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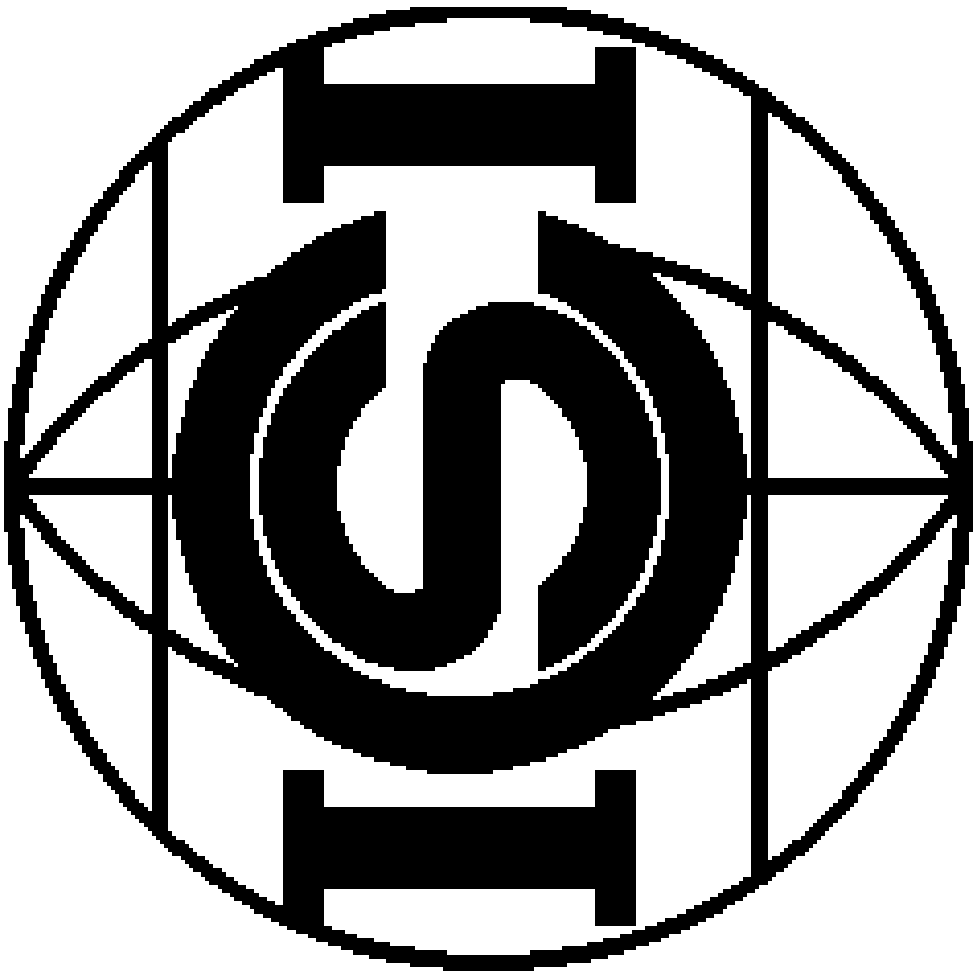
http://www.icsi.berkeley.edu/NTL/

