

Conceptual Graph Background

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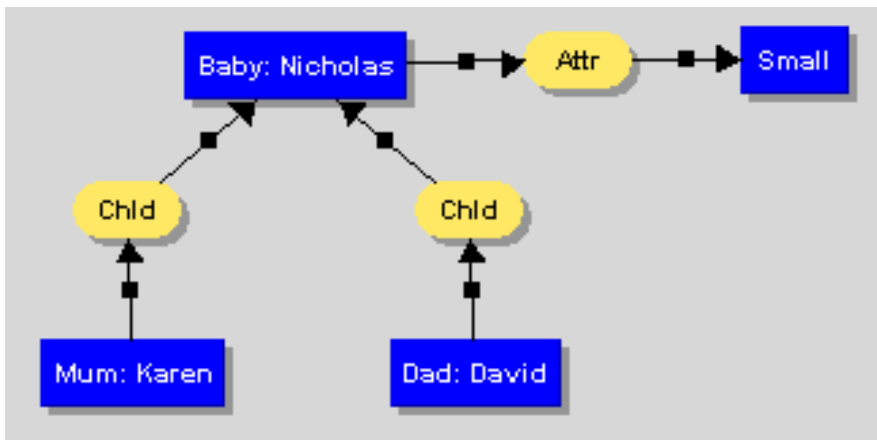
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Conceptual Graphs

- Sowa's CST (1984) permits knowledge representation via bipartite CGs:
 - Concepts
 - Conceptual Relations, e.g. thematic roles
 - Type Lattices



(Attr)-

-> [Small]

<- [Baby: Nicholas]-

<-2- (Chld) <-1- [Mum: Karen]

<-2- (Chld) <-1- [Dad: David]

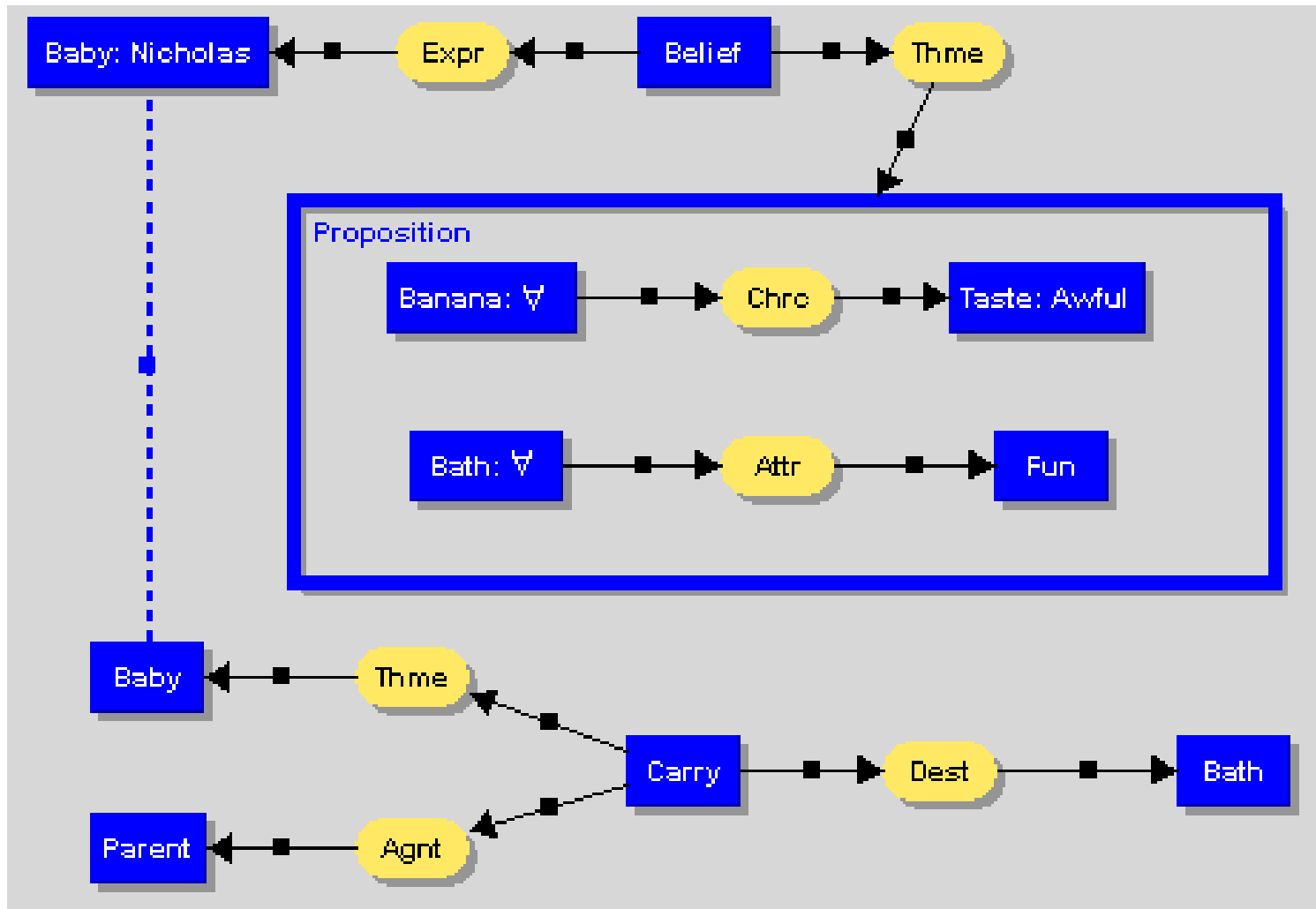
(Attr [Baby *a: "Nicholas"] [Small])

