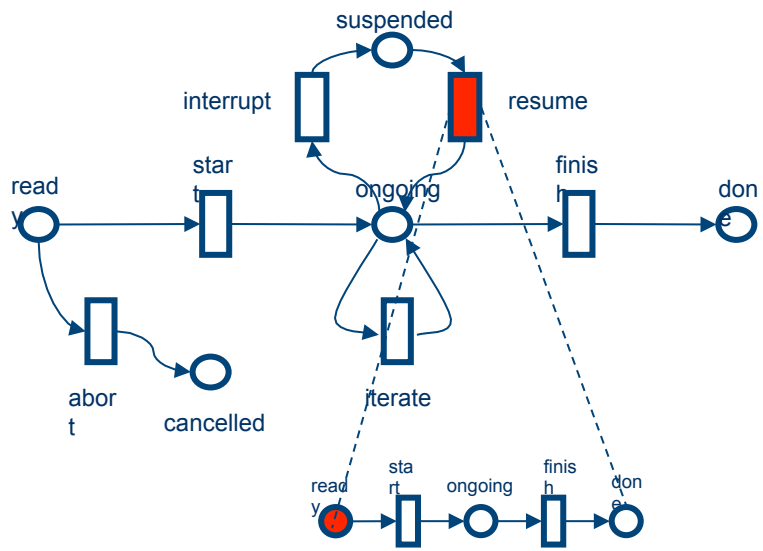
# Reframing aspectual composition

Nancy Chang
Sony Computer Science Laboratory Paris
(International Computer Science Institute, Berkeley)

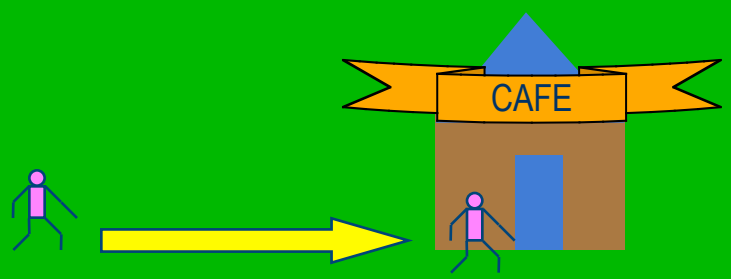
20 May 2010, Universitat Autònoma de Barcelona



# Temporal and event structure

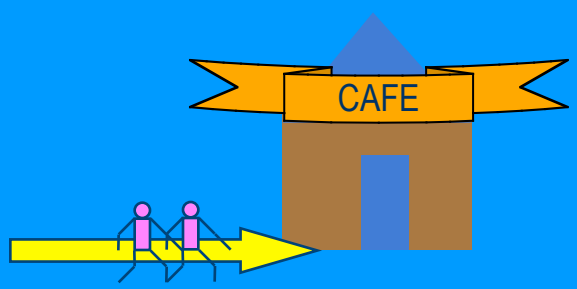
Different tense and aspect markings yield different scenes and inferences:

"Harry walked to the cafe."

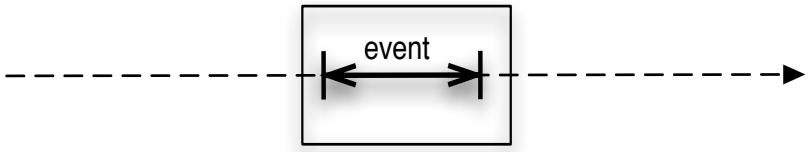


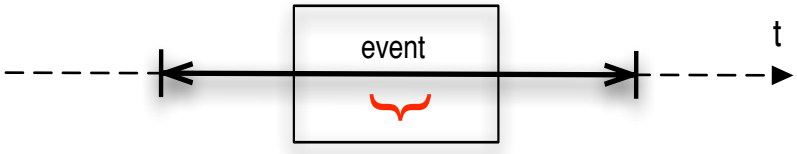

- action = before speech time
- goal reached
- profile = entire event

"Harry is walking to the cafe."

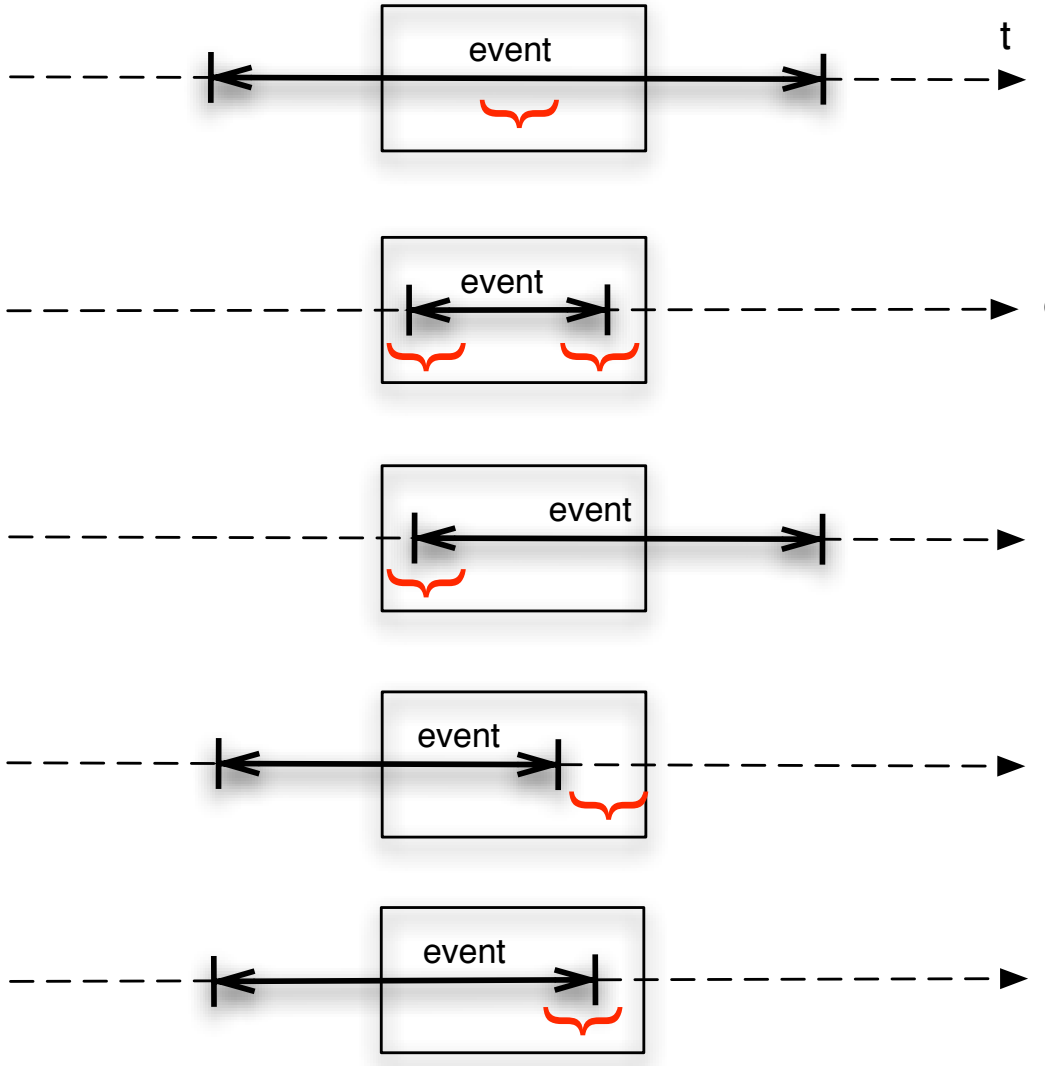



- action = **at** speech time
- goal **unreached**
- profile = **ongoing / in progress stage**

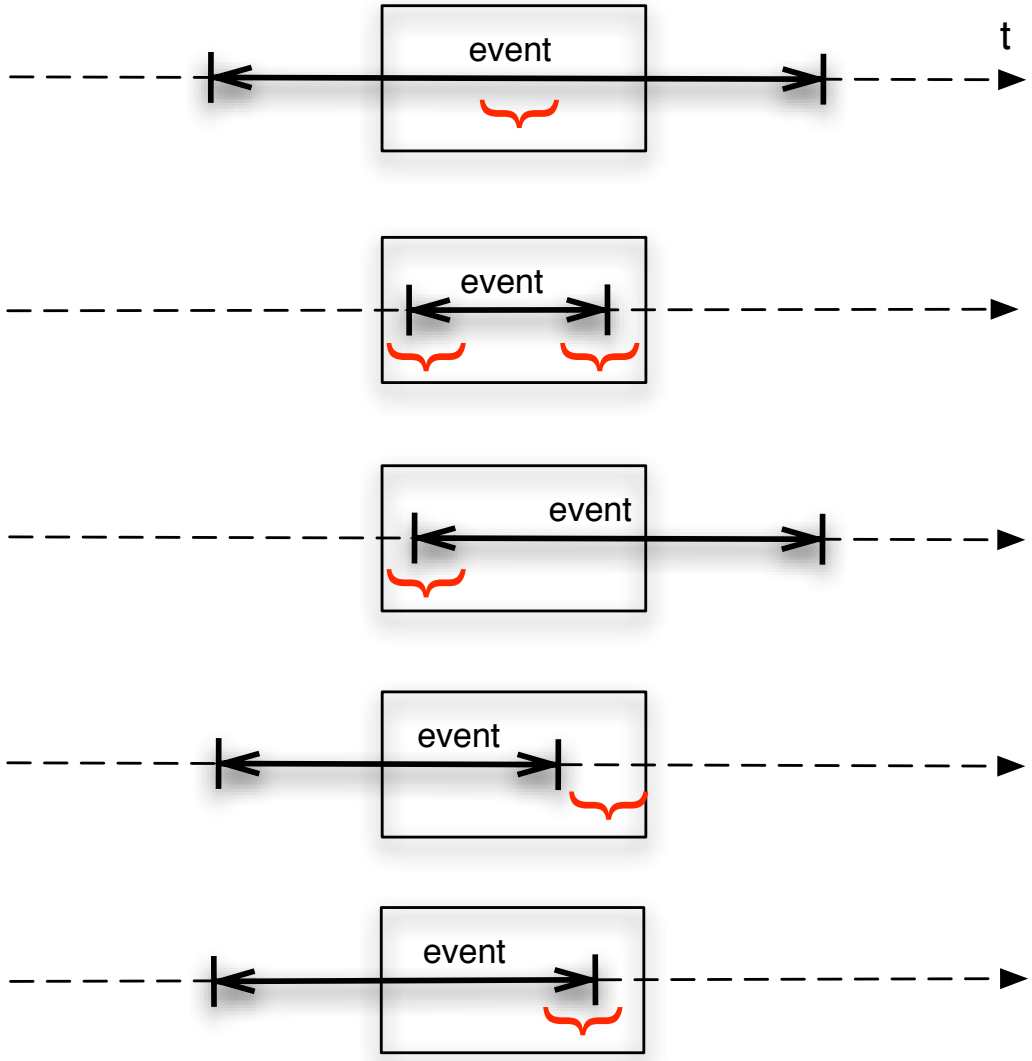


# Events on the timeline



# Phasal aspect in English




progressive — **be** V-**ing**
*is walking*

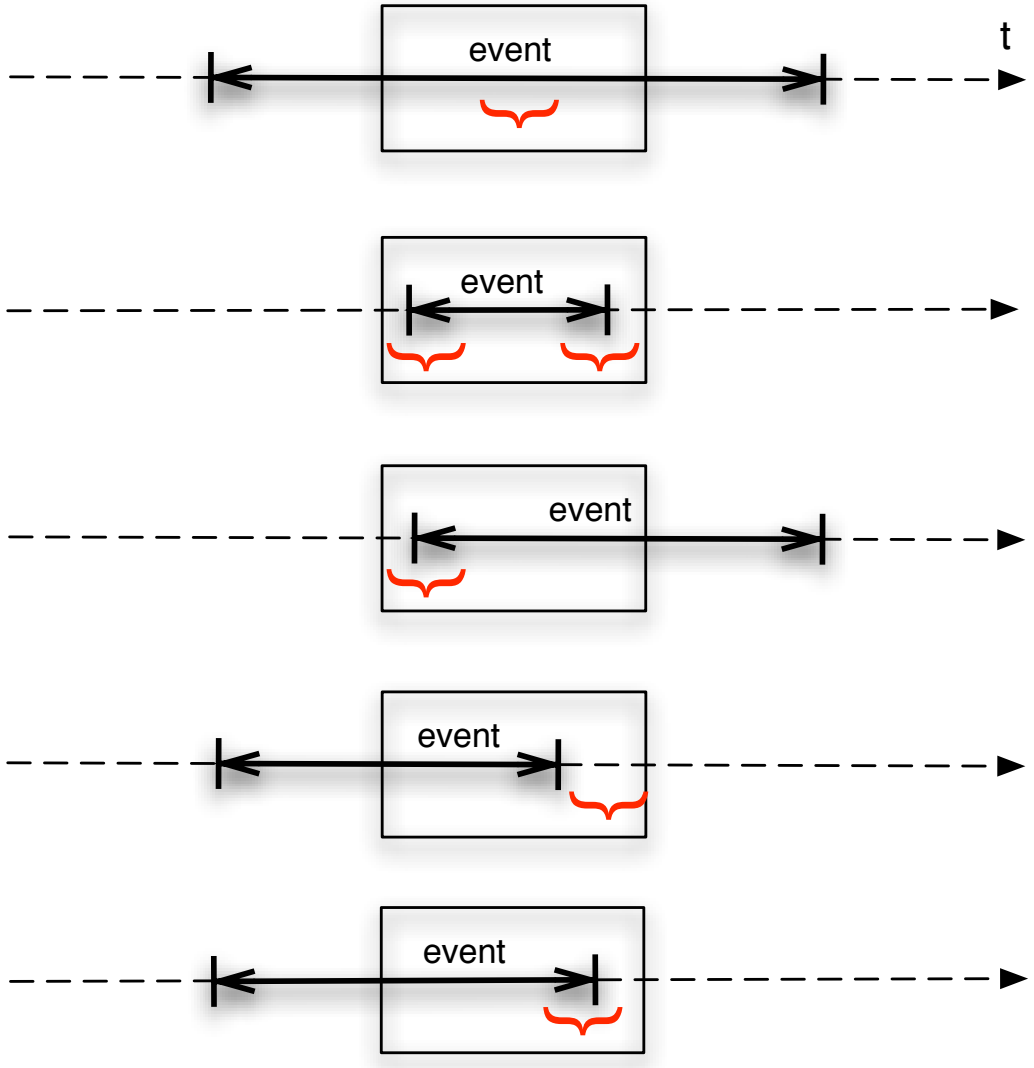
durative — V (**for a minute**)
*walk (**for a minute**)*