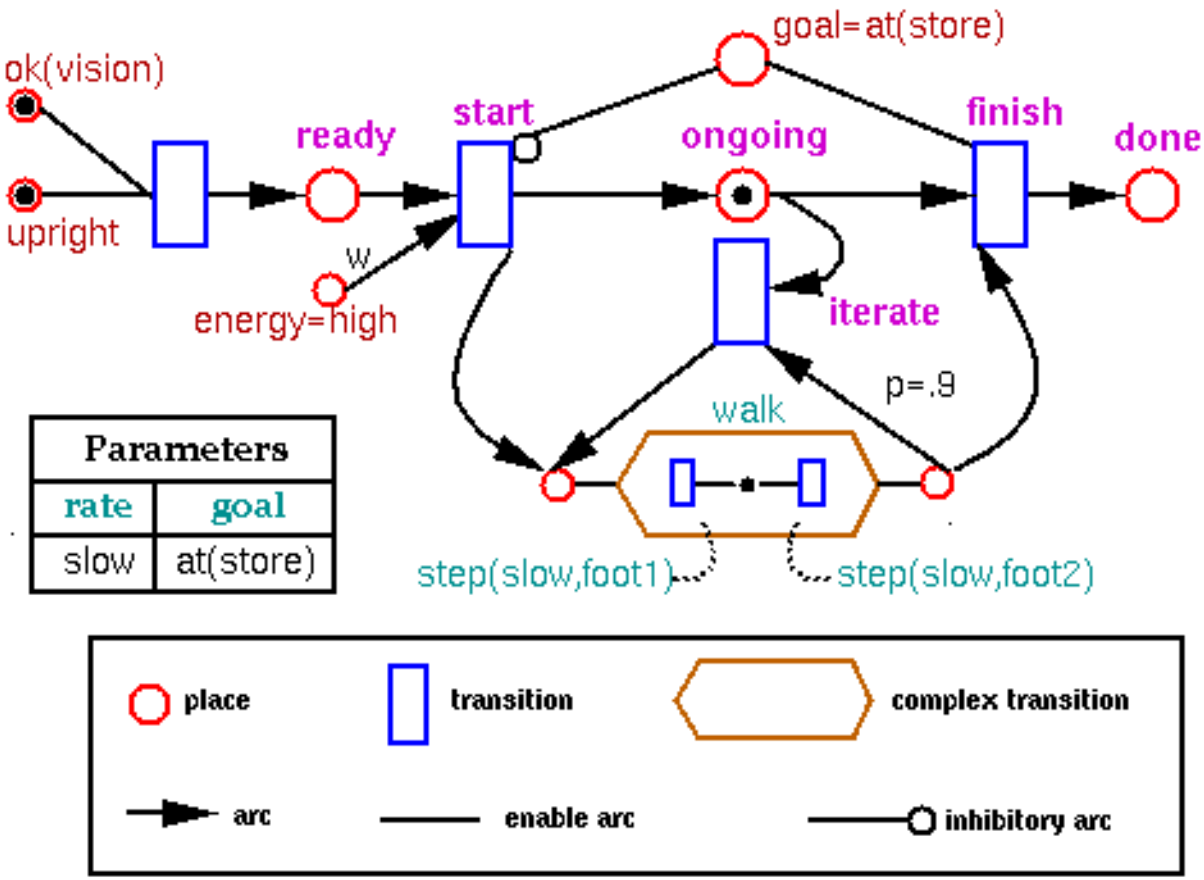
Aspectual Composition

A Dynamic Model of


THE UNIVERSITY OF CALIFORNIA
A
LET THERE BE
LIGHT
1868



X-schema example: WALK (to store)



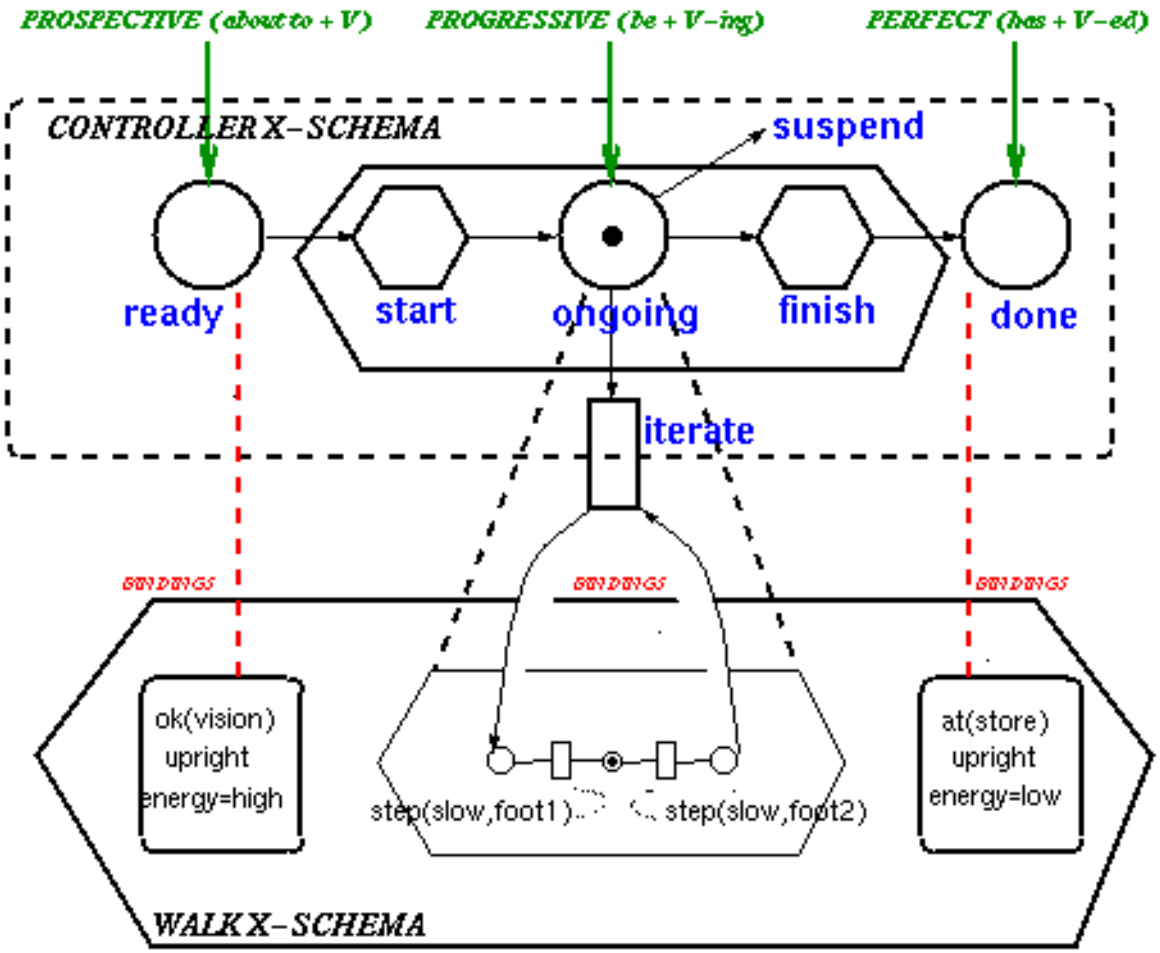
EXECUTING SCHEMAS (X-SCHEMAS)

- Actions are coded computationally using active representations called x-schemas, extensions to Petri nets.
  - fine-grained action and event representations that can be used to monitor and control the execution of the motor action
  - action/reaction tightly coupled; context-sensitive; real-time
  - dynamic framework can capture changing goals and resources in a complex and uncertain environment
  - support event simulation (needed for inference)

- Extended Petri nets: graph token-passing formalism
  - weighted bipartite graph of places and transitions
  - state of net captured in its marking (token distribution)
  - evolution of net specified by firing rules (enabled transitions move tokens from input to output places)
  - sequence, concurrency, event-based control, distributed system
  - extensions: typed arcs, hierarchy, parameters, stochasticity

