i], ~atoms[i]], {i, 1, Length[atoms]}];
sds = (And @@ & @ (set @@ vs));
f[s_] := Pr[s] = 1;
Length[sds]
m'2,3 = PrSAT[(f @@ sds), BypassSearch -> True];

ln[53] = x_ y_ := (x o y) \ (y o x);

ln[54] = EvaluateProbability[Pr[(Ea o (Oa => Ga)) \ (Eb o (Ob => Gb))], m'2,3] // N
Out[54] = 0.5625

ln[55] = EvaluateProbability[Pr[EB \ Ga], m'2,3] // N
Out[55] = 0.25

ln[56] = EvaluateProbability[Pr[OB \ Ea \ Ga], m'2,3] // N
Out[56] = 0.5

ln[57] = EvaluateProbability[Pr[GB \ Ea \ Ga], m'2,3] // N
Out[57] = 0.5

ln[58] = EvaluateProbability[Pr[GB], m'2,3] // N
Out[58] = 0.5

ln[59] = EvaluateProbability[Pr[EB \ GB], m'2,3] // N
Out[59] = 0.5

ln[60] = EvaluateProbability[Pr[EB \ GB \ Ea \ Ga], m'2,3] // N
Out[60] = 0.5

ln[61] = EvaluateProbability[Pr[EB \ GB \ Ea \ Ga], m'2,3] // N
Out[61] = 0.5

ln[62] = EvaluateProbability[Pr[(Ea \ Ga) \ (Eb \ Ga) | Ea \ Ga], m'2,3] // N
Out[62] = 0.75

ln[63] = EvaluateProbability[Pr[(Ea \ Ga) \ (Eb \ Ga) | ~Ea \ ~ Ga], m'2,3] // N
Out[63] = 0.75
```
Now, for m^{2,3}, we must be a little more clever. We have to compute the structure descriptions, and then the probabilities for them, etc.

```
    states = set /@ tvs;
    
    results = {};
    For[i = 1, i <= Length[states], i++, a = states[[i]]; temp = {};
            AppendTo[temp, i]; For[j = 1, j <= Length[states], j++, b = states[[j]];
            If[Sort[a] == Sort[perm[b]], AppendTo[temp, j]]; AppendTo[results, temp]];
        structIndices = Union/@ Union[Sort/@ results];

    in[x_, s_] := Or @@ Table[x === S[[i]], {i, 1, Length[S]}];

    pr[sn_] := 36 Length[Flatten[Select[structIndices, in[sn, #1] &]]];

    f[n_] := Pr[And @@ states[[n]]] = pr[n];