(Child ?a [Mum: "Karen"])

(Child ?a [Dad: "David"])



Conceptual Graphs



Conceptual Graphs

- **Display and Linear forms, and CGIF.**
- **CST primitives model static knowledge.**
- **Modification of knowledge base (KB) via:**
 - **Copy**
 - *Restriction*
 - *Join*
 - **Simplification**
 - *Projection* (π)



Processes

- **Addressing a lack in CST:**
 - **CGs represent declarative information;**
 - **By themselves they are insufficient for:**
 - doing computation;
 - simulating events and processes.
 - **Some kind of truth maintenance engine is required: *assertion* and *retraction* of graphs over time.**
 - **Mineau's (1998) CG Processes are one such approach.**



Processes

- **Key notions:**
 - state transitions;
 - knowledge-based *precondition* matching: conjunction of CGs;
 - *post-conditions* modify Knowledge Base (KB) by graph assertion and retraction; may use matched information;
- *process* $p(\text{in } g1, \text{out } g2, \dots)$ is
$$\{ r_i = \langle pre_i, post_i \rangle, \forall_i \in [1, n] \}$$
- **forward chaining.**



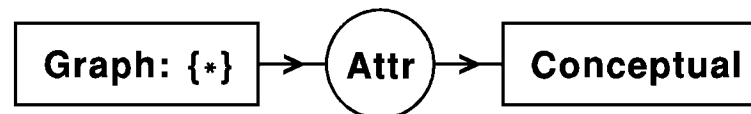
Processes

- **Generalisation of Delugach's (1991) *demons*, and Sowa's *actors or dataflow graphs*.**

process > demon > actor

Formalism	Parameters
Processes	Graphs
Demons	Concepts
Actors	Referents

- **Process mechanism also *uses* actors in practice when referent computation required.**