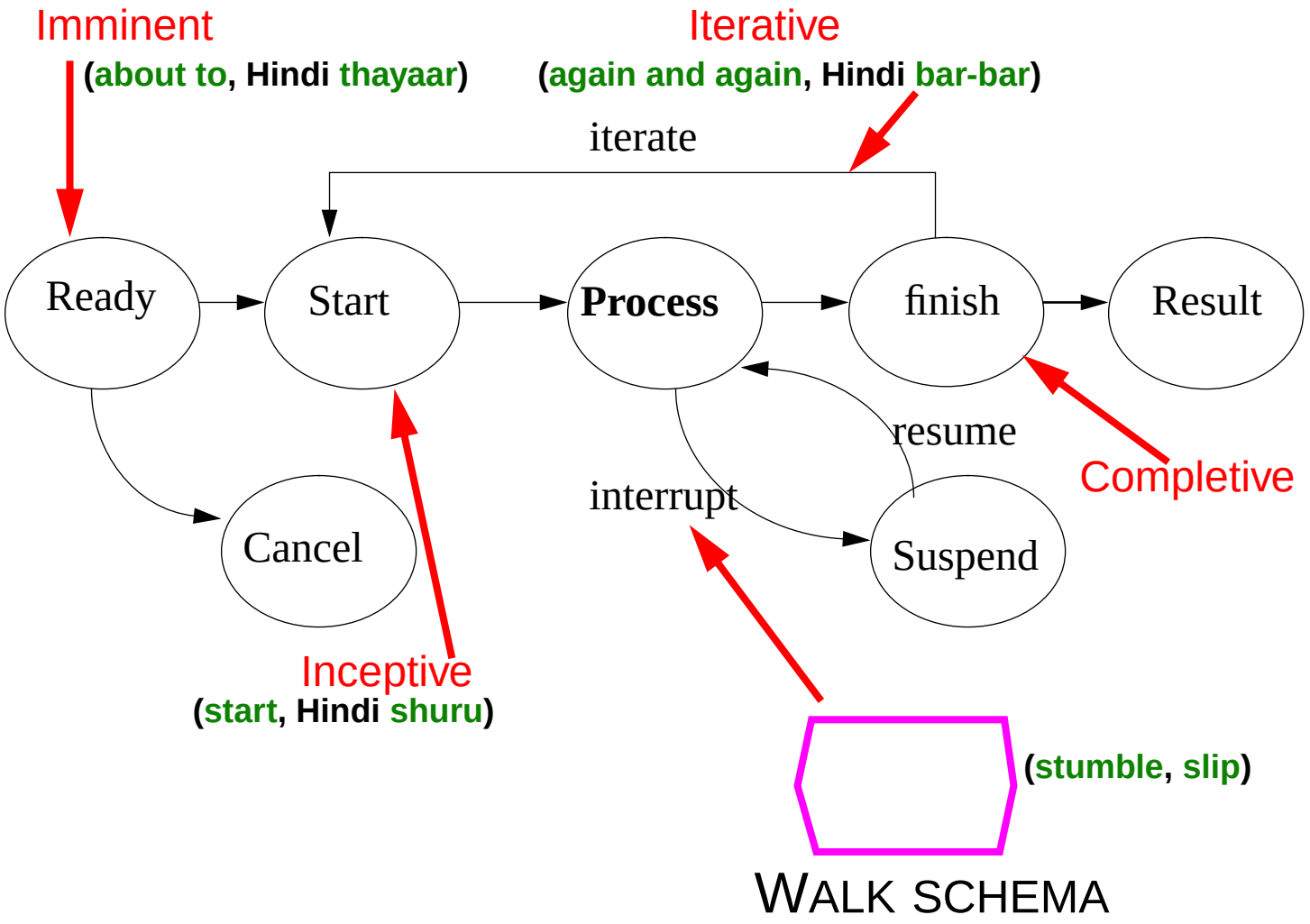
Binding between controller and x-schema

Linguistic devices (e.g. progressive marking) can mark controller x-schema, which in turn is bound to the underlying action x-schema.



Lexicalized aspect

Some lexical items directly encode parts of the controller (possibly in the context of a particular schema, e.g. *stumble* and the WALK schema).Inference