    m^{2,3} = PrSAT[{{f /@ Range[64]}, BypassSearch \[Rule] True}];
```

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<td>T</td>
<td>F</td>
<td>( \alpha = 43 )</td>
<td>( \frac{1}{72} )</td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>F</td>
<td>( \alpha = 44 )</td>
<td>( \frac{1}{72} )</td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>F</td>
<td>( \alpha = 45 )</td>
<td>( \frac{1}{72} )</td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>( \alpha = 46 )</td>
<td>( \frac{1}{72} )</td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>( \alpha = 47 )</td>
<td>( \frac{1}{72} )</td>
</tr>
</tbody>
</table>

In[186] = EvaluateProbability[Pr[(\( \sim (Oa \equiv Ga) \) \land (Eb \supset (Ob \equiv Gb)))] \land (Eb \supset (Ob \equiv Gb)) \land (Ga \land Oa \land Ga)], \( m^* \), \( \alpha = 39 \) \] // N

Out[186] = 0.583333

In[78] = EvaluateProbability[Pr[(\( \sim (Oa \equiv Ga) \) \land (Eb \supset (Ob \equiv Gb)) \mid (Ga \land Oa \land Ga)]] \land (Eb \supset (Ob \equiv Gb)), \( m^* \), \( \alpha = 39 \) \] // N

Out[78] = 0.703704

In[187] = EvaluateProbability[Pr[(\( \sim (Ga \equiv Ga) \) \land (Eb \supset (Ob \equiv Gb)))] \land (Eb \supset (Ob \equiv Gb)) \land (Ga \land Oa \land Ga)], \( m^* \), \( \alpha = 39 \) \] // N

Out[187] = 0.777778

In[188] = EvaluateProbability[Pr[(\( \sim (Ga \equiv Ga) \) \land (Eb \supset (Ob \equiv Gb)))] \land (Eb \supset (Ob \equiv Gb)) \land (Ga \land Oa \land Ga)], \( m^* \), \( \alpha = 39 \) \] // N

Out[188] = 0.583333

In[189] = EvaluateProbability[Pr[(\( \sim (Ga \equiv Ga) \) \land (Eb \supset (Ob \equiv Gb)))] \land (Ga \land Oa \land Ga)], \( m^* \), \( \alpha = 39 \) \] // N

Out[189] = 0.388889

In[190] = EvaluateProbability[Pr[(\( \sim (Ga \equiv Ga) \) \land (Eb \supset (Ob \equiv Gb)))] \land (Ga \land Oa \land Ga)], \( m^* \), \( \alpha = 39 \) \] // N

Out[190] = 0.388889

In[191] = EvaluateProbability[Pr[(\( \sim (Ga \equiv Ga) \) \land (Eb \supset (Ob \equiv Gb)))] \land (Ga \land Oa \land Ga)], \( m^* \), \( \alpha = 39 \) \] // N

Out[191] = 0.777778

In[192] = EvaluateProbability[Pr[\( \sim (Ga \equiv Ga) \) \land (Eb \supset (Ob \equiv Gb)) \mid (Ga \land Oa \land Ga)]] \land (Ga \land Oa \land Ga)], \( m^* \), \( \alpha = 39 \) \] // N

Out[192] = 0.777778

In[193] = EvaluateProbability[Pr[\( \sim (Ga \equiv Ga) \) \land (Eb \supset (Ob \equiv Gb)) \mid (Ga \land Oa \land Ga)]] \land (Ga \land Oa \land Ga)], \( m^* \), \( \alpha = 39 \) \] // N

Out[193] = 0.75

In[194] = EvaluateProbability[Pr[\( \sim (Ga \equiv Ga) \) \land (Eb \supset (Ob \equiv Gb)) \mid (Ga \land Oa \land Ga)]] \land (Ga \land Oa \land Ga)], \( m^* \), \( \alpha = 39 \) \] // N

Out[194] = 0.777778
In[195]:= EvaluateProbability[Pr[\(Eb \land (Ob \equiv Ga) \mid Ea \land (Oa \land Ga)\)], \(m^*_{2,3}\) // N
Out[195]= 0.333333

In[196]:= EvaluateProbability[Pr[\(Eb \land (Ob \equiv Ga) \mid Ea \land (Oa \equiv Ga)\)], \(m^*_{2,3}\) // N
Out[196]= 0.333333

In[197]:= EvaluateProbability[Pr[\(Eb \land (Ob \equiv Ga) \mid Ea \land (Oa \equiv Ga) \land (Oa \land Ob)\)], \(m^*_{2,3}\) // N
Out[197]= 0.4

In[198]:= EvaluateProbability[Pr[\(Eb \land (Ob \equiv Ga) \mid (Oa \land Ob)\)], \(m^*_{2,3}\) // N
Out[198]= 0.25

In[199]:= EvaluateProbability[Pr[\(Eb \land Gb \mid Ea \land (Oa \equiv Ga) \land (Oa \land Ob)\)], \(m^*_{2,3}\) // N
Out[199]= 0.4

In[200]:= EvaluateProbability[Pr[\(Eb \land Gb \mid Oa \land Ob\)], \(m^*_{2,3}\) // N
Out[200]= 0.25

In[201]:= EvaluateProbability[Pr[\(Eb \land (Ob \equiv Ga)\)], \(m^*_{2,3}\) // N
Out[201]= 0.25

In[202]:= EvaluateProbability[Pr[\(Eb \land (Ob \lor Gb)\)], \(m^*_{2,3}\) // N
Out[202]= 0.125

In[203]:= EvaluateProbability[Pr[\(Eb \land (Ob \lor Gb) \mid Ea \land (Oa \lor Ga)\)], \(m^*_{2,3}\) // N
Out[203]= 0.222222

In[204]:= EvaluateProbability[Pr[\(Gb \mid Ea \equiv Ga\)], \(m^*_{2,3}\) // N
Out[204]= 0.5

Comparison with 2.2:

In[205]:= EvaluateProbability[Pr[\(Gb \mid Ea \equiv Ga\)], \(m^*_{2,2}\) // N
Out[205]= 0.5

In[206]:= EvaluateProbability[Pr[\(Gb \mid Ea \equiv Ga\)], \(m^*_{2,3}\) // N
Out[206]= 0.5

In[207]:= EvaluateProbability[Pr[\(Gb\)], \(m^*_{2,2}\) // N
Out[207]= 0.5

In[208]:= EvaluateProbability[Pr[\(Gb\)], \(m^*_{2,3}\) // N
Out[208]= 0.5

In[209]:= EvaluateProbability[Pr[\(Eb \equiv Gb\)], \(m^*_{2,2}\) // N
Out[209]= 0.5

In[210]:= EvaluateProbability[Pr[\(Eb \equiv Gb\)], \(m^*_{2,3}\) // N
Out[210]= 0.5

In[211]:= EvaluateProbability[Pr[\(Eb \equiv Gb \mid Ea \land Ga\)], \(m^*_{2,2}\) // N
Out[211]= 0.5
Here's a counterexample to Fine's L7:

```plaintext
evaluateProbability[Pr[ Eb \L\ Ga, m_{2,2}]] // N
Out[2]= 0.5
```

```plaintext
evaluateProbability[Pr[ (Ea \L\ Ga) \L\ (Eb \L\ Gb) | Ea \L\ Ga], m_{2,2}]] // N
Out[2]= 0.75
```

```plaintext
evaluateProbability[Pr[ (Ea \L\ Ga) \L\ (Eb \L\ Gb) | \neg Ea \L\ \neg Ga], m_{2,2}]] // N
Out[2]= 0.75
```

```plaintext
evaluateProbability[Pr[ (Ea \L\ Ga) \L\ (Eb \L\ Gb) | \neg Ea \L\ Ga], m_{2,2}]] // N
Out[2]= 0.75
```

```plaintext
evaluateProbability[Pr[ (Ea \L\ Ga) \L\ (Eb \L\ Gb) | \neg Ga], m_{2,2}]] // N
Out[2]= 0.75
```

```plaintext
evaluateProbability[Pr[ Ga | Gb \L\ (Ea \L\ \neg Eb)], m_{2,2}]] // N
Out[2]= 0.5
```

```plaintext
evaluateProbability[Pr[ Ga | Gb], m_{2,2}]] // N
Out[2]= 0.5
```

```plaintext
evaluateProbability[Pr[ Ga], m_{2,2}]] // N
Out[2]= 0.5
```