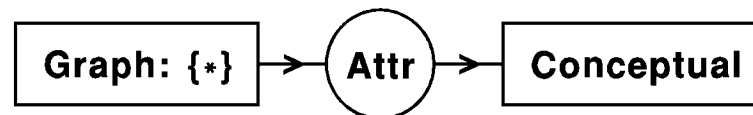
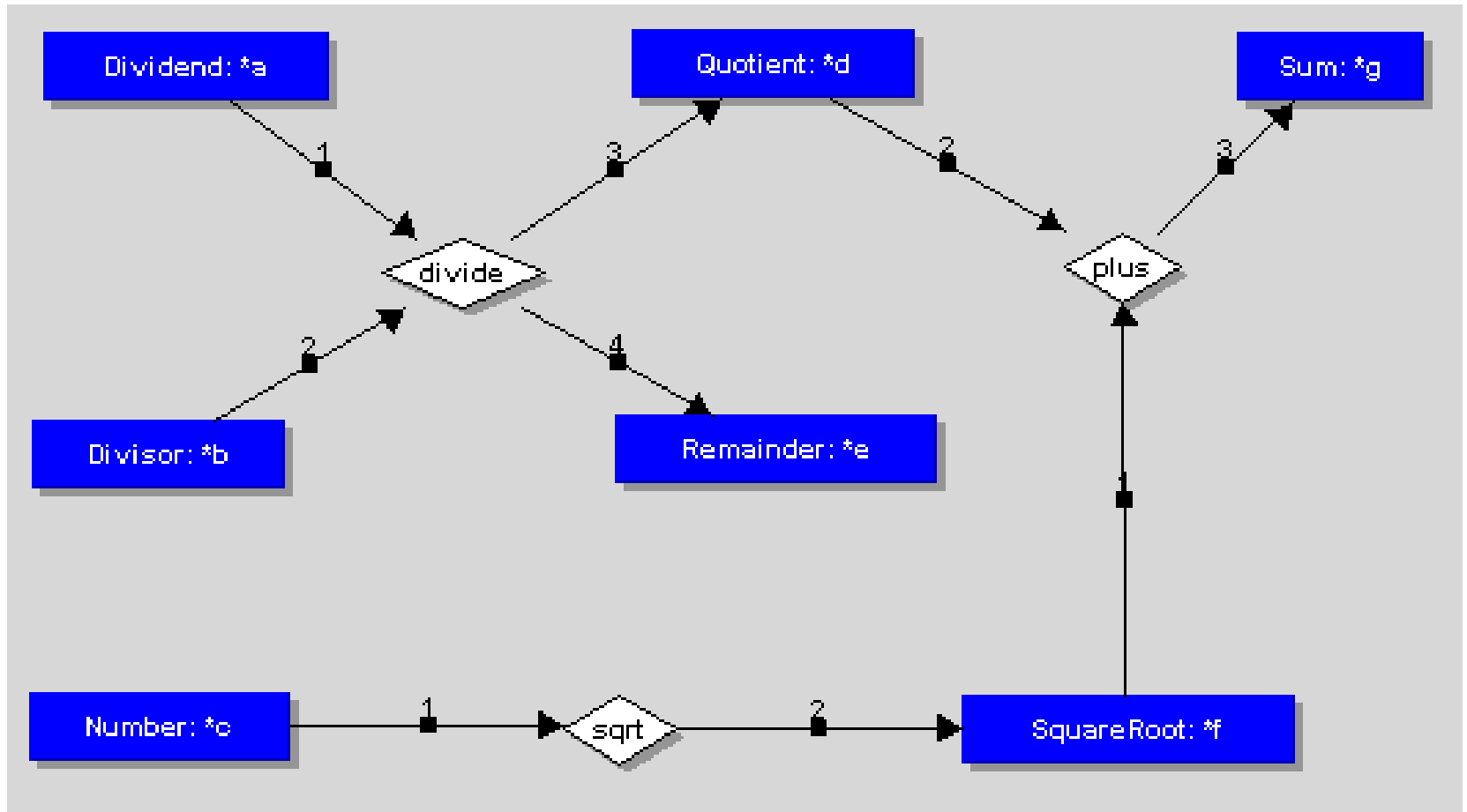


Thesis Content

- **Current work:**
 - provides a primer on CGs;
 - surveys literature re: dynamic CG formalisms & tools, and Petri Nets (coloured, actor mechanism description);
 - presents a general-purpose programming language, *pCG*, developed by the author which embodies Mineau's process formalism (<http://www.adelaide.net.au/~dbenn/Masters/>);
 - presents and discusses pCG experiments;
 - suggests future directions.