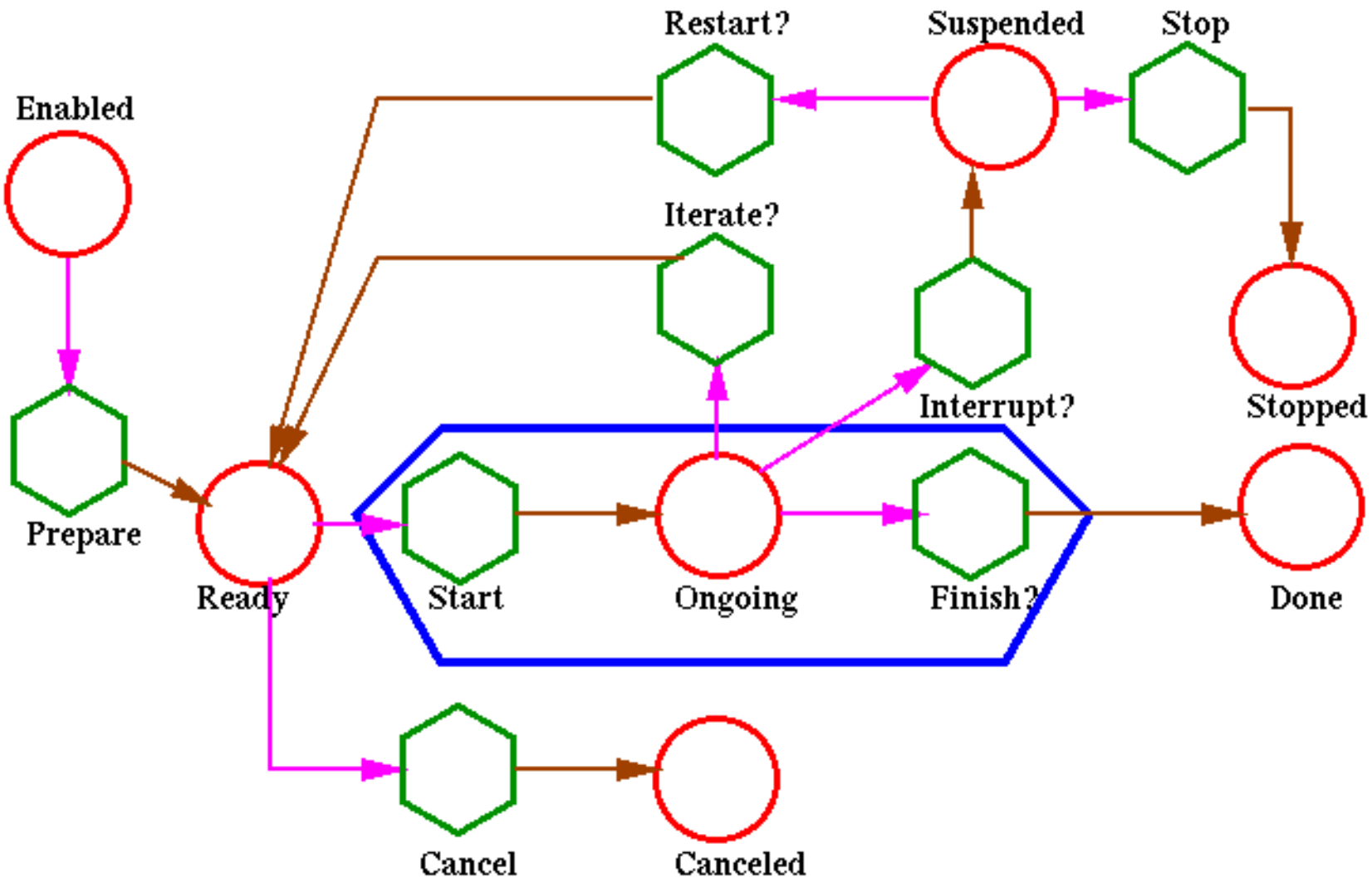
SUMMARY

Result: The semantics of aspect and aspectual composition arises from the dynamic binding between verb-specific x-schemas and a controller x-schema that captures regularities in the evolution of complex events.

Different requirements of these x-schemas and of the linguistic markers together determine how an expression is interpreted.

A computational framework for the simulation of x-schemas interaction plays a crucial role in accounting for patterns of aspectual inference.

(See http://www.icsi.berkeley.edu/NTL for more information about the computational model.)



The controller schema mediates between linguistic elements and active representations of individual events (denoted by particular verbs).

PROPOSED SOLUTION

We present a dynamic model of aspectual composition in which features needed for planning and controlling actions also motivate and ground simple analyses of linguistic phenomena.

- We use active representations (executing schemas, or x-schemas) inspired by biological control theory.
- Linguistic elements provide information required for the initiation and control of the underlying x-schemas.

Some aspectual phenomena

- Temporal modifiers have different effects

She loved him for five years.	*[period of loving]*
She ran for five minutes.	*[period of running]*
She sneezed for a few minutes.	*[period of repeated sneezing]*
She read the book for an hour.	*[period of reading, book unfinished]*
She read the book in an hour.l	*[period of reading, book finished]*
She left for an hour.	*[period after having left, before returning]*
She left in an hour.	*[period up to and including leaving]*
***She won the race for a few minutes.**	*[neither period can easily be modified]*
She won the race in a few minutes.	*[period up to and including winning]*

- Combination with subjects: animacy (% = habitual reading)

%**She runs** from here to there. *[habitual]*	**The road runs** from here to there.
She is running from here to there.	***The road is running** from here to there.

- Combination with objects: goals (# = iterative reading)

She ran for an hour.	*She ran in an hour.
#She ran a mile for an hour.	She ran a mile in an hour.
#She ran to the park for an hour.	She ran to the park in an hour.

THE PROBLEM: ASPECTUAL COMPOSITION

All languages have devices for conveying aspectual information about the structure of the event or situation depicted, e.g.:

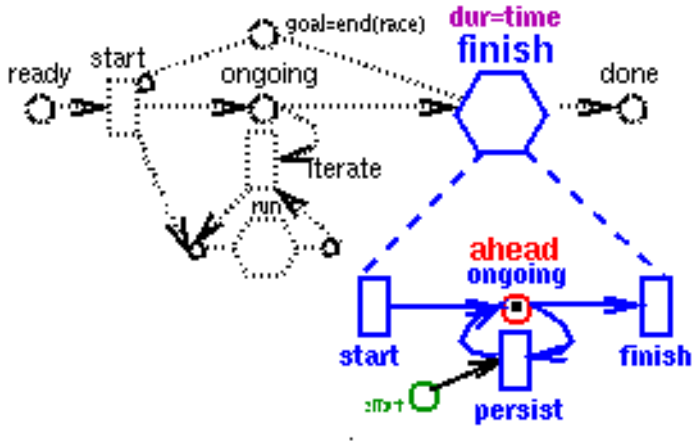
- whether the event is in progress or completed (*going* vs. *gone*)
- whether it is a punctual event or involves iteration (*sneeze* vs. *sneezing*)
- whether it is telic (goal-oriented) (e.g. *walk to the park*
- whether it consumes resources (*eat sandwiches* vs. *be tall*)

Verbs and the situations they denote have an inherent or default aspectual structure. But both simple acceptability and fuller contextual interpretation are determined by the interaction of a wide range of factors, including:

- inherent characteristics of the event
- grammatical markers (e.g. *-ing*, Mandarin *le*, Tamil *ind*)
- specific lexical phrases (*start*, *be in process of*, *again and again*)
- tense

Complex example: *win (the race)*

- Some events take place in context of larger event.