inceptive — **start** V-**ing**
*start walking*

perfect — **have** V-**ed**
*have walked*

terminative — **finish** V-ing
*finish walking*

# Russian




durative — V *risovat'*

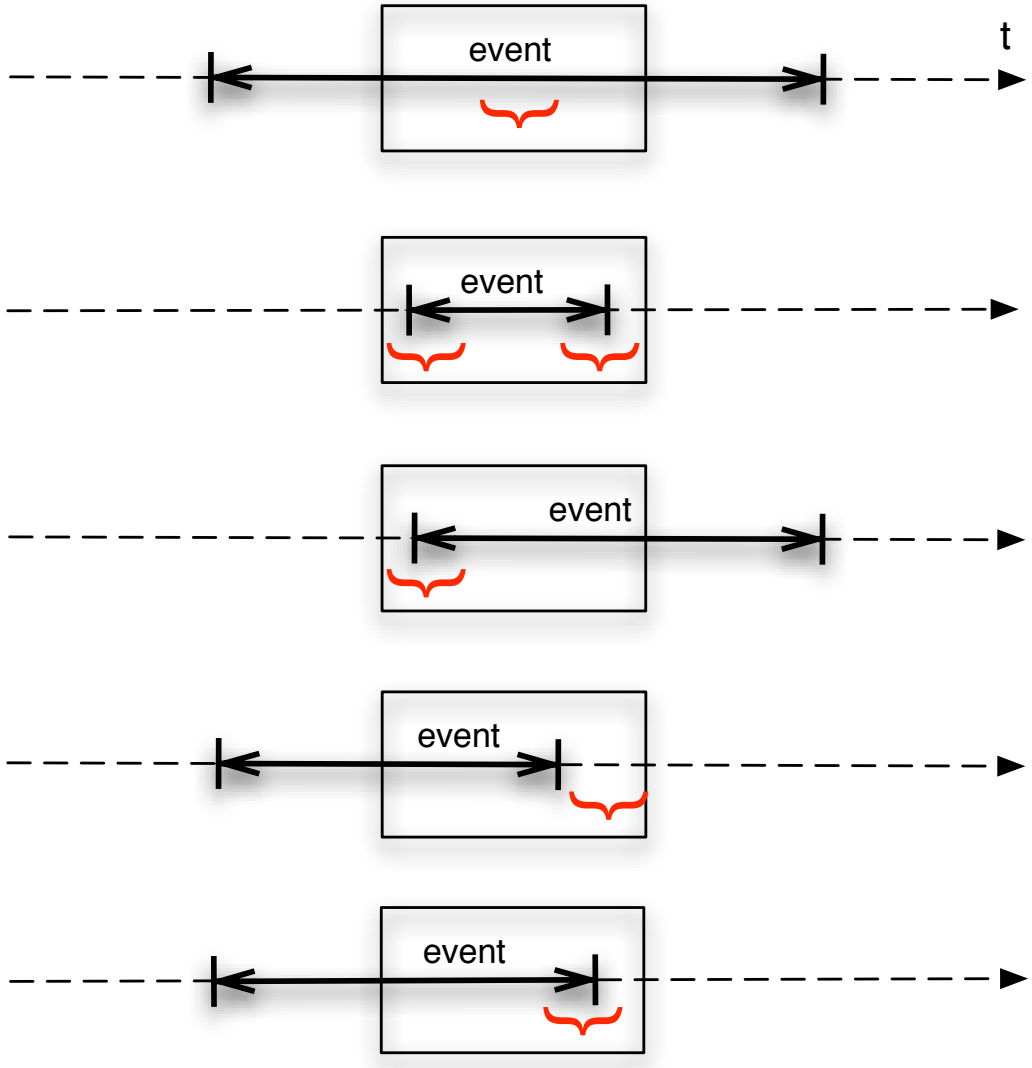
deliminative — **po-** V *porisovat'*

ingressive — **za-** V *zarisovat'*

telic — **na-** V *narisovat'*

terminative — **do-** V *dorisovat'*

# Mandarin Chinese




progressive **zhèngzài** V
***zhèngzài*** *zǒu*

durative V **yīhuír**
*zǒu* ***yīhuír***

inceptive **kāishǐ** V
***kāishǐ*** *zǒu*

realized V **le**
*zǒu* ***le***

terminative V **wán** **(?)**
*zǒu* ***wán***

# Aspectual inference

- Languages employ a wide range of devices for conveying information about the internal temporal structure of an event, e.g. whether it:
  - is still **in progress** or **completed** (***going*** vs. ***gone***)
  - is **punctual** or **iterated** (***sneeze*** vs. ***sneezing***)
  - is **telic**, i.e. has a well-defined goal/endpoint/result (***walk*** vs. ***walk to the park***, ***read*** vs. ***read a book***)
  - lasts for a specified **duration** (***walk for five hours***)
  - …

# …and a few challenges

- Temporal modifiers have different effects
  - Mary read the book [**for 5 hours / in 5 hours**]. *(book finished?)*
  - Barry [ **stood / swam / sneezed** ] for 5 minutes. *(iterated?)*
  - Gary [ **swam / left**] for 5 minutes. *(bounded? reversible?)*
  - Terry left [ **in / for** ] 5 minutes. *(modified period? reversible?)*

- Subtle interactions among verb, argument structure, nominals, temporal modifiers, etc.
  - Terry went to the mall [**for 5 hours / ?in 5 hours**]. *(inceptive?)*
  - Larry ate [**sandwiches /** ?**a sandwich**] for 5 minutes. *(bounded?)*
  - Carrie [**washed /** ?**pushed**] **the cart** in 5 minutes. *(telic?)*
  - Perry [ **is / is being** ] totally ridiculous. *(transient?)*

# Goals

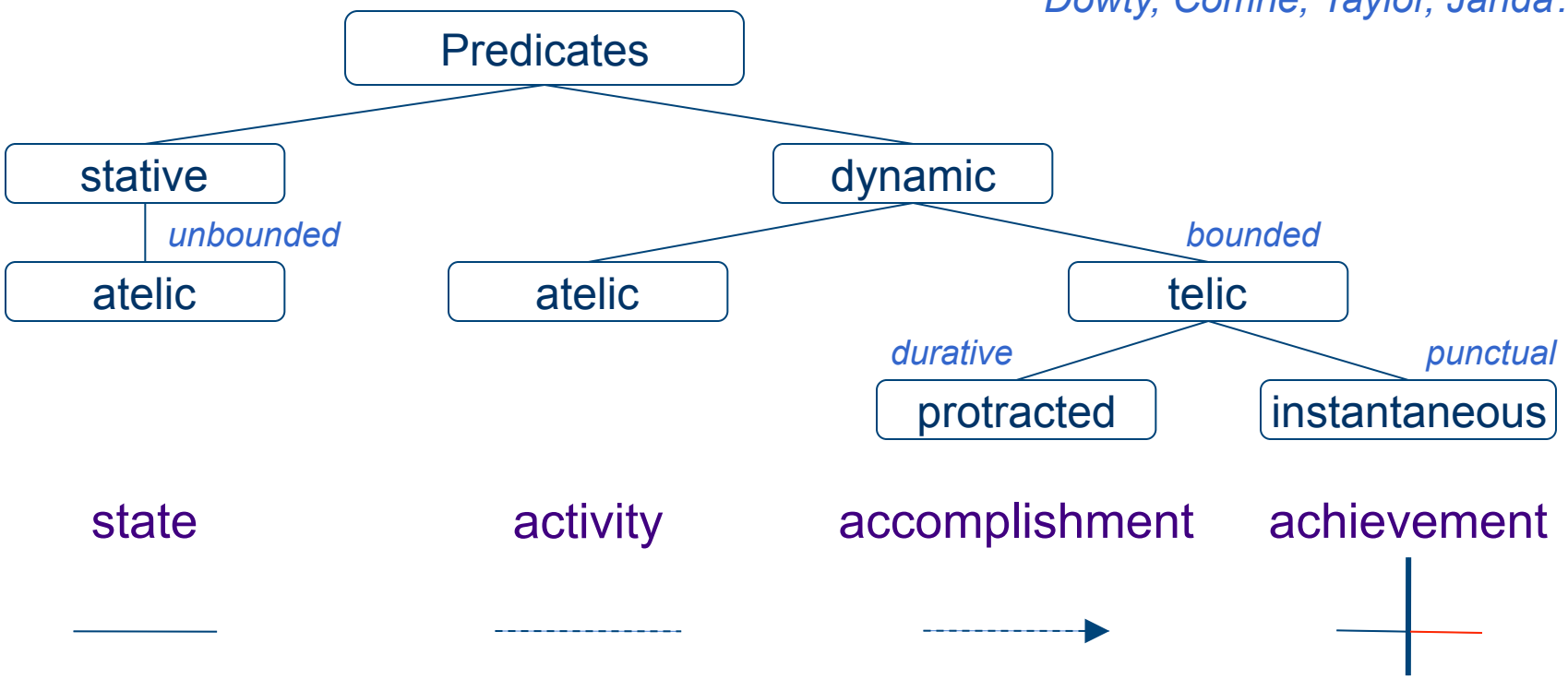
- What basic semantic and conceptual structures are needed to represent aspectual structure?
- How can we account for patterns of **acceptability** and **interpretation**?
- **Overview**:
  - Embodied simulation semantics
  - Aspectual schemas and constructions
  - Applications and opportunities

# 1.
# Embodied simulation semantics

# Aspectual classes: Vendler

- Zeno Vendler (1967) distinguished 4 aspectual classes

*…and many more from others!*
*Dowty, Comrie, Taylor, Janda…*




*know*
*resemble*

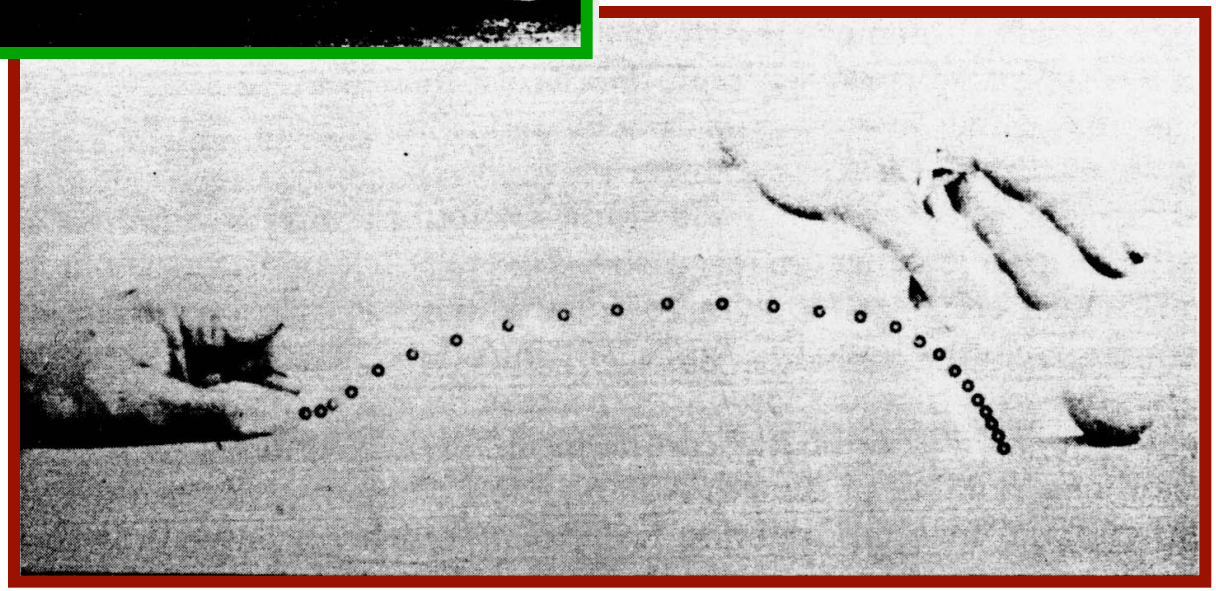
*run*
*swim*

*write a letter*
*run a mile*

*sneeze*
*recognize*

# Embodied semantics

# Preshaping for grasping



# Event-based distinctions

- Action patterns
  - One-shot, repeated, periodic, punctual
  - Decomposition: sequential, concurrent, alternatives
- Goal-based schema enabling/disabling
  - Telicity, change of state
- Generic control features
  - Interruption, suspension, resumption
- Resource usage
  - Production/consumption of time, energy, objects

**Richer than traditional classes!**

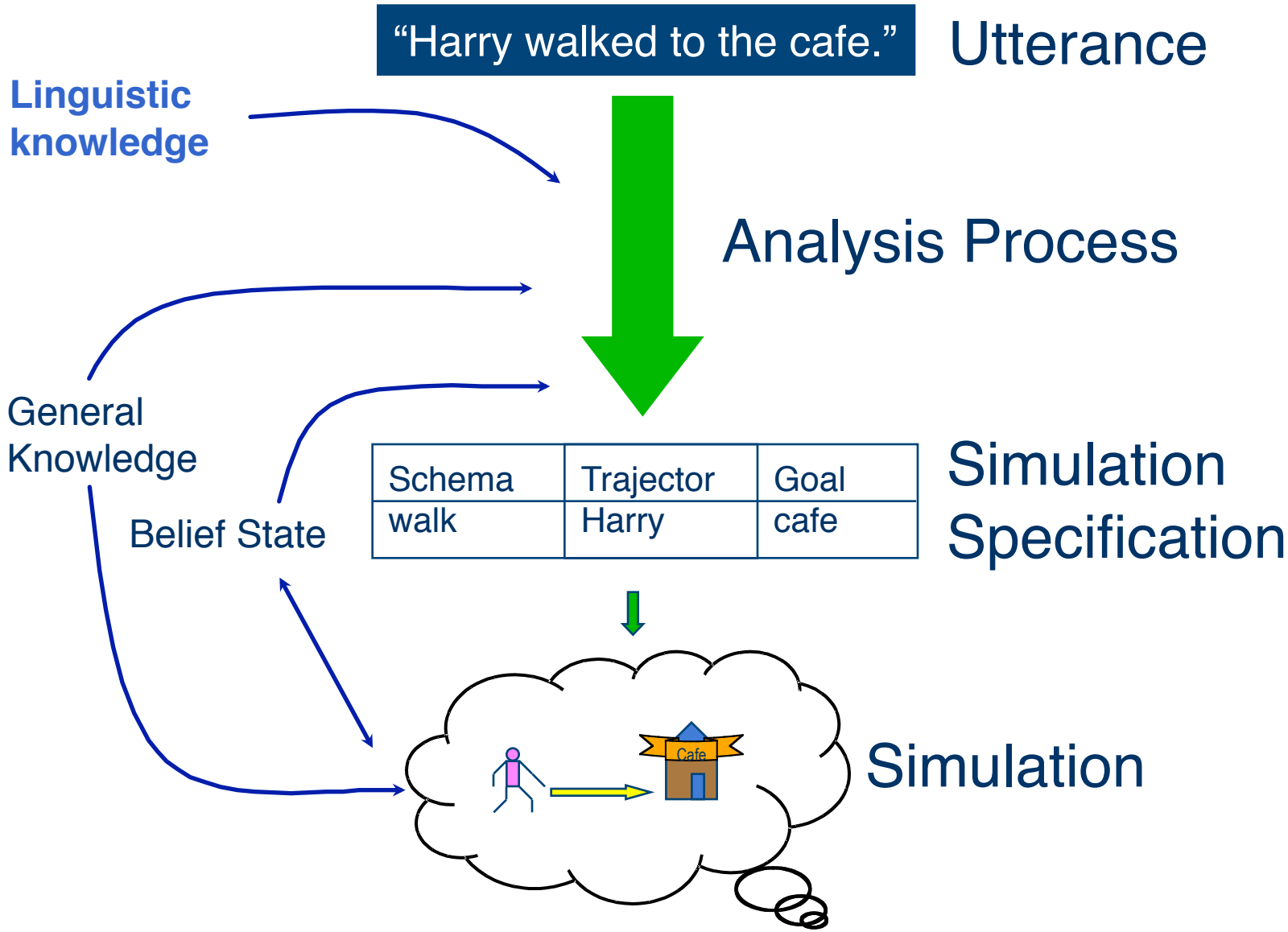
# Simulation hypothesis

We understand utterances by
**mentally simulating their content**.