Actors



Actors

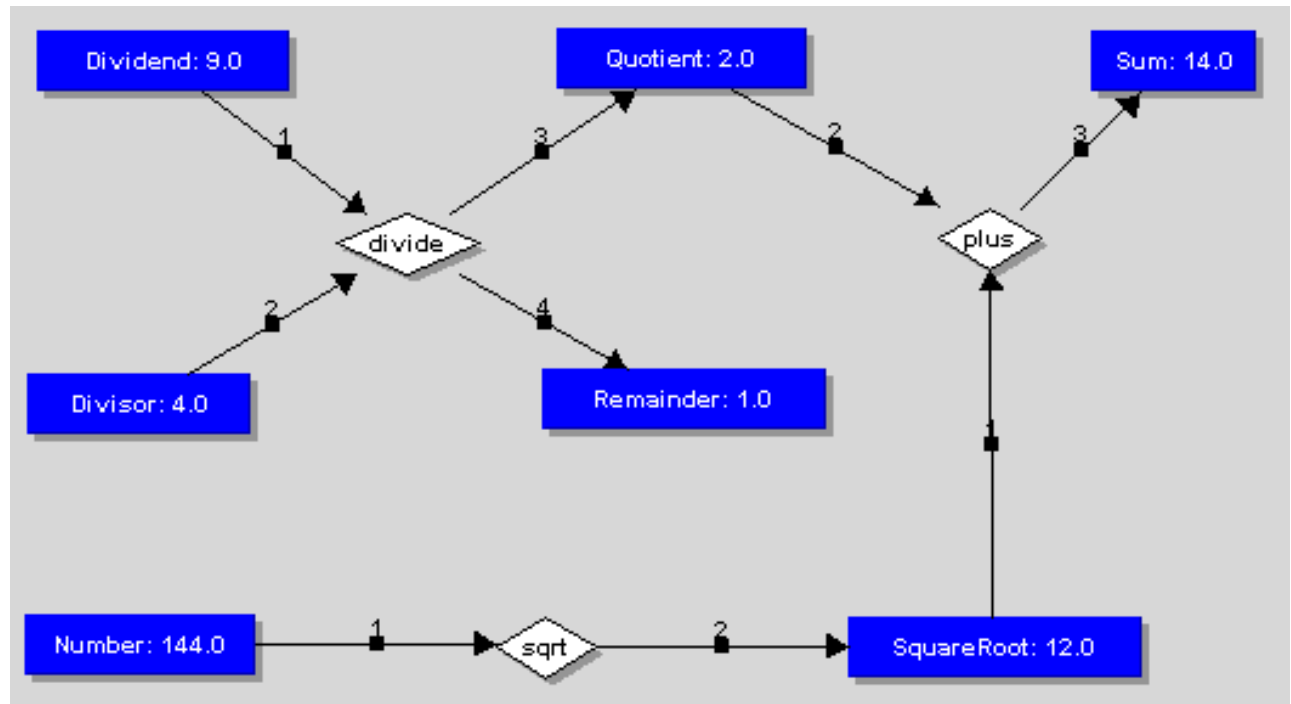
- **CGIF generated by Delugach's CharGer:**

```
[Remainder:*a'*e';CGHSD2.3b&Concept|243|232,190,117,25|&]  
[Divisor:*b'*b';CGHSD2.3b&Concept|240|20,192,92,25|&]  
[Dividend:*c'*a';CGHSD2.3b&Concept|238|24,51,104,25|&]  
[Number:*d'*c';CGHSD2.3b&Concept|234|19,291,95,25|&]  
[Sum:*e'*g';CGHSD2.3b&Concept|231|458,51,68,25|&]  
[Quotient:*f'*d';CGHSD2.3b&Concept|229|238,50,103,25|&]  
[SquareRoot:*g'*f';CGHSD2.3b&Concept|227|358,292,121,25|&]  
<divide?c?b|?f?a;CGHSD2.3b&Actor|237|147,126,59,25|&>  
<sqrt?d|?g;CGHSD2.3b&Actor|233|213,292,41,25|&>  
<plus?g?f|?e;CGHSD2.3b&Actor|226|395,124,42,25|&>/*CGHSD2.3b&G  
raph|225|0,0,40,25|&*/
```