Marc won the race in 5.3 minutes. (entire race)
?Marc won the race for a few minutes.
Marc was winning the race for the {last/?first} few minutes.
(Progressive marking makes subschema accessible for durative modification.)

- Meaning of win is even more complicated: simulation?
- Interpretation of complex events very context-sensitive.

?Susan reached the peak for a few minutes.
Susan reached the peak of fitness for a few years.

Nominals: more special cases

- X-schema characteristics can determine presence of goal: cart is a secondary trajector (not a goal)

He pushed the cart for an hour.	?He washed the cart for an hour.
?He pushed the cart in an hour.	He washed the cart in an hour.

- Verbs of creation: count noun (and goal) book exists only when finish transition marked; *for* implies finish unmarked (and goal not achieved)

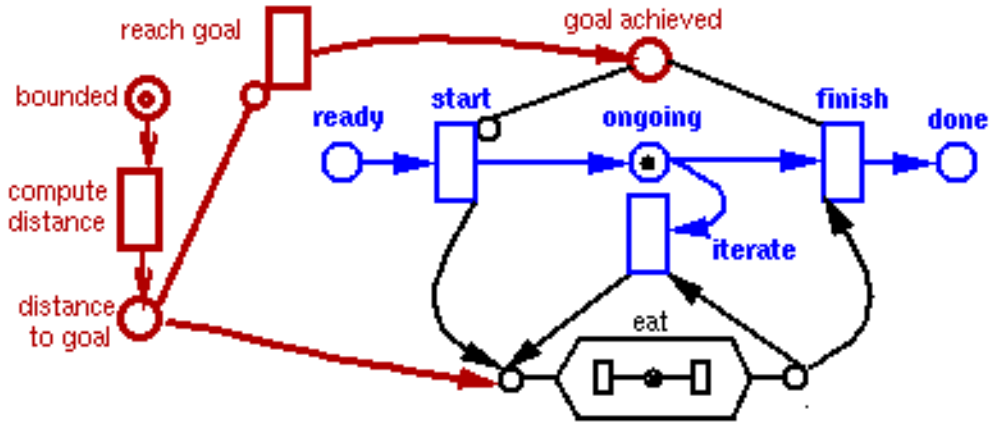
I read the book for an hour.	*[book unfinished]*
I wrote poetry for an hour.	*[mass of poetry created]*
?I wrote the book for an hour.	*[book finished or not?]*

- Dative construction: again, *for* implies cake unfinished, but construction requires it is created (and transferred)

I baked the cake for an hour.	*[atelic, cake unfinished]*
*I baked you the cake for an hour.	*[cake finished (and given) or not?]*

Patients and goal consumption

- **Patients** and **goals** can provide a resource to consume and thus determine whether a telic reading is possible.



- Presence of a goal depends on boundedness of resource:.

Bounded (count / quantified mass / specified mass) nouns do furnish goal;

Bart ate {a sandwich / a pound of cheese / the cheese} in an hour.

Unbounded (bare plural / mass) nouns do not furnish goal.

Bart ate {sandwiches / cheese} for an hour.

INTERACTION WITH NOMINAL FEATURES

- Nominals may provide goals (e.g. goal of motion) or merely location/background (depending on the preposition).

  John walked to the park.

  John walked in the park.

- **Agents** provide intentional resources (effort, animacy, etc.)

  The road runs to the store.

  *The road is running to the store.

  Mary runs to the store (every day).

  Mary is running to the store.

  Present tense can produces habitual reading (a variant of iteration).

- Multiple agents and patients can enable iterate:

  Kids run to the store every day.

  Kids were running to the store all day.

  Harry hits balls every day.

  Harry was hitting balls all day.

She read for an hour.
*She read in an hour.

She read the book for an hour.
She read the book in an hour.

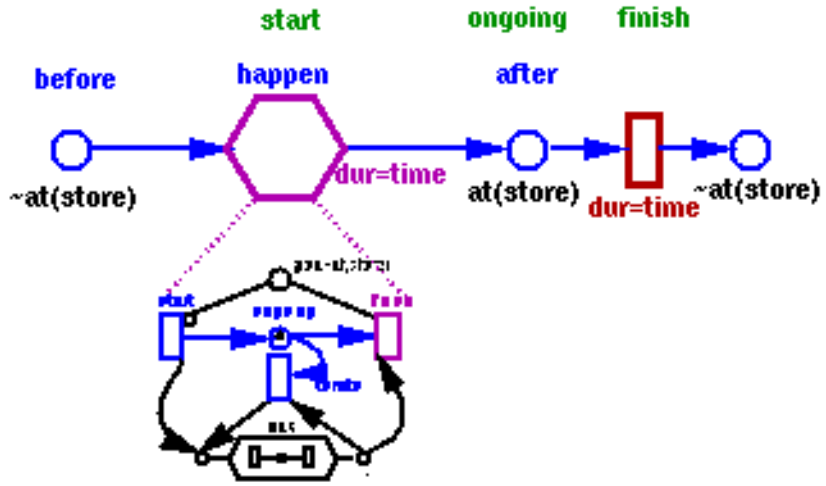
She walked for an hour.
*She walked in an hour.