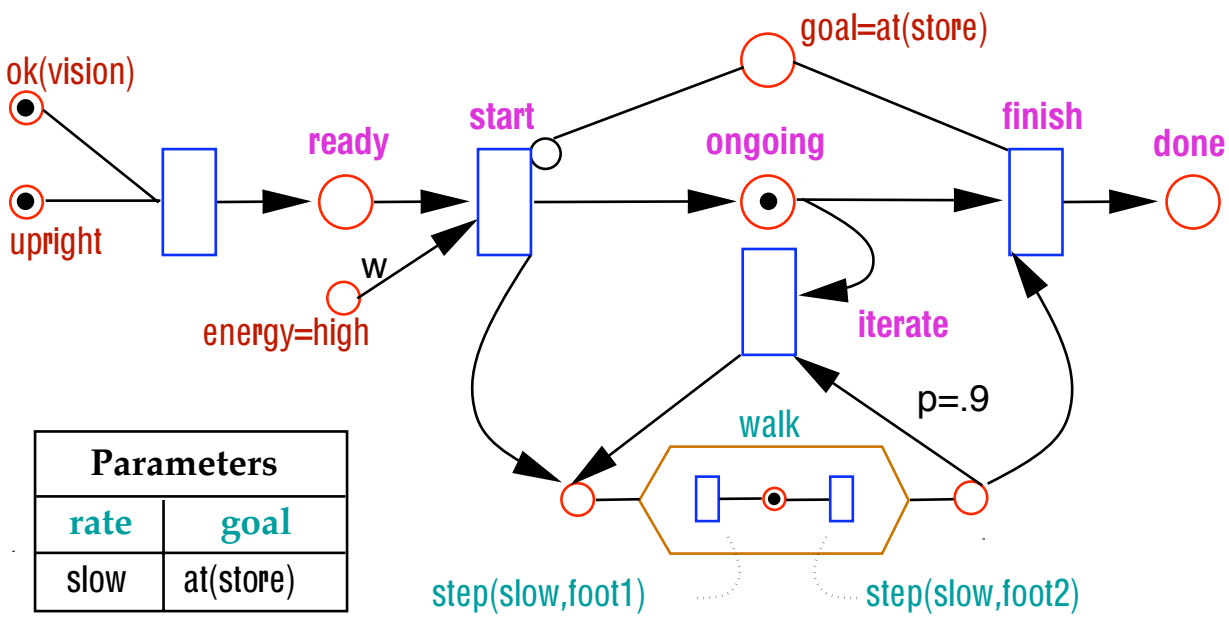
– Simulation exploits some of the **same neural structures** activated during performance, perception, imagining, memory…

– Linguistic structure **parameterizes** the simulation.
  - Language gives us enough information to simulate

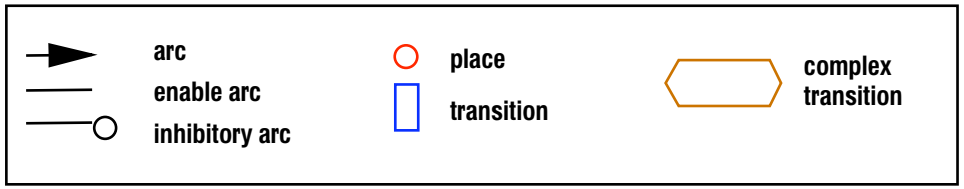
# Language understanding as simulation



# X-schema example: WALK (to store)

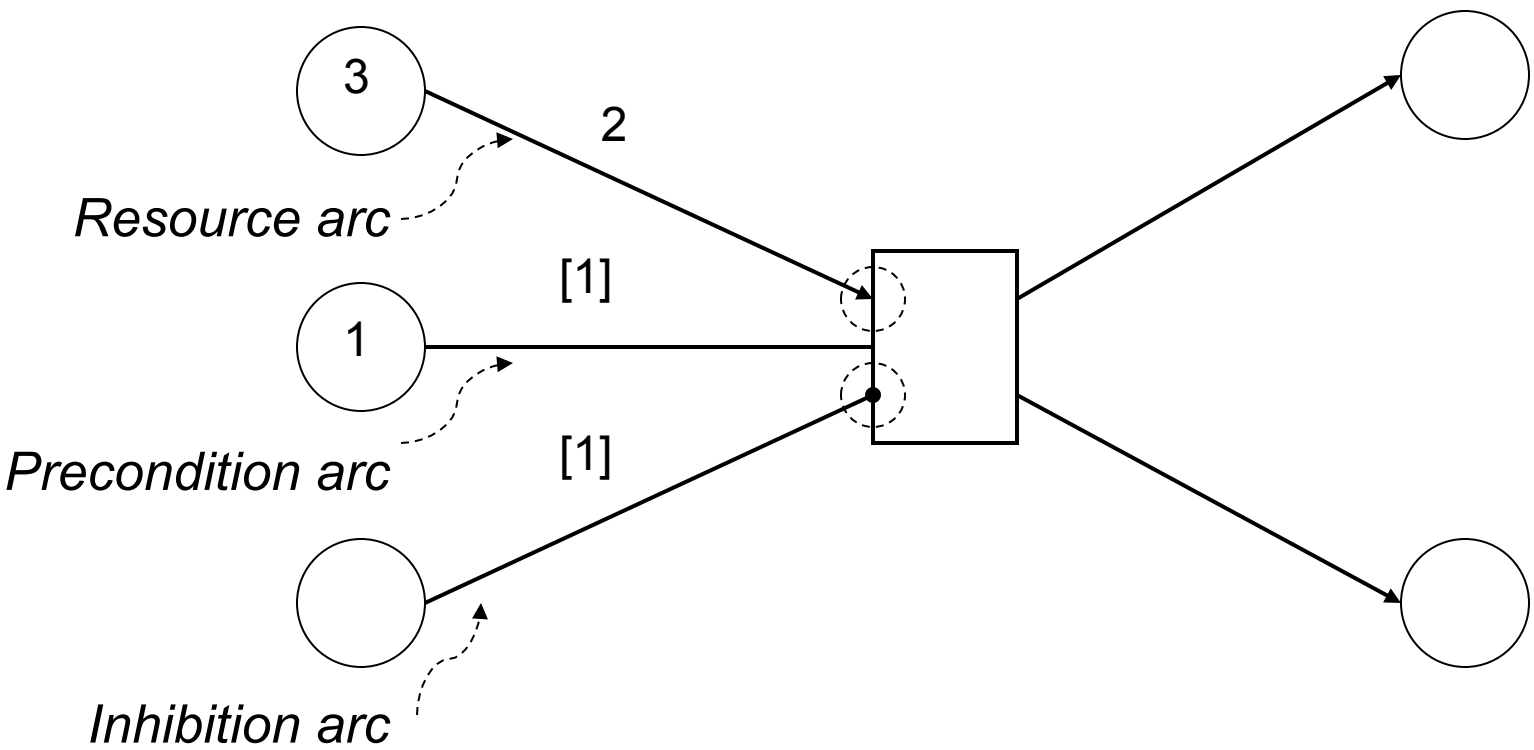



| Parameters | |
|---|---|
| rate | goal |
| slow | at(store) |



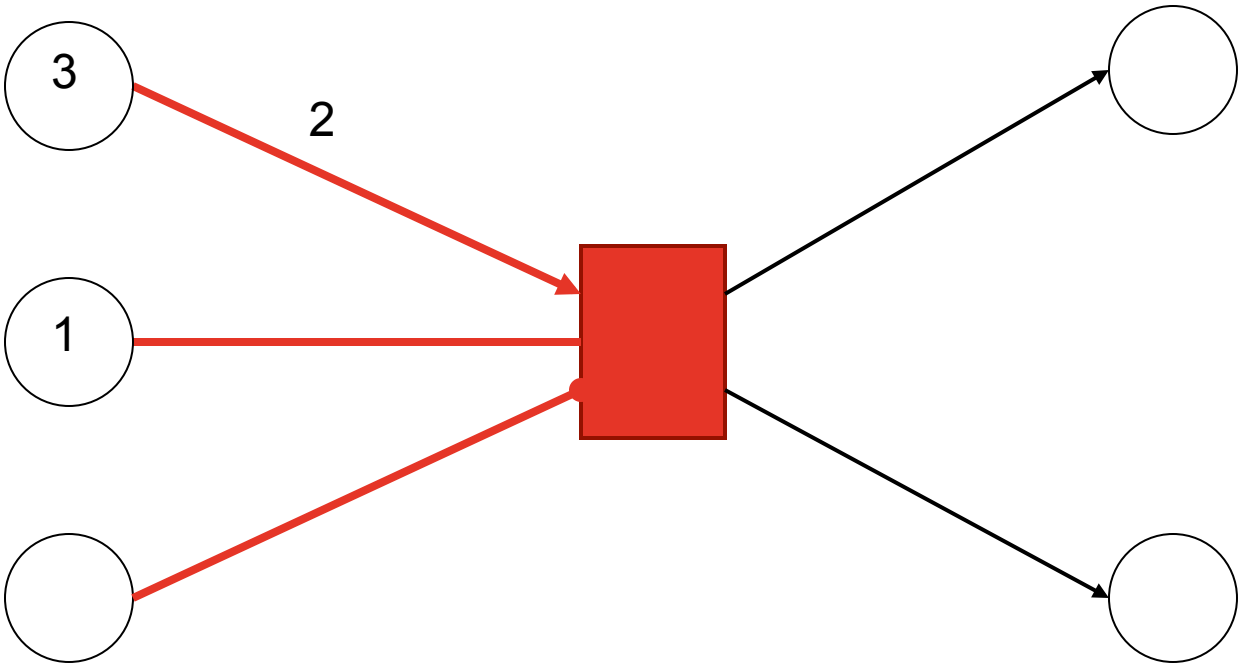
# Executing schemas

## Basic Mechanism



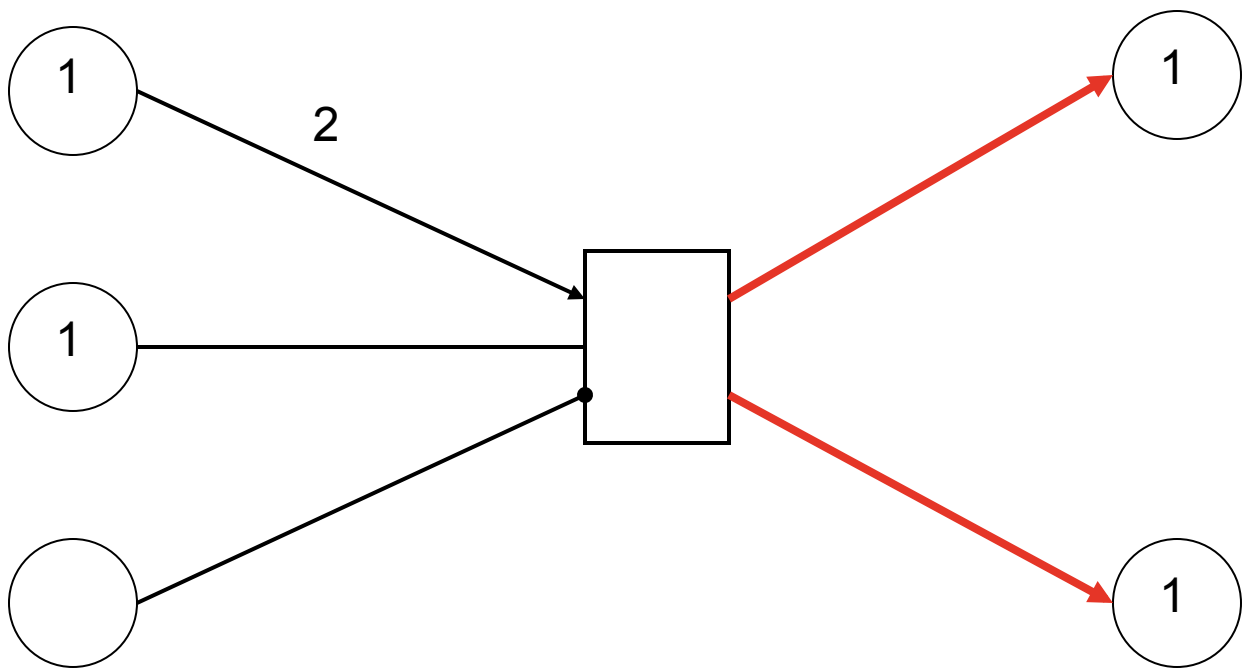
# Executing schemas

Firing Semantics



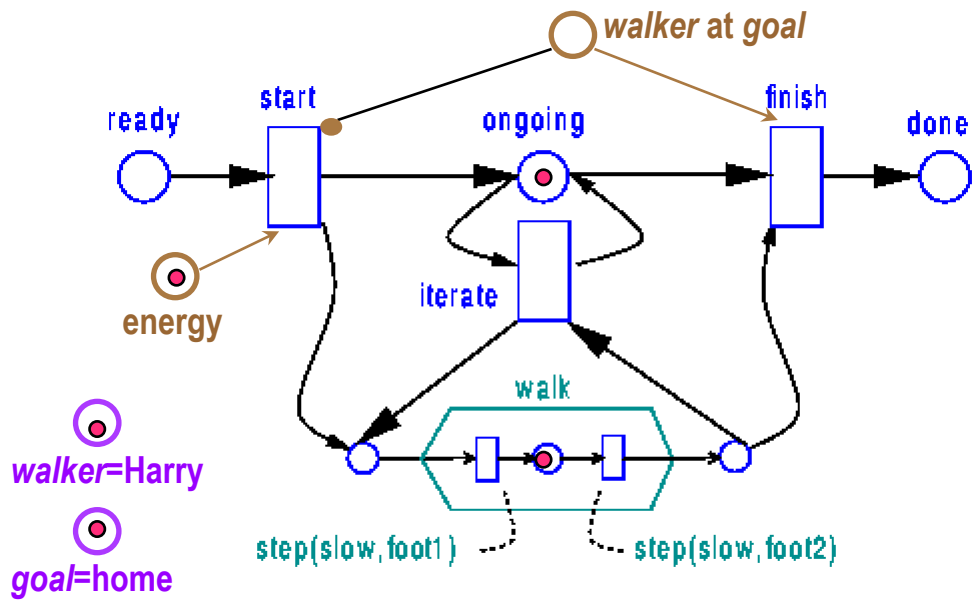
# Executing schemas

Result of Firing



# Active representations

- Executing schema (**x-schema**)
  - extension to stochastic Petri nets *[Narayanan 1997, 1999, 2002]*
  - Fine-grained, dynamic, parameterized control
- Useful for monitoring, control and inference