Actors

```
r = file (dir + "Figure1.CGF");  
actor Figure1(a,b,c) is r.readGraph();  
g = Figure1(9,4,144);  
out_path = dir + "Figure1Out.cgf";  
w = file (">" + out_path);  
w.writeln(g);
```



Results

- The development of *anonymous recursive actors* in pCG, obviating the need for an actor type definition in the special case of a recursive actor, e.g. in preconditions:

```
function multiply(a,b,result)
  first = a.designator;
  second = b.designator;
  result.designator = first * second;
end
```

```
pre
```

```
...
```

```
`[Integer:*a'*fValue'] [Variable:*b'#f']
 [Integer:*c'*iValue'] [Variable:*d'#i']
 [Integer:*e'*product']
```

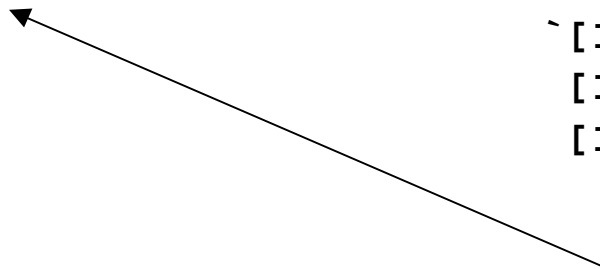
```
(val?b?a)
```

```
(val?d?c)
```

```
<multiply?a?c|?e>`;
```

```
...
```