She walked to the store for an hour.
She walked to the store in an hour.

Temporal modifiers and transitions

- Transitions need a time interval to be modified

  ***for* attaches to the resulting state (especially with reversible change-of-location transitions like *leave* and *go*); *in* reading depends on tense.**



Note: internal structure of complex event (e.g. availability of goal) also influences interpretation.

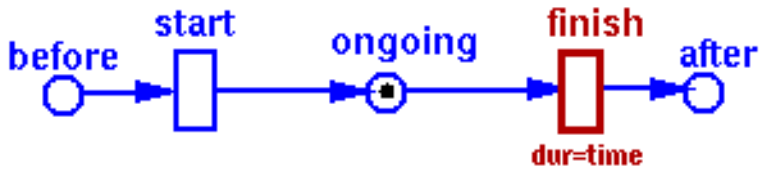
John went to the store in an hour.
Jill left in an hour.

John went to the store for an hour.
Jill left for an hour.

DURATION: TEMPORAL MODIFIERS

- Both *for* and *in* specify event durations, but *in* also implies goal achievement (finish marked)

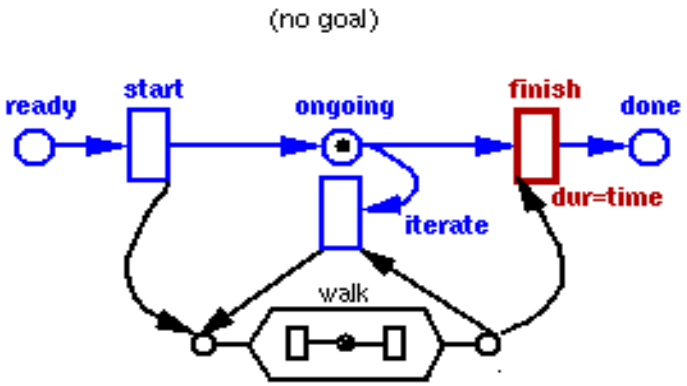
States: can't combine easily with present tense; *for* implies state has finished; *in* may force a marked reading with goal (inception)

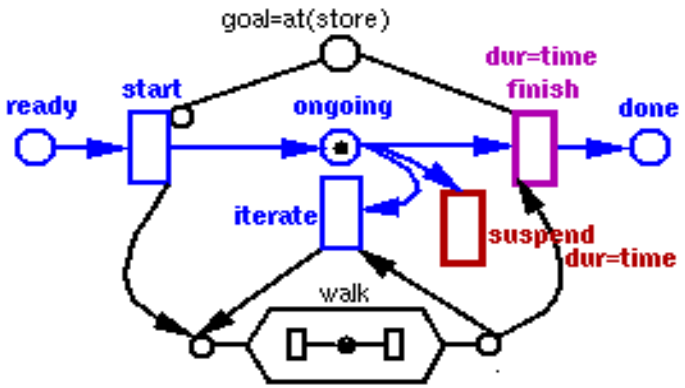


I lived in Texas for a week.

*I lived in Texas in a week.

Processes: *for* implies goal unachieved; *in* implies goal achieved (so odd when no goal is present or inferrable)





This explains inference patterns like the following:

I am living in Texas. / The lamp is standing by the door. (temporary)

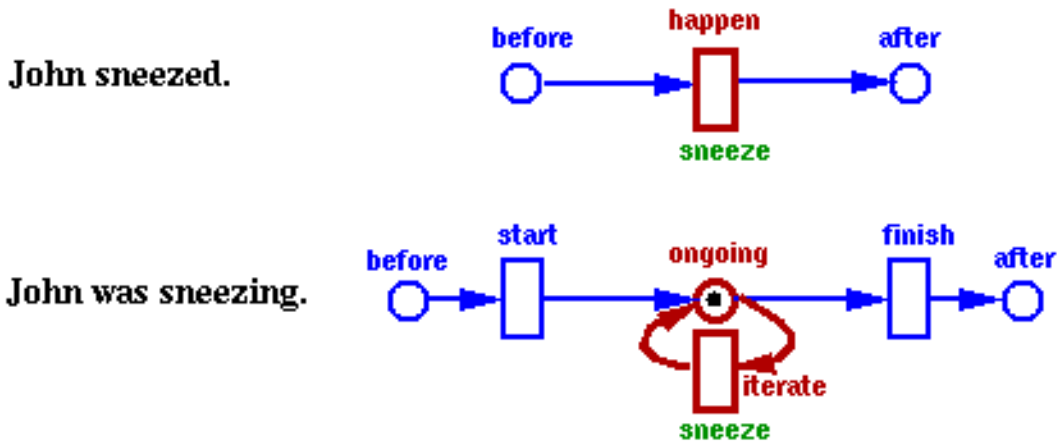
Bill's being silly. (temporary/effortful)

*The moat is surrounding the castle. (neither)
*The road is running to the store. / *Paul's being tall.