**Walking:**

bound to a specific *walker* with a direction or *goal*

consumes resources (e.g., energy)

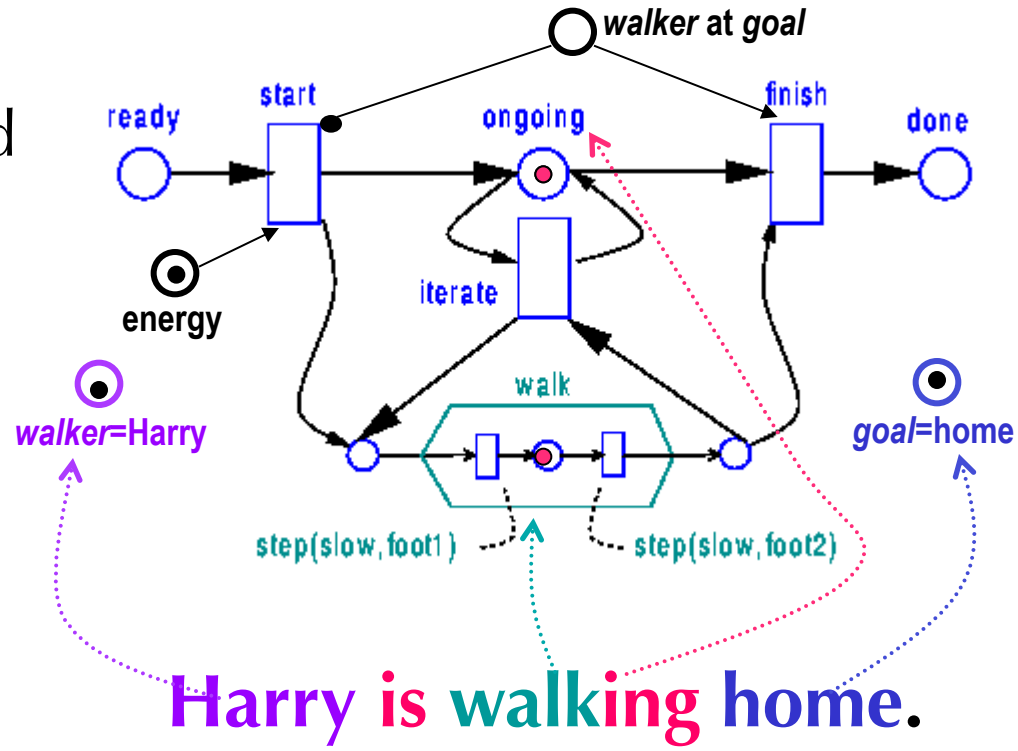
may have termination condition (e.g., *walker* at *goal*)

ongoing, iterative action

# Language sets simulation parameters

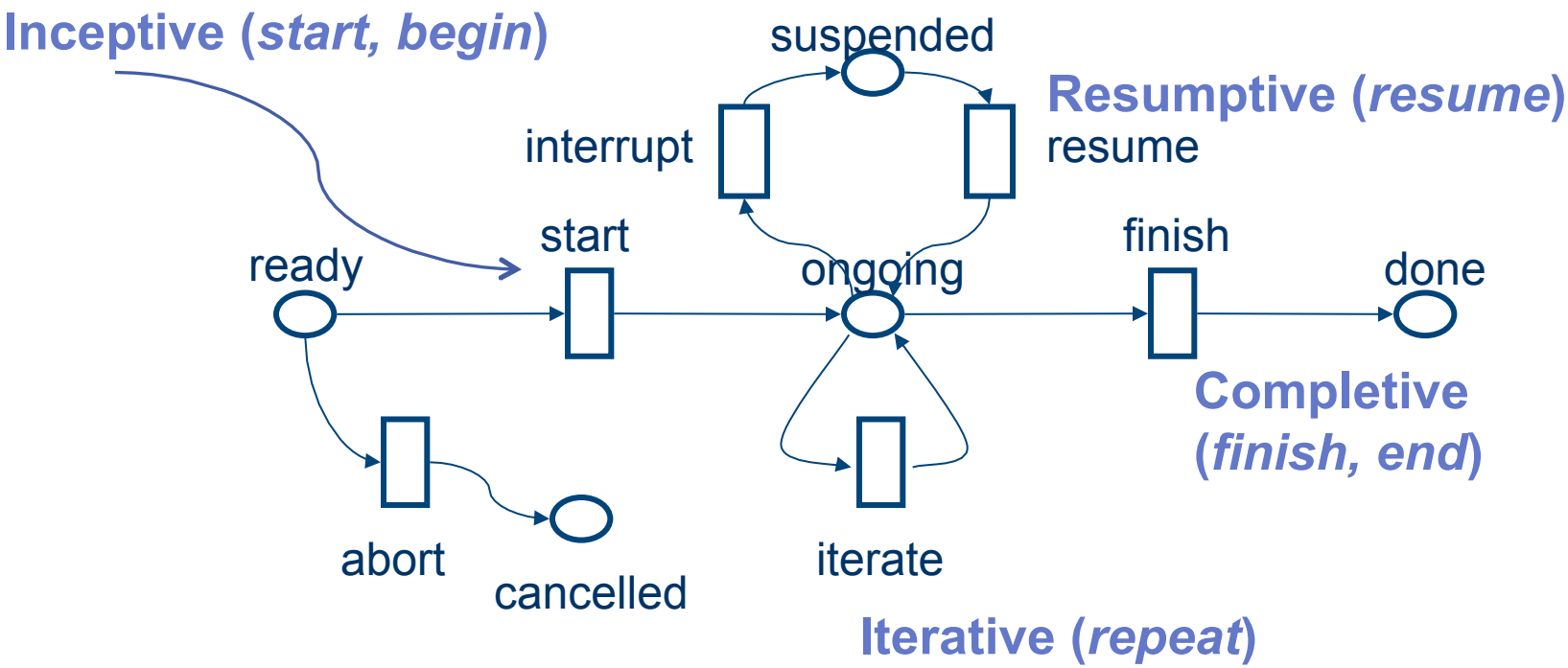
Constructions can:

- specify which schemas and entities are involved in an event, and how they are related
- profile particular stages of an event
- set parameters of an event

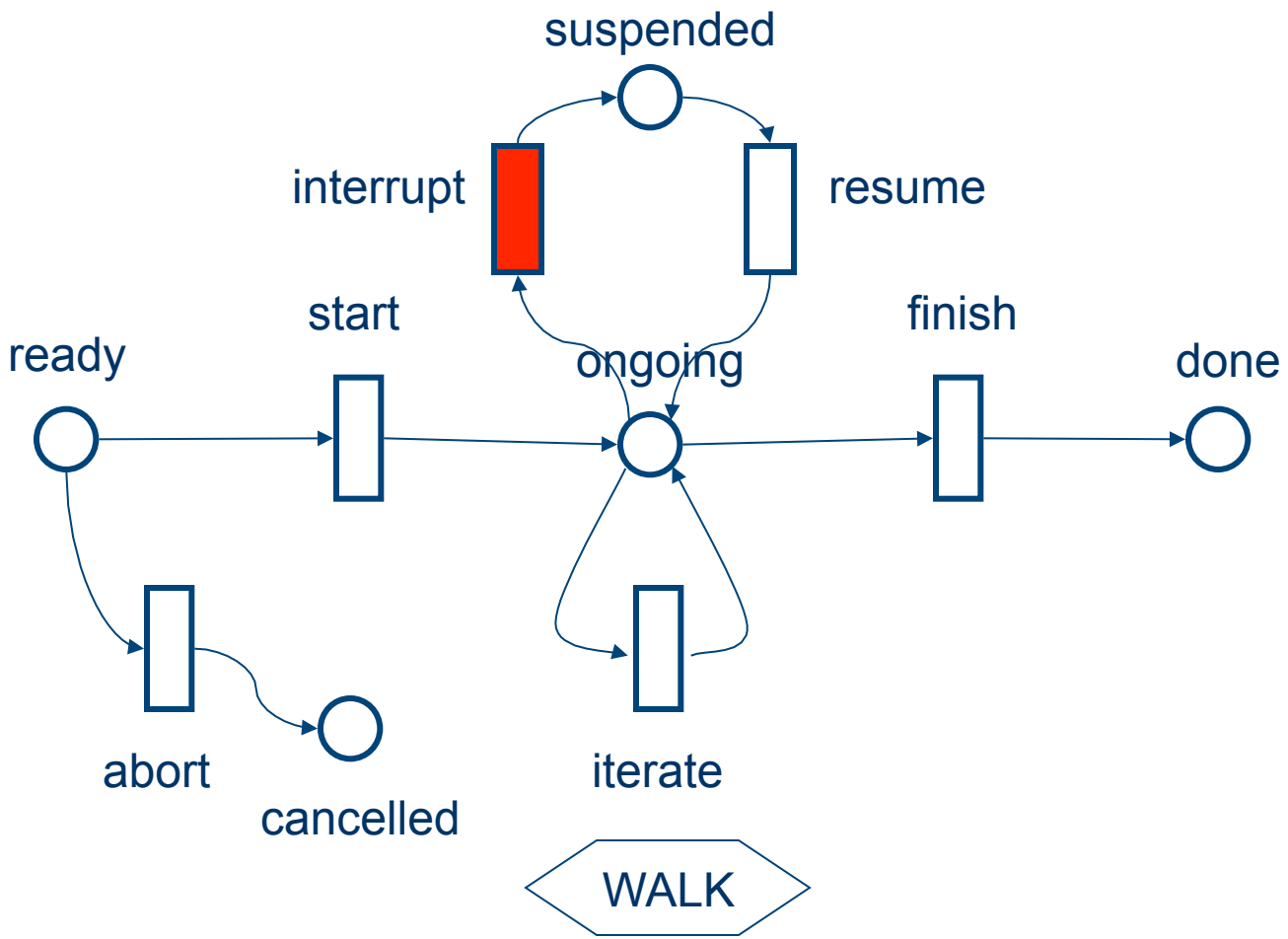


# Basic process controller

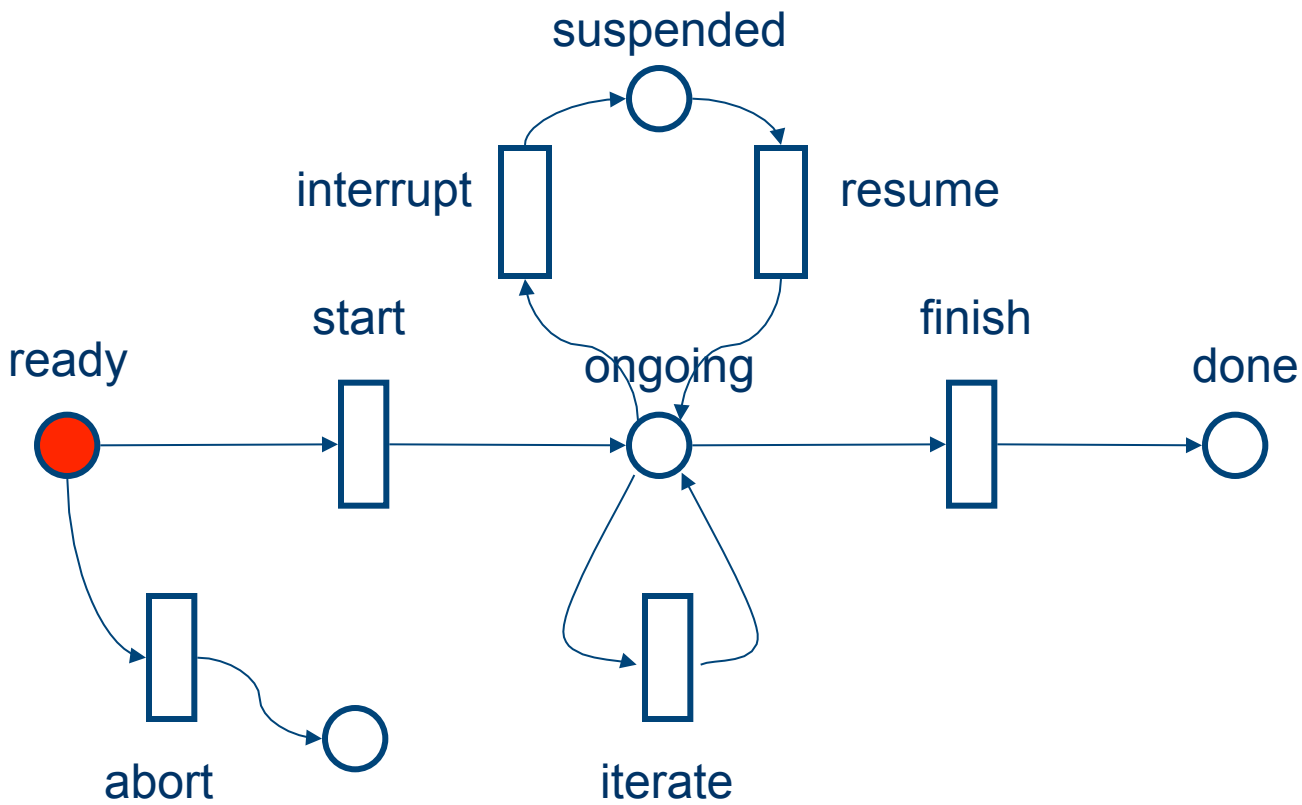
- A general controller x-schema captures the generic event structure associated with a process
- Linguistic constructions can mark (or profile) specific states or transitions in the **controller schema**.



