COMPSCI 366 S1 C 2006
Foundations of Artificial Intelligence

—Qualitative Reasoning—

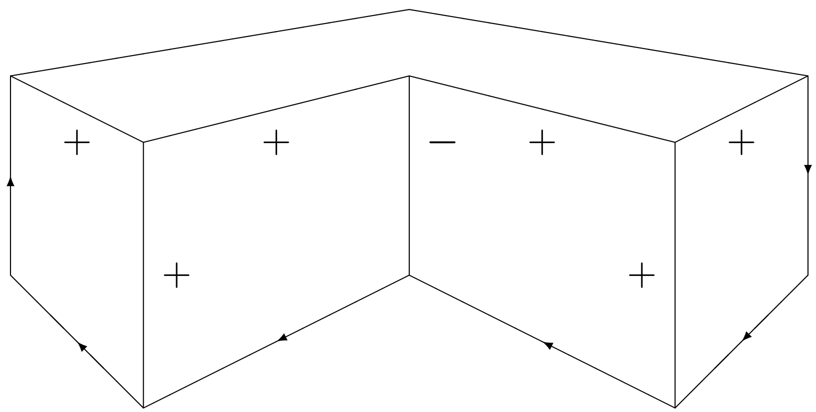
Hans W. Guesgen
Computer Science Department

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

Limitations of Other Formalisms

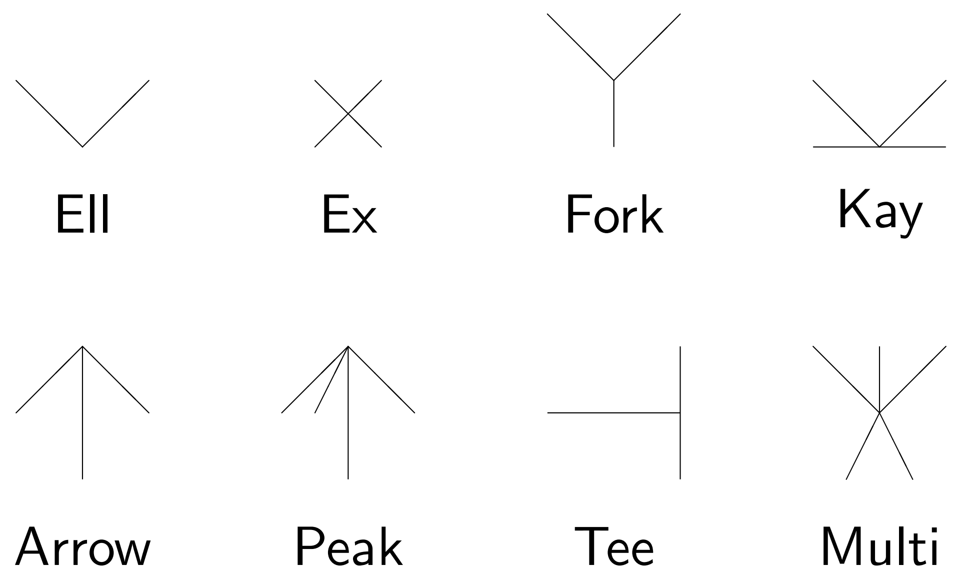
- In some areas it is difficult to solve problems using general theories or rules.
- Therefore, alternative techniques are necessary, which often involve qualitative reasoning.