Transitions

- Some events (e.g. sneezing) lack structure and duration; correspond to simple x-schema transitions.
- Interaction with controller can affect interpretation

Marking of ongoing produces iterative construal:



BASIC ASPECTUAL TYPES

States

- Static situations correspond to x-schema places

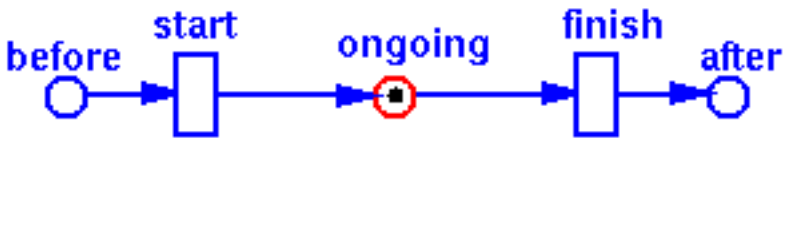
  Prototypical states have minimal internal structure, no change over time and no expenditure of energy:

  I live in Texas. / Bill is silly. / Paul is tall. /

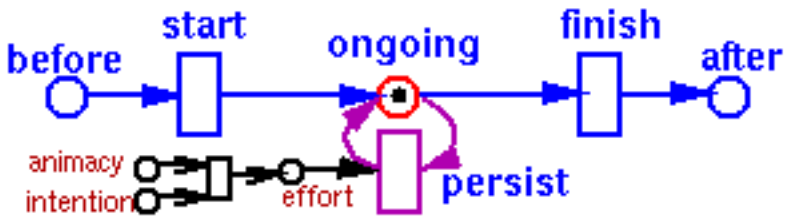
  The lamp stands by the doorway. / The moat surrounds the castle.

- In controller context, states can also be seen as:

  temporary situations that start and finish, or
  effortful processes that require some resource to persist (iterate).

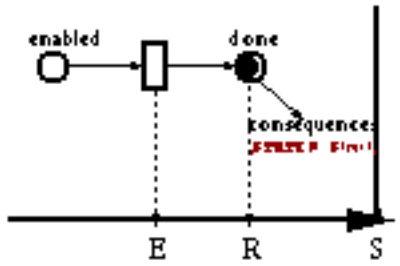


a) temporary reading

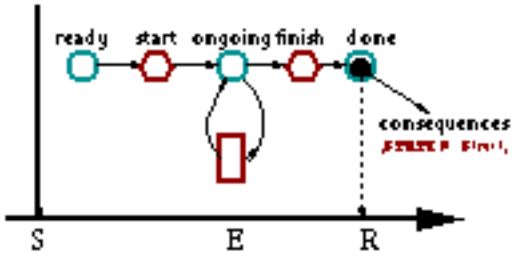


b) effortful reading

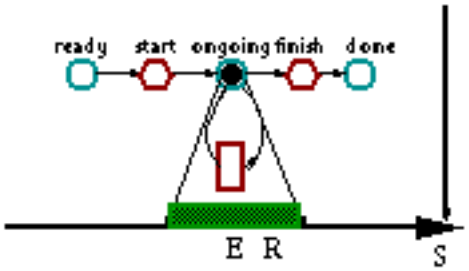
Examples of tense/aspect interaction



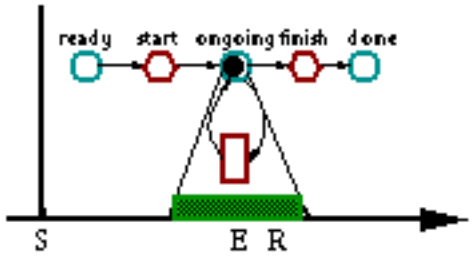
a) John had lost his keys



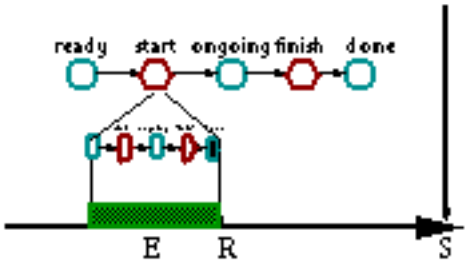
b) John will have walked to the store



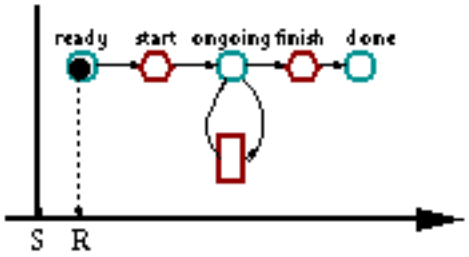
c) John waswalking to the store



d) John will be walking to the store



e) John had started eating



f) John will be ready to eat

INTERACTION WITH TENSE

- Reichenbach (1947) analyses tense in terms of relationship between speech time (S), event time (E) and reference time (R):