# Lexicalized aspect: *stumble*



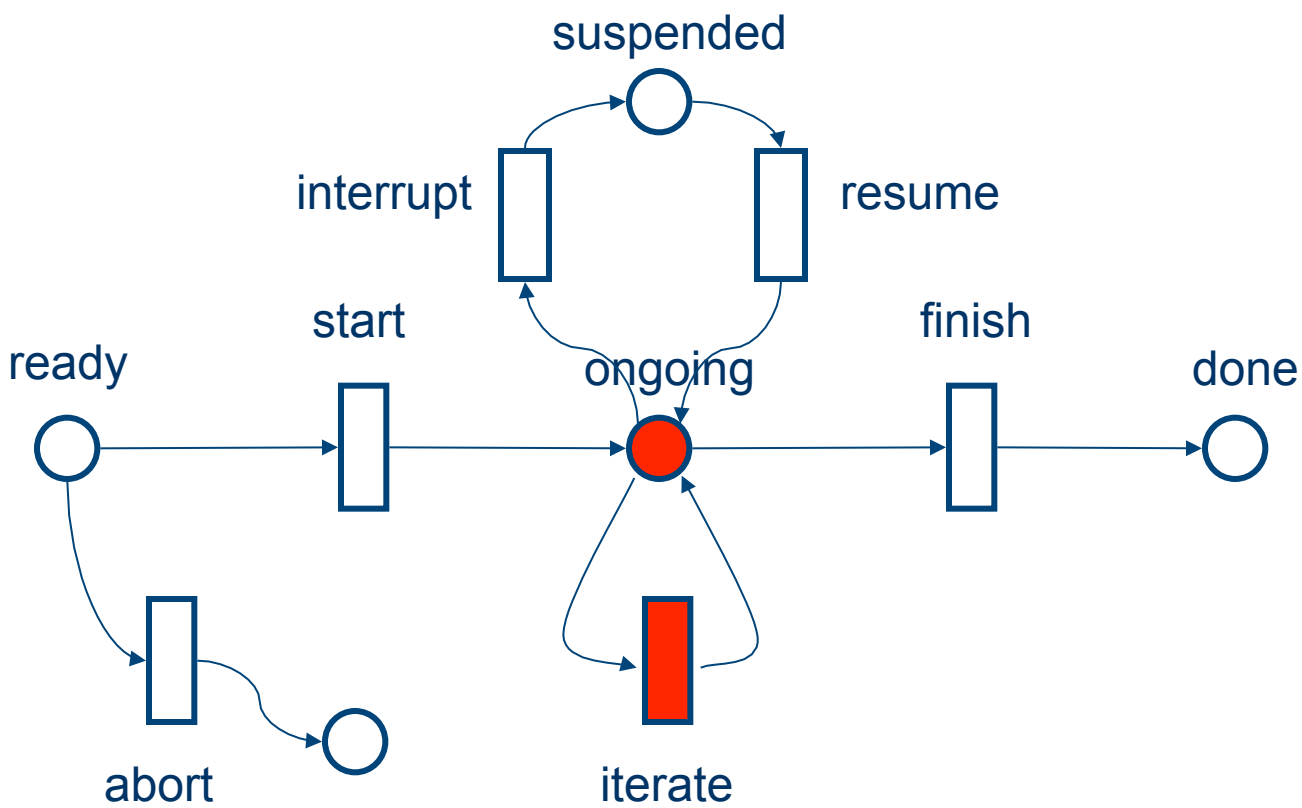
# Harry *is about to* walk to the cafe.





| Schema | Trajector | Goal |
|---|---|---|
| walk | Harry | cafe |

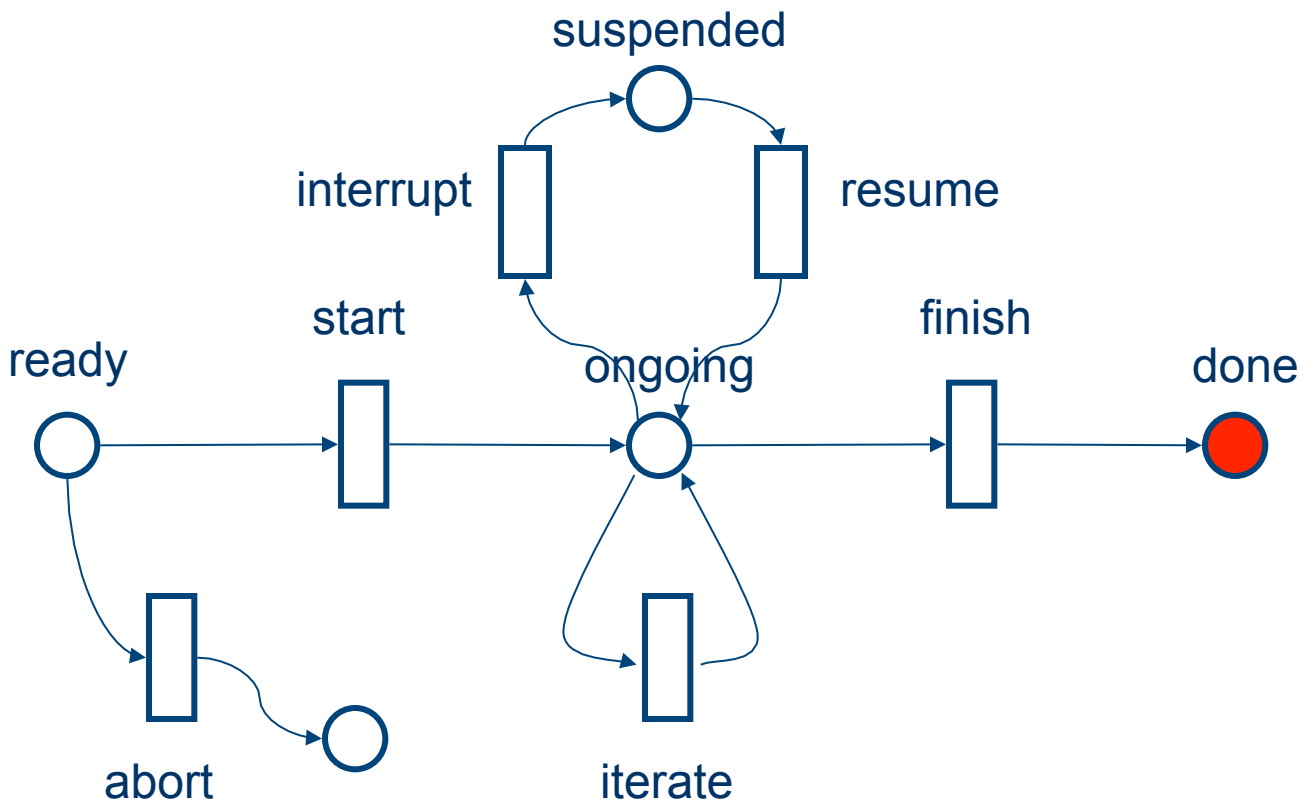
# Harry *is* walk*ing* to the cafe.





| Schema | Trajector | Goal |
|---|---|---|
| walk | Harry | cafe |

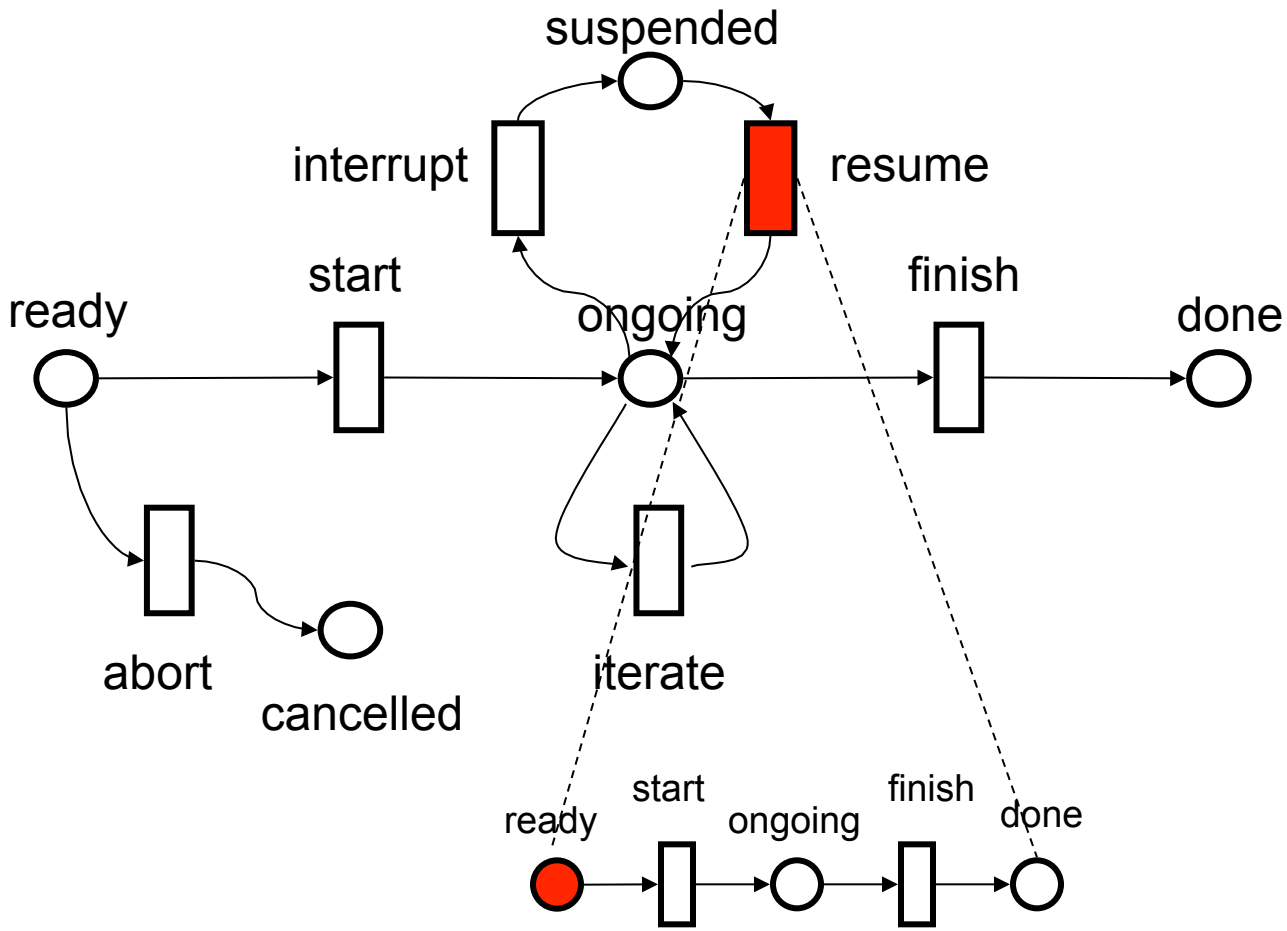
# Harry *has* walk*ed* to the cafe.





| Schema | Trajector | Goal |
|---|---|---|
| walk | Harry | cafe |

# They are *getting ready to continue* their journey across the desert.



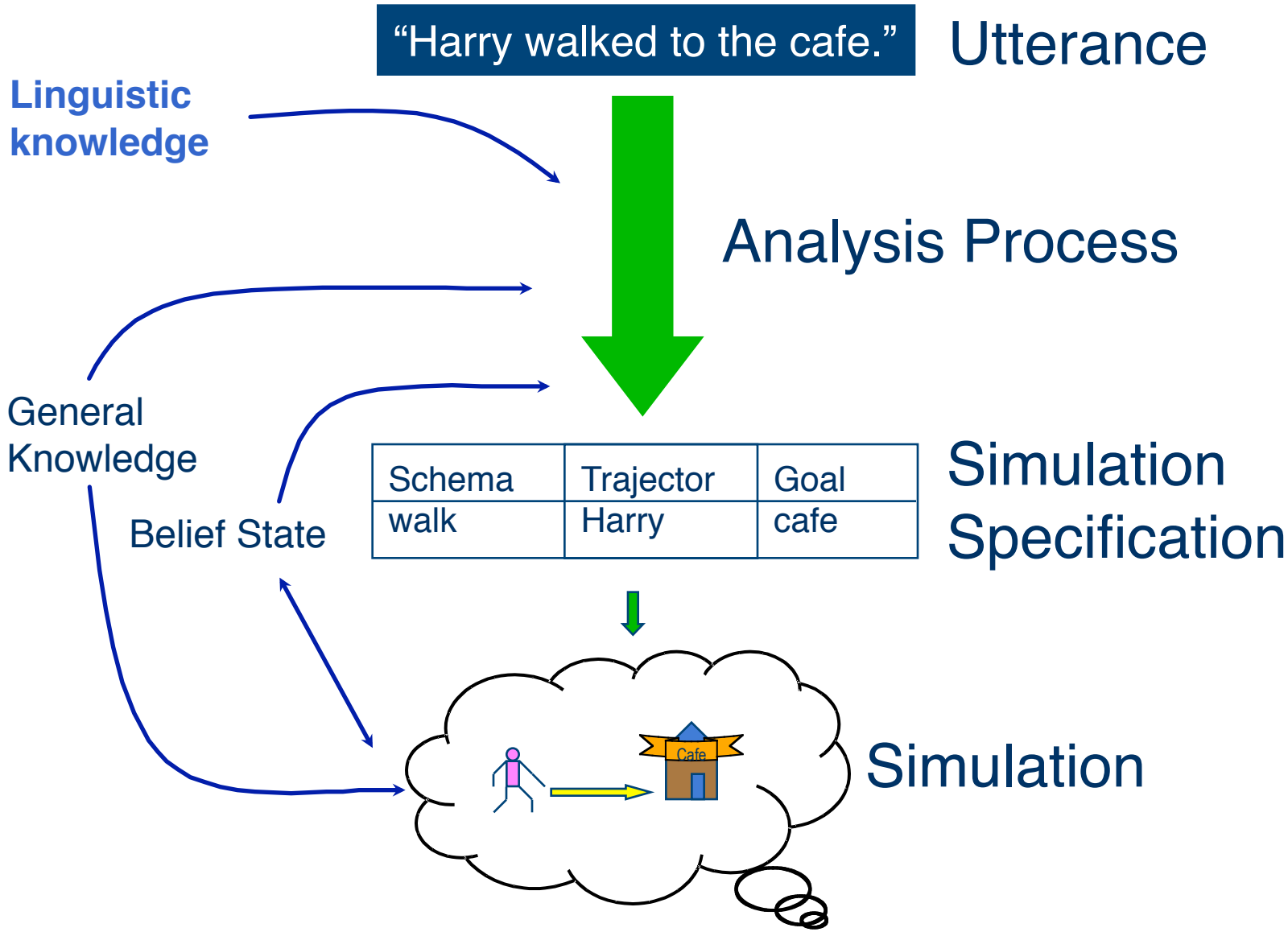
# Interim summary

- Simulation semantics provides a rich, embodied basis for modeling event structure.
- Fine-grained aspectual distinctions and contextual conditions can be naturally captured as part of a dynamic simulation.

- BUT: **how** does language parameterize the simulation?