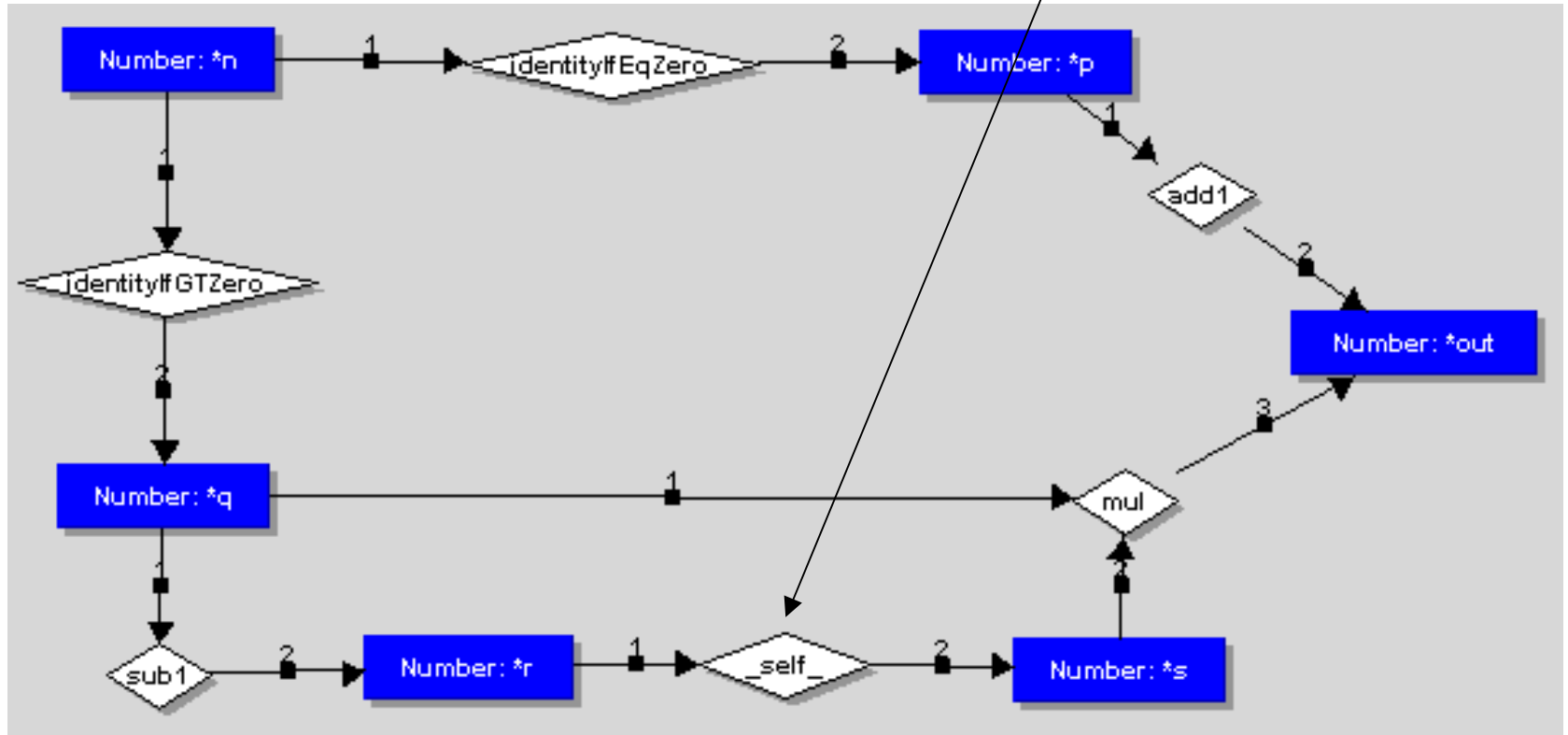
```
end
```



Results

An anonymous recursive actor:

`_self_` refers to this defining graph



```

r = file (dir + "Factorial.CGF");
actor Factorial(n) is r.readGraph();
    
```

← unnecessary



Some Future Directions

- Conjunction of preconditions in a rule should be treated as a goal. Internal backtracking required, e.g. for Sisyphus-I constraint re: room sharing and project members.
- Process constraints for real truth maintenance.
- Conformity relation should be implemented.
- Process algorithm needs to be reconciled with the CG Rules of Inference (Sowa, 1999); incorporate into pCG.
- Aspects of process algorithm bear re-examination, e.g. stopping criteria, graph morphology, π efficiency.
- Environment: IDE, Emacs mode.
- Expts/Apps: invoking a process within a process, temporal logic, business processes.
- Comparison against CLIPS, other CG mechanisms.



References

- **Delugach, H., Dynamic Assertion and Retraction of Conceptual Graphs, *Proceedings of the 6th Annual Workshop on Conceptual Graphs*, Eileen C. Way, editor, SUNY Binghamton, New York, pp. 15-26, July 1991.**
- **Linster, M., Documentation for the Sisyphus-I Room Allocation Task, [Accessed Online: November 2000], URL: <http://ksi.cpsc.ucalgary.ca/KA W/Sisyphus/Sisyphus1/>**
- **Mineau, G., From Actors to Processes: The Representation of Dynamic Knowledge Using Conceptual Graphs. In *Proceedings of the 6th International Conference on Conceptual Structures*, Montpellier, France, pp. 65–79, August 1998.**
- **Sowa, J.F., *Conceptual Structures: Information Processing in Mind and Machine*, Addison-Wesley, 1984.**
- **Sowa, J.F. et al, Conceptual Graph Standard, draft proposed American National Standard (dpANS) NCITS.T2/98-003, 1999. [Accessed Online: November 1999], URL: <http://www.bestweb.net/~sowa/cg/cgdpansw.htm>**