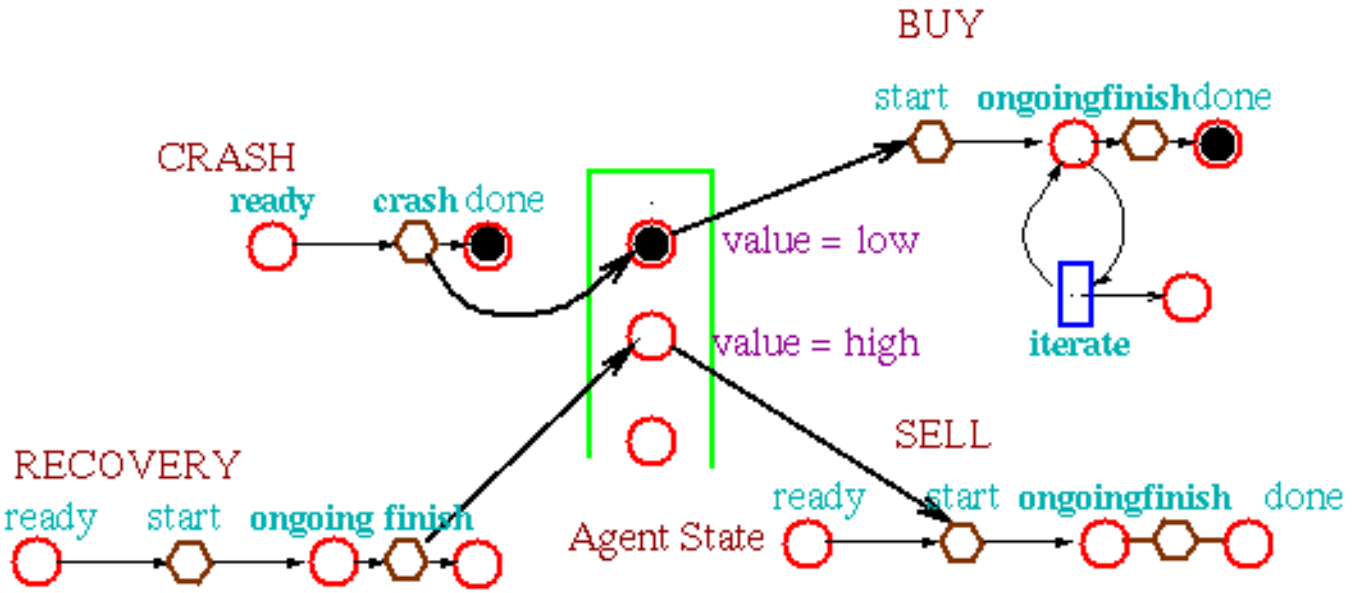
	(< denotes sequence)	
simple past	**E, R < S**	John lost his keys.
future	**S < E**	John will lose his keys.
past perfect	**E < R <S**	John had lost his keys.
future perfect	**S < E < R**	John will have lost his keys.

- Tense and aspect are integrated in our model by the projection of the controller onto the timeline.

S	**speech time**
E	**time (interval) when ongoing is marked**
R	**time of controller state in linguistic description**

- Tense still indicates relative positions of S/E/R, but controller provides additional constraints.

Simulation of *when* example



Links between individual event x-schemas and the agent state vector represent some world knowledge about contingency relations between stock values and buying/selling behavior.

This simulation provides an acceptable interpretation of *when* (where buying stocks at low value is contingent on the crash) in:

I bought stock when the market crashed.

DISAMBIGUATING WHEN

Interaction with world state: pragmatic information

- Temporal connectives or contingency relations?

  I bought stock when the market crashed.

  ? The market crashed when I bought stock.

  I was buying stock when the market crashed.

- when introduces a contingency relation without directly specifying which one
- World knowledge + simulation can provide means for disambiguation!

X-schemas for imaginative simulation

- Basic assumption: same representation for planning and simulative inference

  Evidence for common mechanisms for recognition and action (mirror neurons) in F5 area (Rizzolatti et al. 1996, Gallese 1996) and from motor imagery (Jeannerod 1996)

- Implementation: interactions between x-schemas

  X-schemas affect each other by enabling, disabling or modifying execution trajectories.Whenever the CONTROLLER schema makes a transition it may set, get or modify state leading to triggering or modification of other x-schemas.

  State is completely distributed (a graph marking) over network.

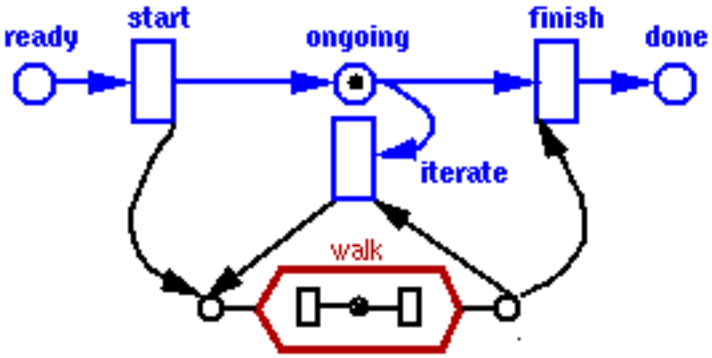
- Result:

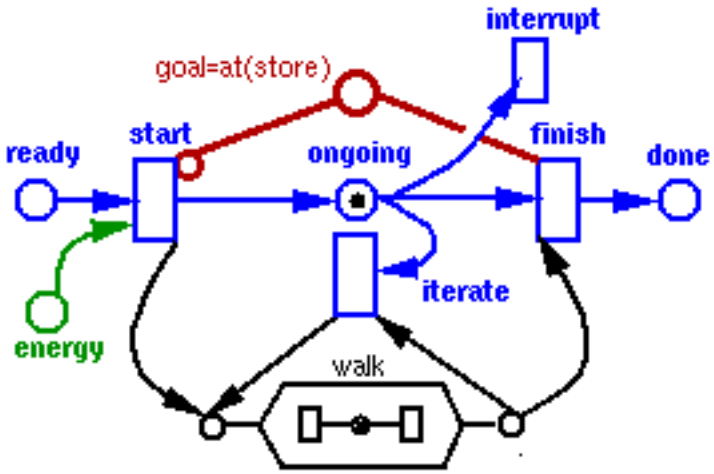
  INTERPRETATION IS IMAGINATIVE SIMULATION!

Inference and default reasoning

- Different bindings give rise to different interpretations.
  Dowty's "Imperfective Paradox"

(1) Harry was walking.	*entails*	Harry walked.
(2) Harry was walking to the store.	*does not entail*	Harry walked to the store.





But telic events like (2) still implicate that the the activity eventually completes, *unless*: lack of resources (energy runs out), interruption (meet a friend), voluntary suspension (goal no longer active)

- Controller specifies exact conditions under which implicated interpretation can be overridden.