# 2.
# Aspectual schemas and constructions

# Language understanding as simulation



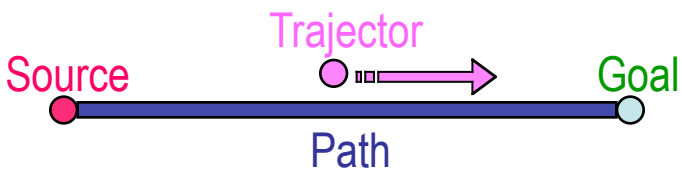
# Embodied schemas

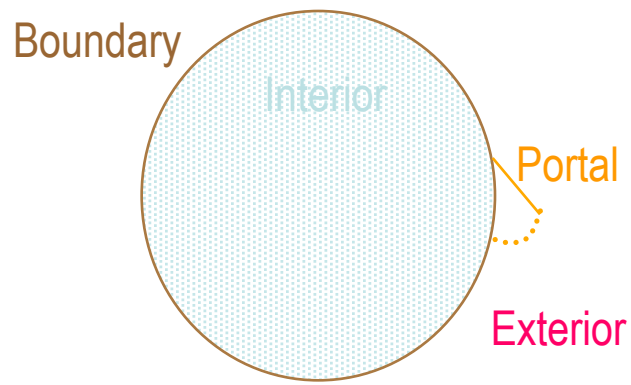
schema name

**schema** *Source-Path-Goal*
**roles**
source
path
goal
trajector

role name

**schema** *Container*
**roles**
interior
exterior
portal
boundary




These are **abstractions** over sensorimotor experiences.

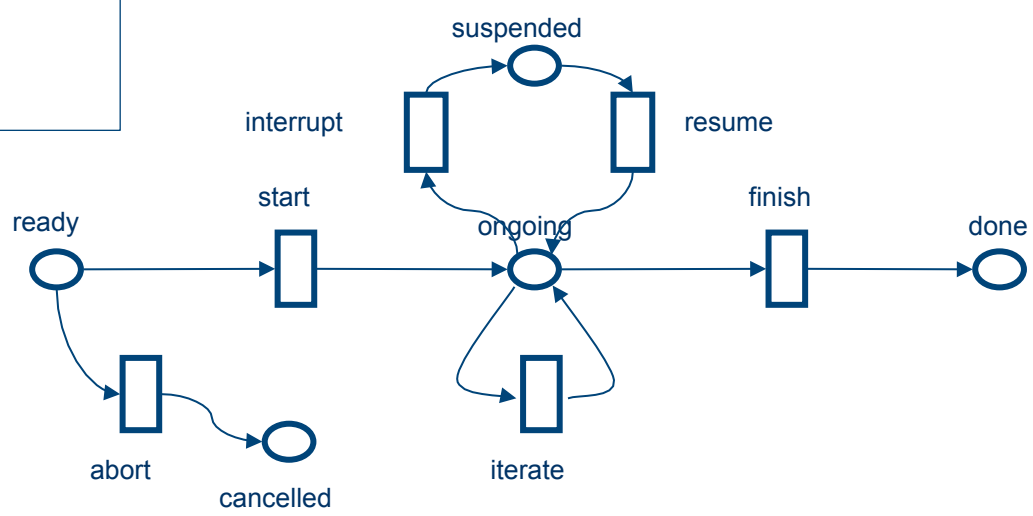
# Aspectual framing

- The generic process controller can also be cast as a **semantic** frame (or schema).
  - Frames allow concepts to be **interdefined**.
  - **Profiling** allows particular participants/props/roles (or even **phases**) to be raised to prominence against background

- Insight: aspectual composition requires framing and profiling

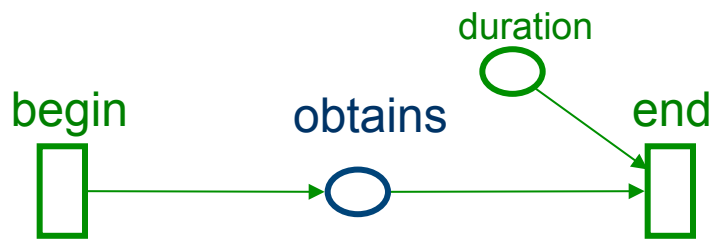
# Basic controller schema

**schema** Controller
  **roles**
    profiledPhase
    controlledProcess: Controller
    boundable : Boolean
    telic: Boolean
    goalResult: State
    ongoing: State
    pre: State
    post: State
    nucleus : Controller
    duration



# Basic event types

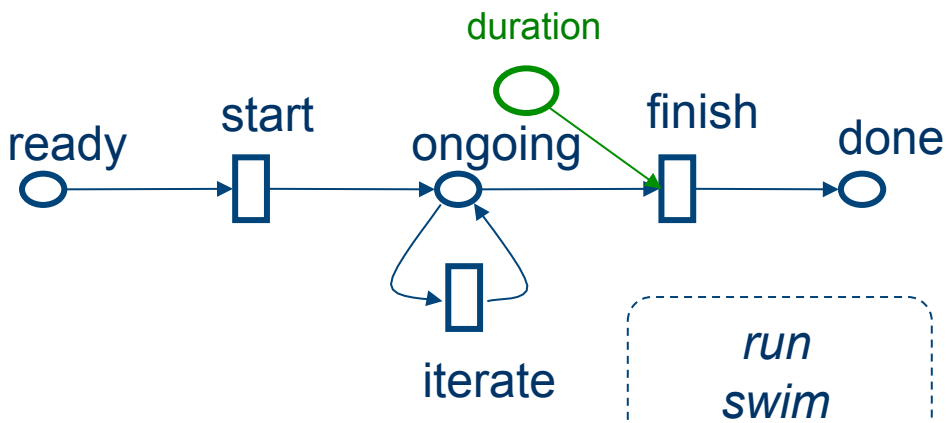
- **States**




*live*
*have*

*(for now)*

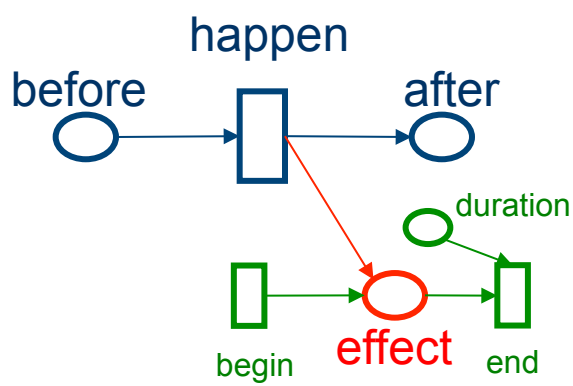
- **Processes** (continuous)




*run*
*swim*

*(for an hour)*

- **Transitions** (discrete)



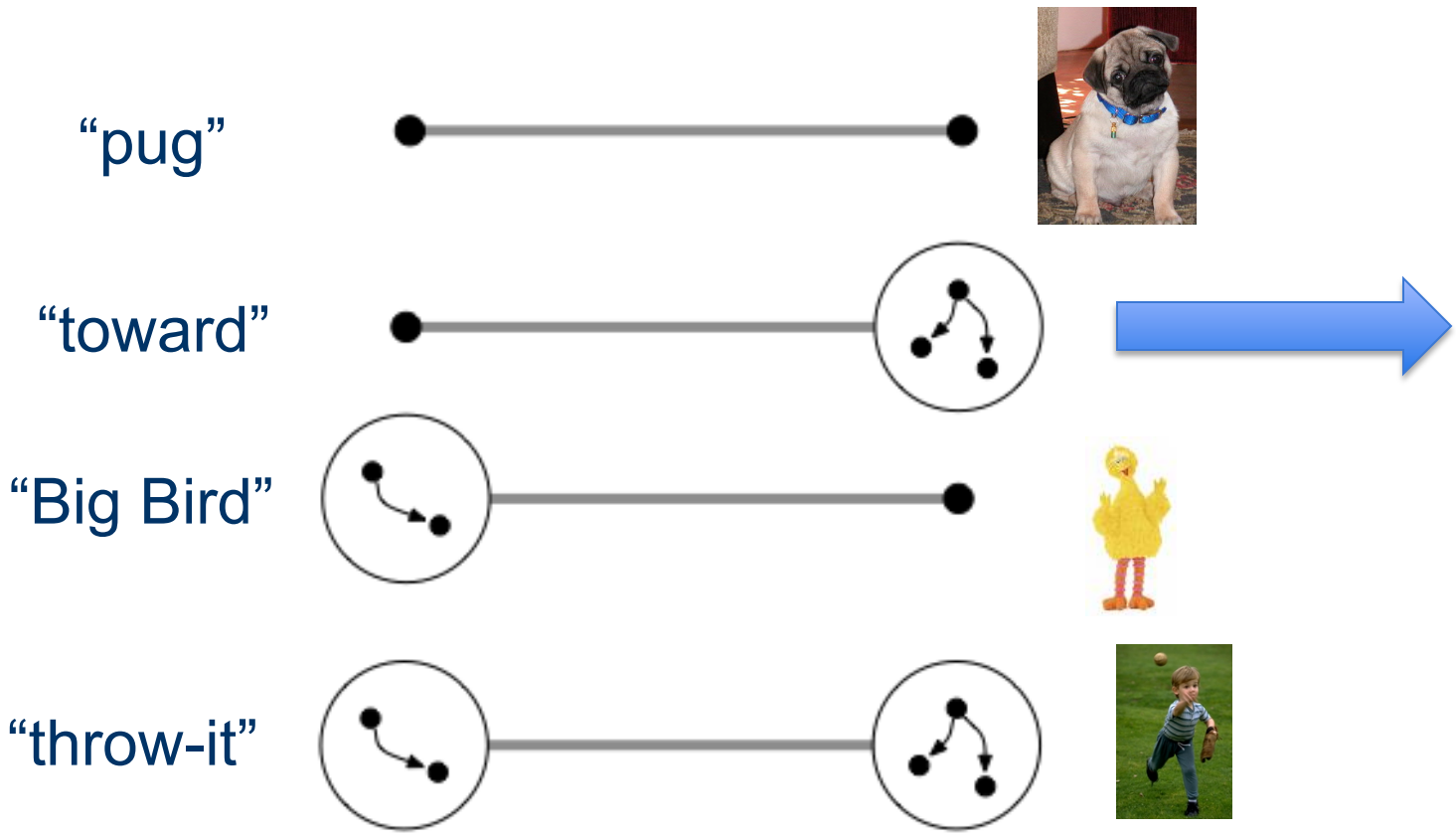

*sneeze*
*leave*
*win*

*(for an hour)*

# Structure: constructions

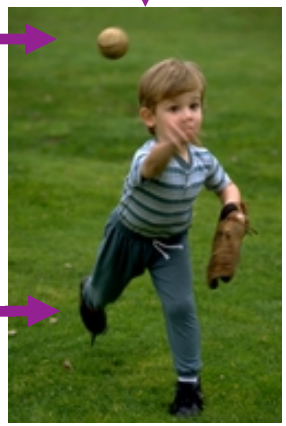
- The basic linguistic unit is a <form, meaning> pair

*(Kay and Fillmore 1999, Lakoff 1987, Langacker 1987, Goldberg 1995, Croft 2001, Goldberg and Jackendoff 2004)*



# Lexical constructions

"You're **throw**ing the **ball**!"



**construction** YOU
**form**
orth: "you"
**meaning:** Addressee

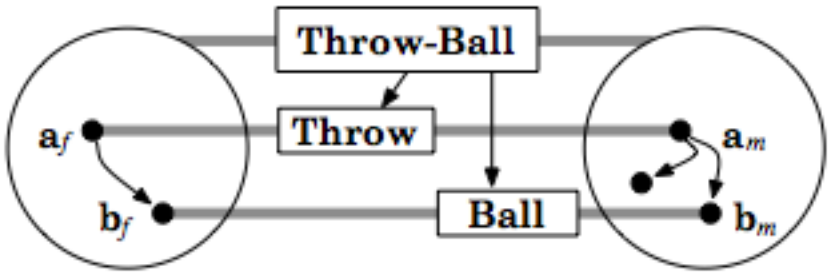
**construction** THROW
**form**
orth: "throw"
**meaning:** Throw

**construction** BALL
**form**
orth: "ball"
**meaning:** Ball

**Embodied Construction Grammar (Bergen and Chang 2005)**

# Complex (relational) constructions

throw ball



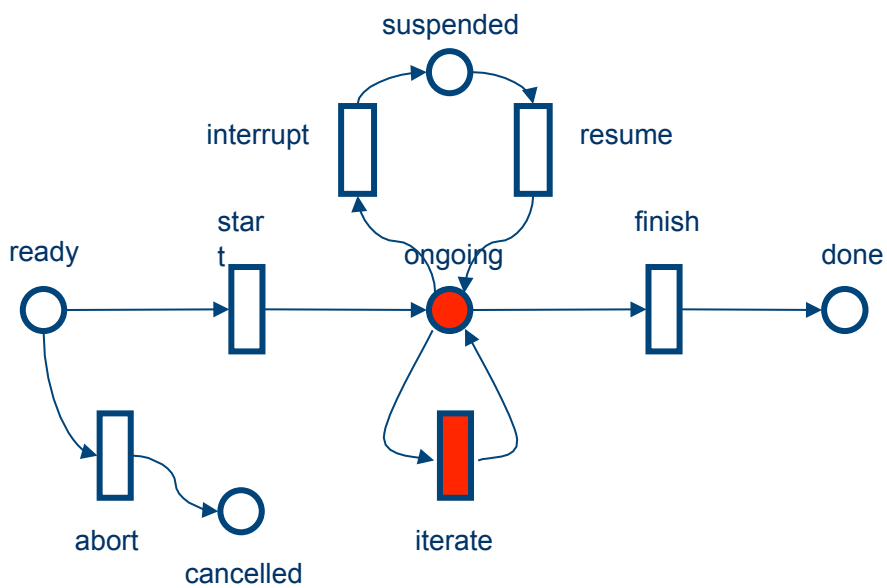

**construction** THROW-BALL
  **constituents**
    t : THROW
    o : BALL
  **form**
    $t_f$ before $o_f$
  **meaning**
    $t_m$.throwee ↔ $o_m$

Embodied Construction Grammar
(Bergen & Chang, 2005)

# Example: progressive -ing

- **Closed-class suffix -ing**
  - **Meaning includes an evoked Process with profiled "ongoing" phase**

**Construction** -Ing
**form**
self$_m$.orth <- "ing"
**meaning**
**evokes Process as p**
p.profile ← ongoing

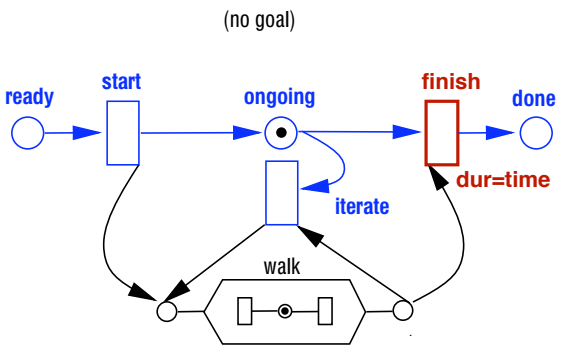


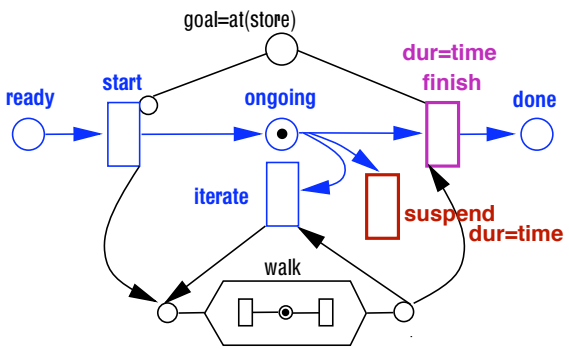
# DURATION: TEMPORAL MODIFIERS

- Both *for* and *in* specify durations, but:

  ***for* implies no goal or goal unachieved; *in* implies goal (achieved)**

**Processes:**




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

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

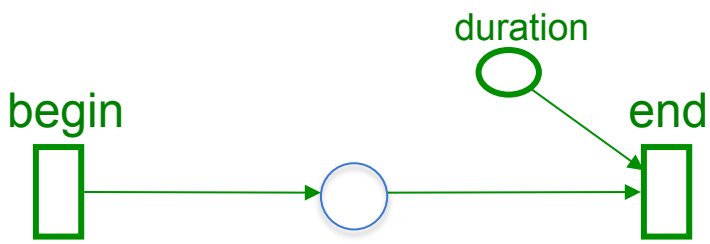
She read the book for an hour.
She read the book in an hour.