Line Labeling

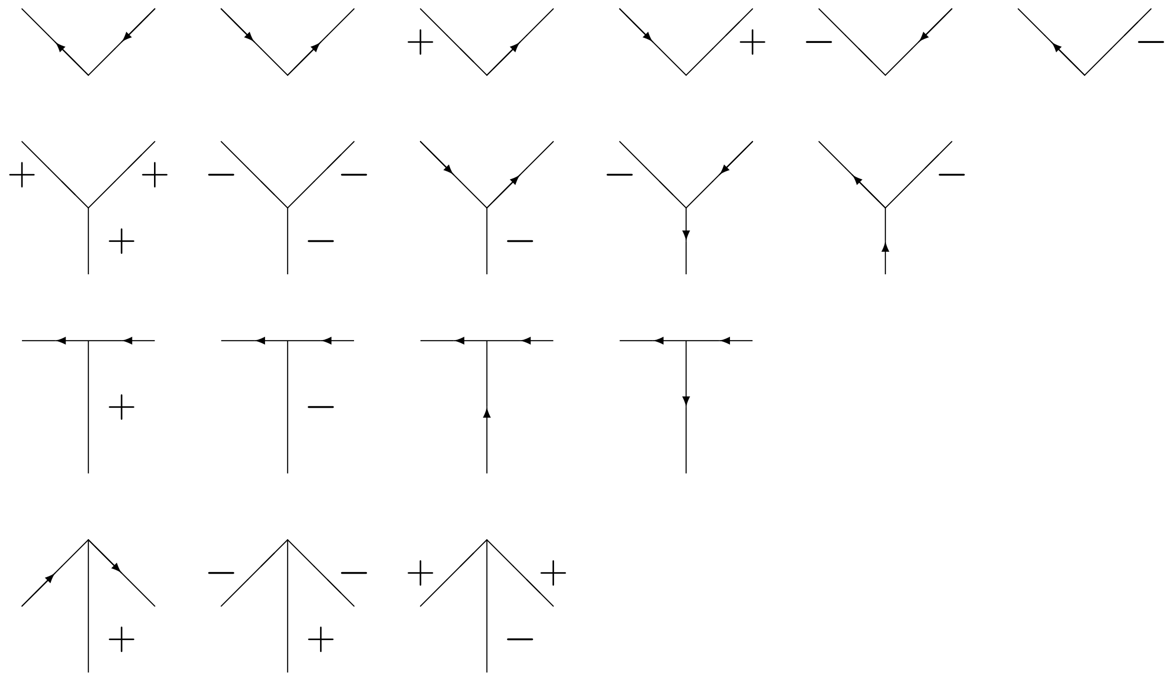


Boundary line:	$>$
Concave interior line:	$-$
Convex interior line:	$+$

Possible Junctions



Labeled Junctions



The Waltz Algorithm

1. Put all junctions that occur in the drawing on to a stack.

2. While the stack is not empty do:

   (a) Let J be the top element of the stack.
   (b) Pop J from the stack.
   (c) If J is visited for the first time, initialize J with all labelings for this type of junction.
   (d) If J has been visited before, compare J's labelings with the labelings of each neighboring junction and delete those of J's labelings that are not consistent with at least one neighboring labeling.
   (e) If J's labelings have been changed in step 2c or 2d, push the neighboring junctions of J on to the stack (unless already there).

Naive Physics

- Based on the intuition about physical phenomena.
- May readily produce the qualitative answers needed in a situation.
- Can directly operate on qualitative input, which would make detailed numeric calculations pointless.
- Is computationally less expensive than quantitative reasoning.

Example: Temperature on a Qualitative Scale

F: frozen ($x < 0\,°\mathrm{C}$)
f: freezing ($x = 0\,°\mathrm{C}$)
C: chilled ($0\,°\mathrm{C} < x < R$)
R: room temperature ($18\,°\mathrm{C} < x < 25\,°\mathrm{C}$)
W: warm ($R < x < H$)
H: hot ($40\,°\mathrm{C} < x < 100\,°\mathrm{C}$)
B: boiling ($x = 100\,°\mathrm{C}$)

Qualitative Temperature Control

	Put in freezer	*Put in fridge*	*Leave out*	*Heat on stove*
F	F	f → C	f → C → R	f → C → R → W → H → B
f	F	C	C → R	C → R → W → H → B
C	f → F	C	R	R → W → H → B
R	C → f → F	C	R	W → H → B
W	R → C → f → F	R → C	R	H → B
H	W → R → C → f → F	W → R → C	W → R	B
B	H → W → R → C → f → F	H → W → R → C	H → W → R	B

Qualitative Addition

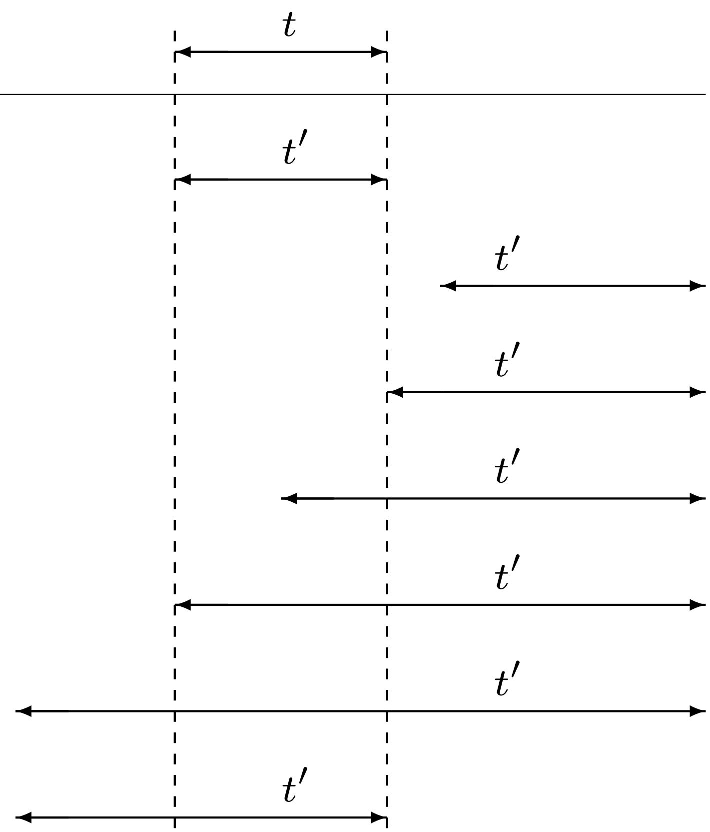
$+$	*empty*	*partly full*	*full*
empty	empty	partly full	full
partly full	partly full	partly full, full, or full^{+}	full^{+}
full	full	full^{+}	full^{+}

Temporal Reasoning

- Time is most commonly conceptualized as a numeric attribute of events.
- Humans reason about time even when precise numeric representations of time are not available.
- This is often accomplished by using the ordering information associated with events and time intervals.

Relations between Time Intervals

Relation	Short	Inverse
Equal(t, t')	$=$	
Before(t, t')	$<$	$>$
Meets(t, t')	m	mi
Overlaps(t, t')	o	oi
Starts(t, t')	s	si
During(t, t')	d	di
Finishes(t, t')	f	fi



Allen's Composition Table (incomplete)

Relation between t_1 and t_2 ↓	Relation between t_2 and t_3				
	<	>	m	mi	...
<	<	?	<	<, m, o, s, d	...
>	?	>	>, mi, oi, d, f	>	...
m	<	>, mi, oi, si, di	<	=, f, fi	...
mi	<, m, o, di, fi	>	=, s, si	>	...
⋮	⋮	⋮	⋮	⋮	