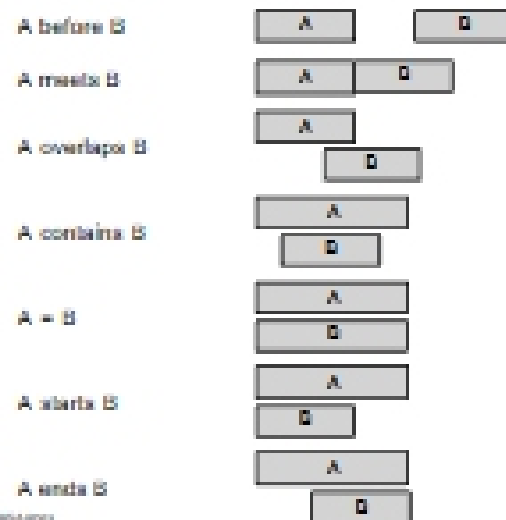


Representing Timing: Qualitative Temporal Relations [Allen AAAI83]



Source: slides by David Borra, AAAI 2009

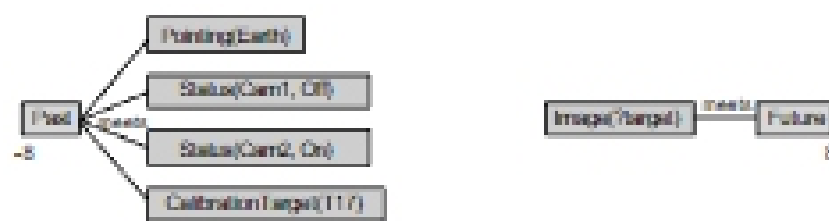
TakelImage Pictorially

TakelImage(?target, ?instr)
 contained-by Status(?instr, Calibrated)
 contained-by Pointing(?target)
 meets Image(?target)



Source: slides by David Borra, AAAI 2009

A Temporal Planning Problem



Source: slides by David Borra, AAAI 2009

A Consistent Complete Temporal Plan



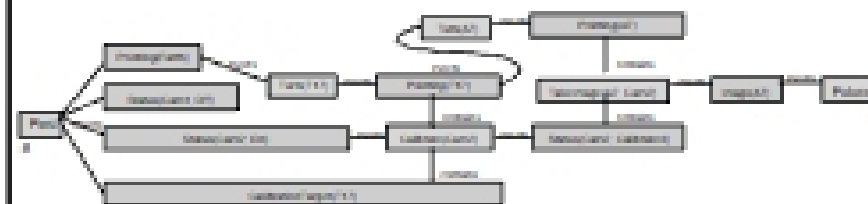
Source: slides by David Borra, AAAI 2009

CBI Planning Algorithm

Choose:
 introduce an action & instantiate constraints
 coalesce propositions
 Propagate temporal constraints

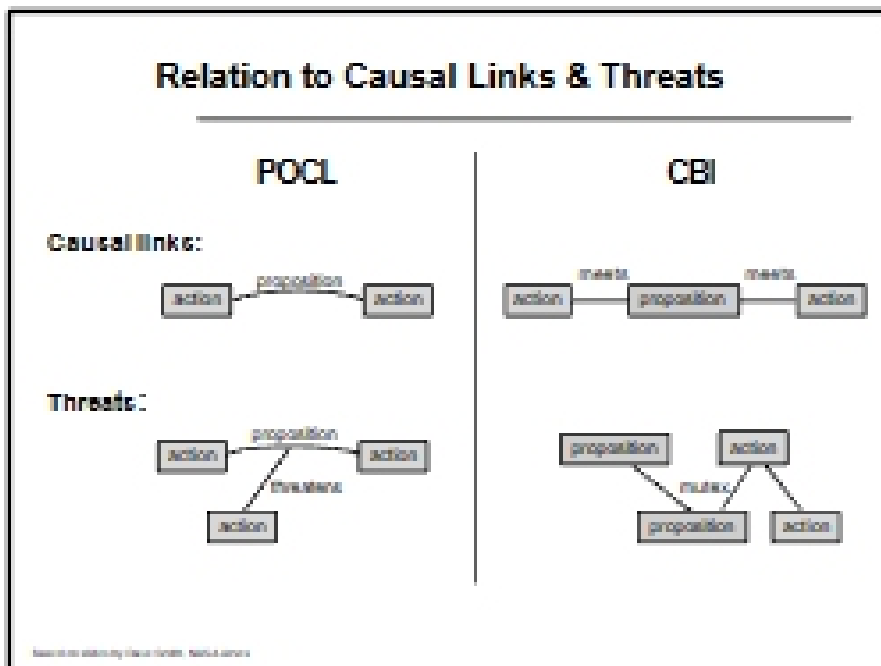
Source: slides by David Borra, AAAI 2009

A Consistent Complete Temporal Plan



Planner Must:

- Check schedulability of candidate plans for correctness.
- Schedule the activities of a complete plan in order to execute.



Examples of CBI Planners

Zeno (Penberthy)	intervals, no CSP
Trains (Allen)	
Descartes (Joslin)	extreme least commitment
ixTeT (Ghallab)	functional rep.
HSTS (Muscettola)	functional rep., activities
EUROPA (Jonsson)	functional rep., activities
Kirk (Williams)	HTN

Source: adapted by Hans Geffner, AAAI-99/00

- ### Outline
- Review: Constraint-based Interval Planning
 - Simple Temporal Networks
 - Temporal Consistency and Scheduling
 - Execution Under Uncertainty
- Source: adapted by Hans Geffner, AAAI-99/00

Qualitative Temporal Constraints Maybe Expressed as Inequalities

(Villem, Kautz 88)

• x before y	$X^* < Y$
• x meets y	$X^* = Y$
• x overlaps y	$(Y < X^*) \& (X < Y^*)$
• x during y	$(Y < X) \& (X^* < Y^*)$
• x starts y	$(X = Y) \& (X^* < Y^*)$
• x finishes y	$(X < Y) \& (X^* = Y^*)$
• x equals y	$(X = Y) \& (X^* = Y^*)$

Inequalities may be expressed as binary interval relations:
 $Y - x < [0, +inf]$

Generalize to include metric constraints:
 $Y - x < [lb, ub]$

Source: adapted by Hans Geffner, AAAI-99/00

Metric Time: Temporal CSPs (Dechter, Meiri, Pearl 91)

"Bread should be eaten within a day of baking."
 $? 0 \leq (T(\text{baking}) - T(\text{eating})) \leq 1 \text{ day}$

$\langle X, T_i, T_{ij} \rangle$

- X_i continuous variables
- T_i, T_{ij} interval constraints
 $\{I_1, \dots, I_n\}$ where $I_i = [a, b]$

- $T_i = (a_i \leq X_i \leq b_i)$ or ... or $(a_i \leq X_i \leq b_i)$
- $T_{ij} = (a_{ij} \leq X_i - X_j \leq b_{ij})$ or ... or $(a_{ij} \leq X_i - X_j \leq b_{ij})$

Source: adapted by Hans Geffner, AAAI-99/00