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

# Example: durative "for"

- **Durative "for" modifier**
  - **Meaning is an Interval of specified length**
  - **Required to be atelic**

**construction** For-TimePeriod
  **constituents**
    f : For
    tp : TimePeriod
  **form**
    $f_f$ before $tp_f$
  **meaning : Interval**
    $self_m$.duration <-> $tp_m$
    $self_m$.telic ← false




*(for now)*

# Aspectual constraints

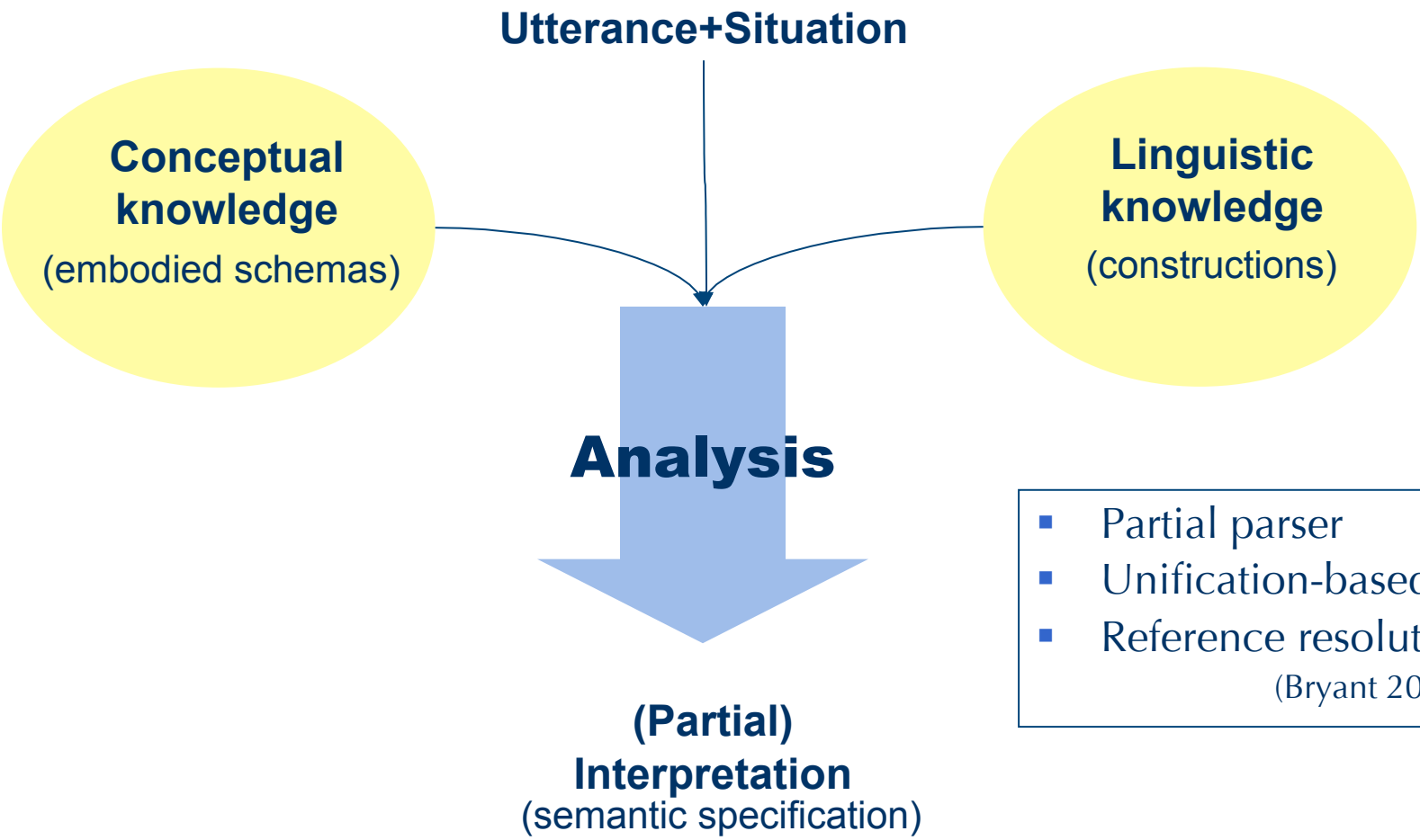
- Durative modifiers require an interval
  - ***for TIME***: no specific goal achieved (atelic)
  - ***in TIME***: specific goal present/achieved (telic)
  - Interval may be coerced / created
- Interaction between goal and conditions
  - Boundedness of resource linked to specific goal
    - She ate [sandwiches | two sandwiches ].
- Ongoing requires a bounded interval
  - May cause inference of iteration, temporariness/ reversability, habitual

# Constructional composition:

## Harry has been reading the book for 5 min

- Nominals: *Harry*, *the book*
- Verb: *reading* (Read, PresentParticiple)
  - Evokes an ongoing process
- **Progressive: Be-Xing**
  - Evokes a process, profiles its ongoing phase
- Perfect: Have-Xed
  - Evokes a completed event, profiles its effect/consequence
- Tense: *has* (Have, PastTense)
  - Locates event as concurrent with speech time
- Argument/participant/causal structure: BoundedEvent
  - Specifies HARRY is protagonist of READ schema
  - Specifies BOOK is undergoer/bounded resource
- **Durative modifier PP: For-Time**
  - Specifies a duration of 5 minutes
- …and possibly more! (frames, metaphors, modals, oh my!)

# Usage: Construction analyzer

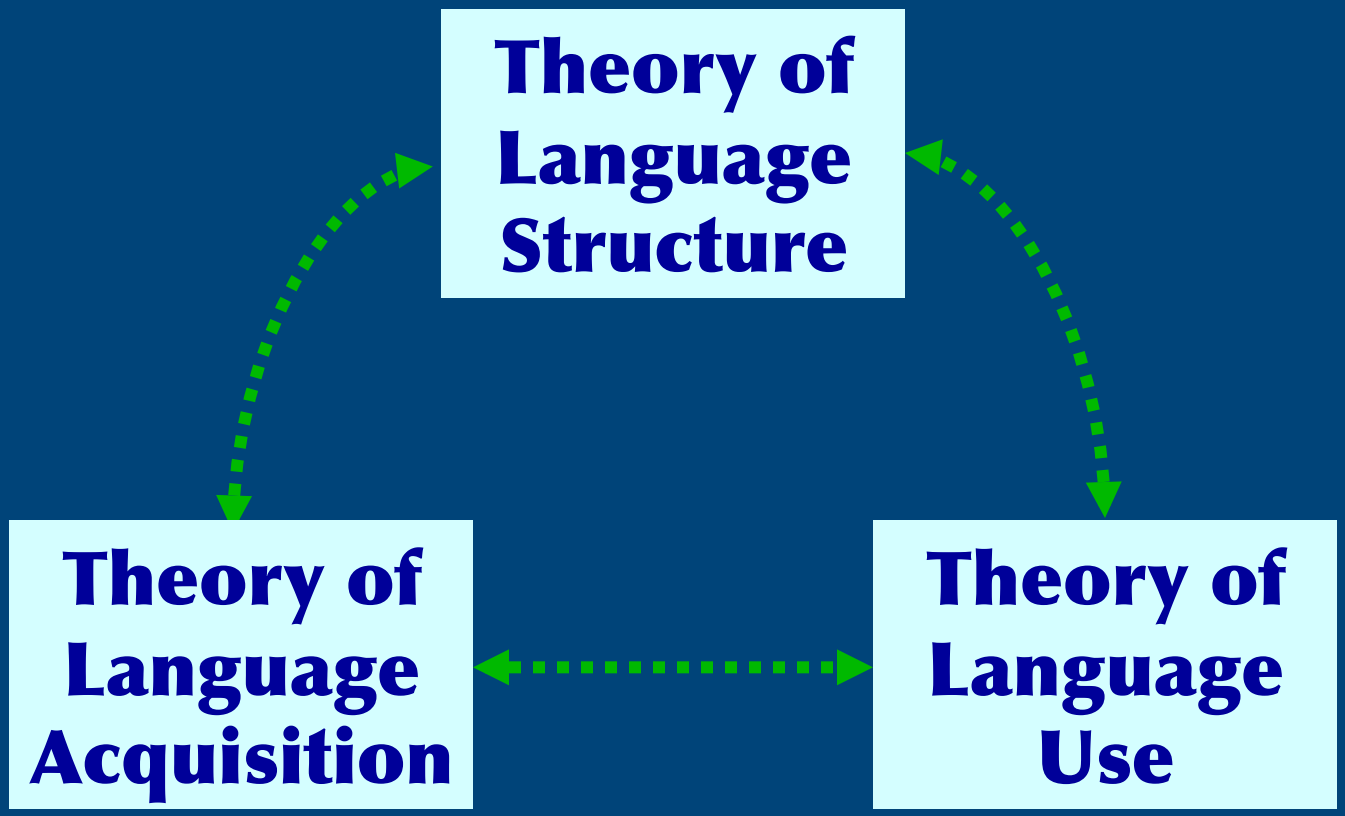



- Partial parser
- Unification-based
- Reference resolution

(Bryant 2004, 2008)

# 3.
# Applications and opportunities

## Embodied Construction Grammar

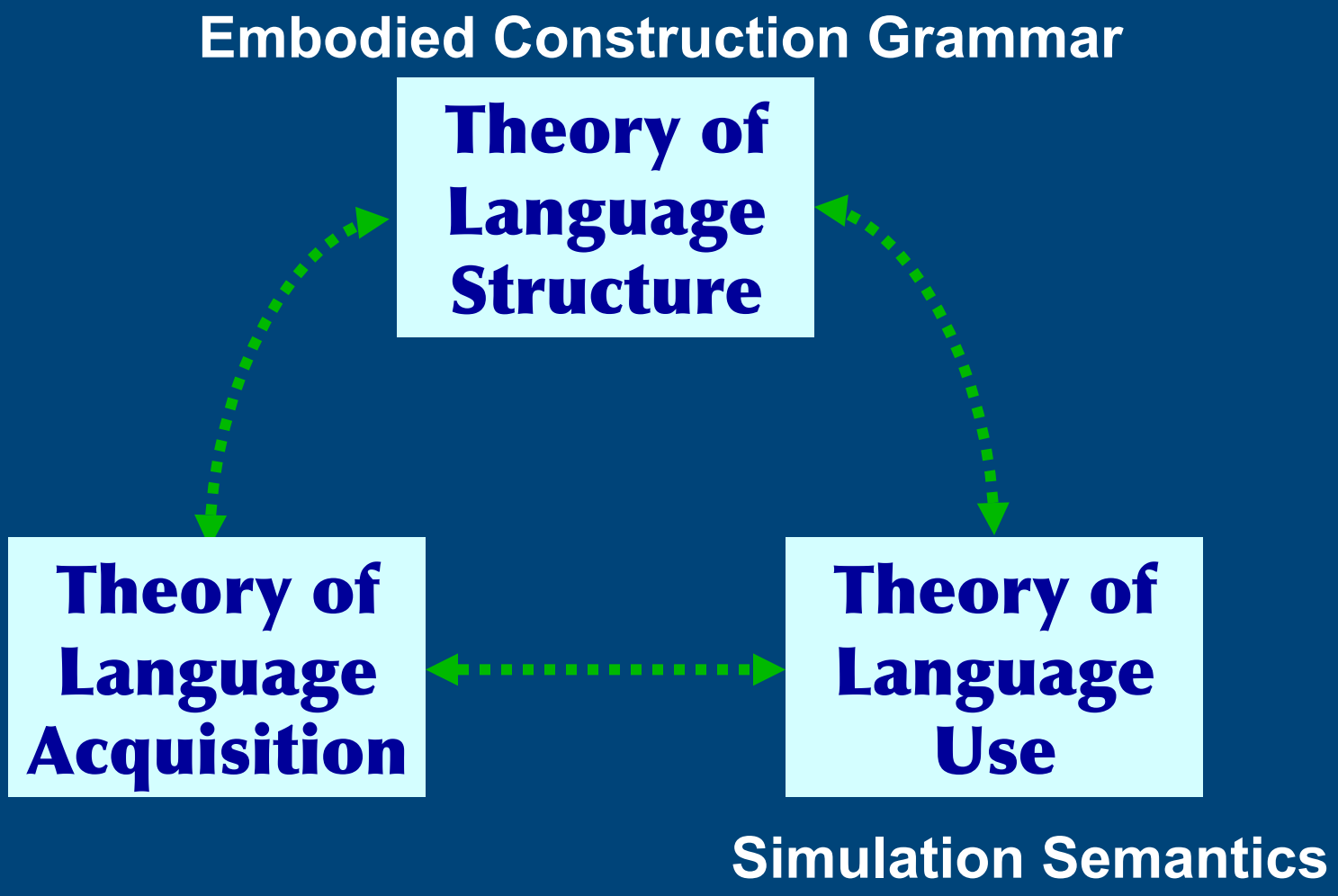



Integrated embodied theories of language

# Applications: Structure

- Motivated basis for crosslinguistic "universals"
  - Common biological / motor basis for representations
  - Faithfully captures richness of event structure
  - Crosslinguistic differences also motivated

- Languages
  - English
  - Russian (Janda, Gerasymova)
  - Mandarin
  - French




Integrated embodied theories of language

# Applications: Usage

- Context-dependent inference
  - Reasoning
    - Special contexts gracefully handled

      He was sneezing for 10 minutes. (slow motion?)
  - Metaphor (Narayanan 1997, 1999), counterfactuals, mental spaces / modality

# Coercion: event operations

- Embodied simulation semantics provides motivated basis for aspectual distinctions as well as possible operations ("coercions") to recover from unexpected combinations.

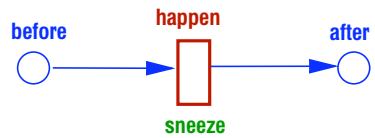
- Coercion operations
  - **Profiling**: She has arrived.
  - **Iteration**: She sneezed for an hour.
  - **Habitual**: She sneezes all the time.
  - **Temporary**: She is living in Paris.
  - **Reversal**: She left for an hour.
  - **Inceptive period**: She walked in a month.

# Transitions

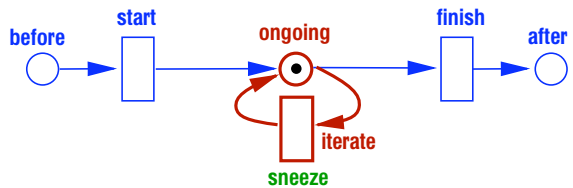
- Some events (e.g. sneezing) lack structure and duration; these correspond to simple x-schema transitions.
- Interaction with controller can affect interpretation

**Marking of ongoing can produce iterative construal:**

**John sneezed.**

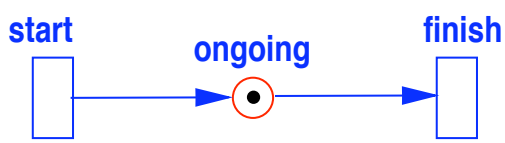



**John was sneezing.**

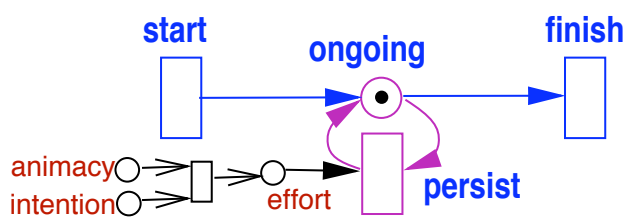


# States and the controller x-schema

- Static situations can correspond to x-schema states
  (little internal structure, no change over time)
- States might also be viewed in context of controller:




a) **temporary reading**




b) **effortful reading**

**Prototypical state reading:**

I live in Texas.

The lamp stands by the doorway.

Bill is silly. / Paul is tall.

The moat surrounds the castle.

The road runs to the store.

**Temporary/effortful reading:**

I am living in Texas.

The lamp is standing by the doorway.

Bill's being silly. / *Paul's being tall.

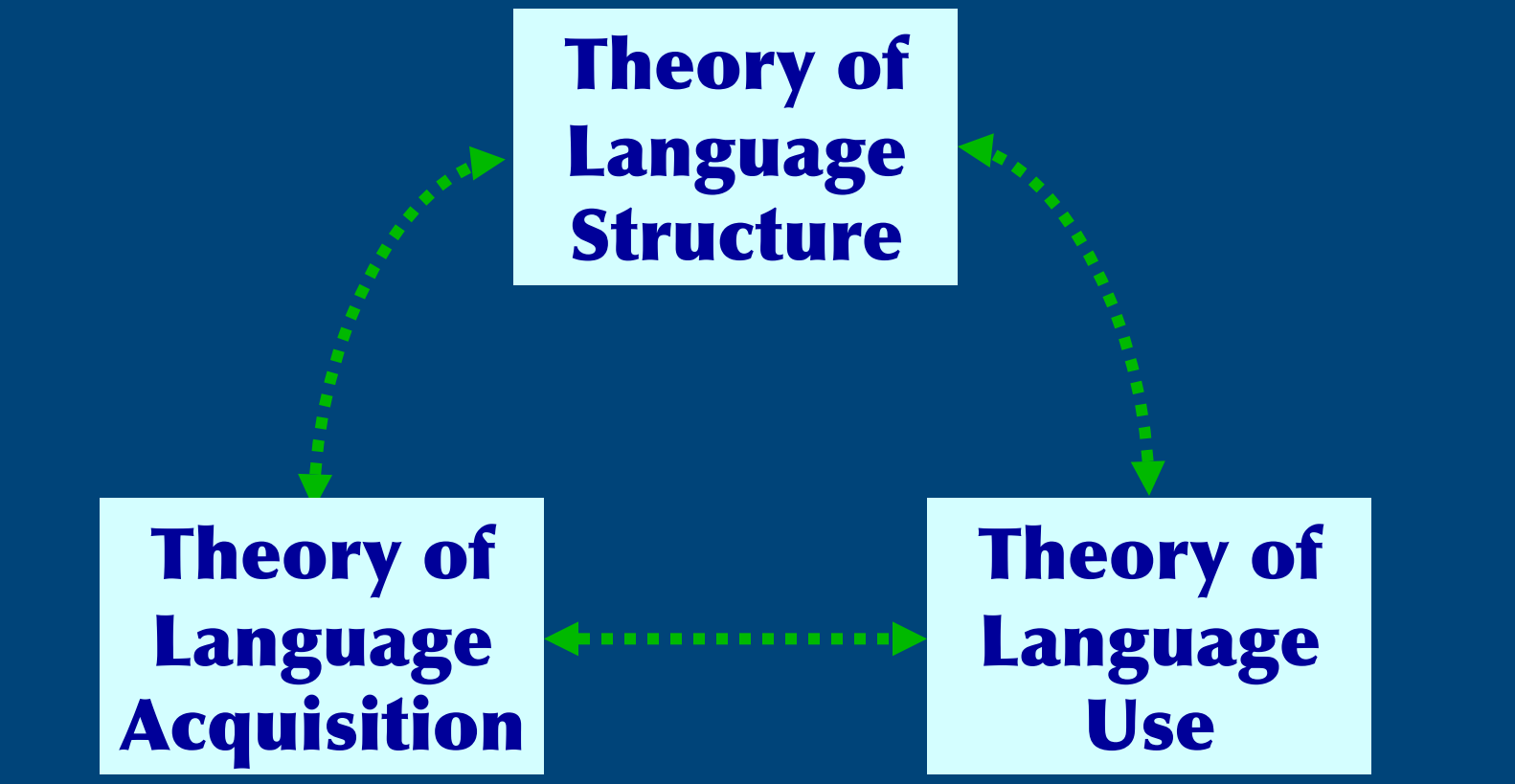
*The moat is surrounding the castle.

*The road is running to the store.

# Applications: Usage

- Psycholinguistic predictions
  - **Progressive** sentences about hand motion facilitate manual action in same direction
  - **Perfect** sentences differing only in aspect do not.
    - Bergen & Wheeler, Brain & Language 2009. Grammatical aspect and mental simulation.

Embodied Construction Grammar




Usage-based Learning

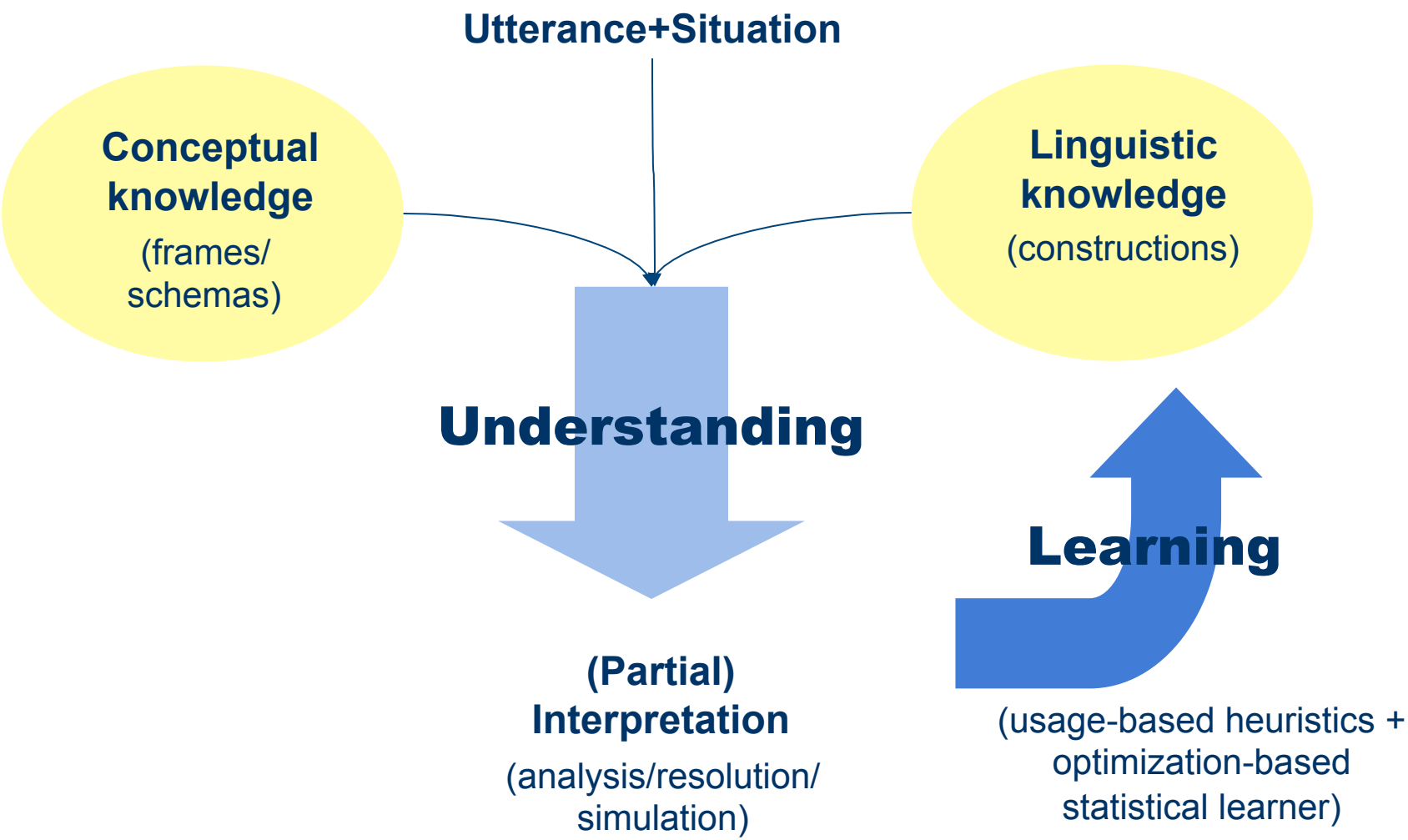
Simulation Semantics

# Integrated embodied theories of language

# Applications: Learning

- Useful starting point for acquisition
  - Candidate universals
  - "Learnability" / complexity constrained in cognitively motivated ways, and measured relative to event structure primitives
    - How complex is a constructional mapping (relational?)
    - How complex is the event semantics
  - May predict developmental trends
- Suggests useful standards for semantic annotation!

# Usage-based learning model

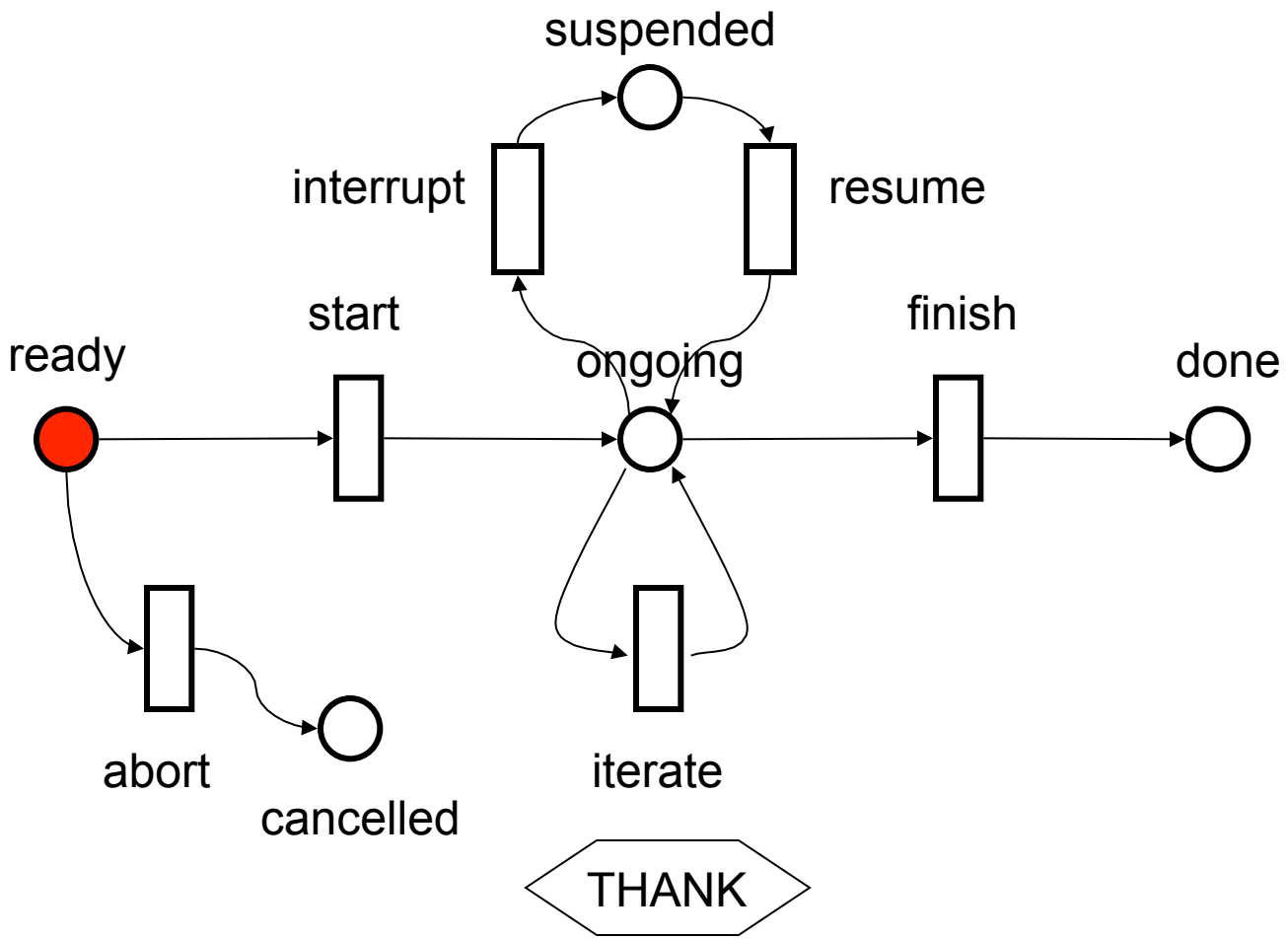


# Summary and outlook

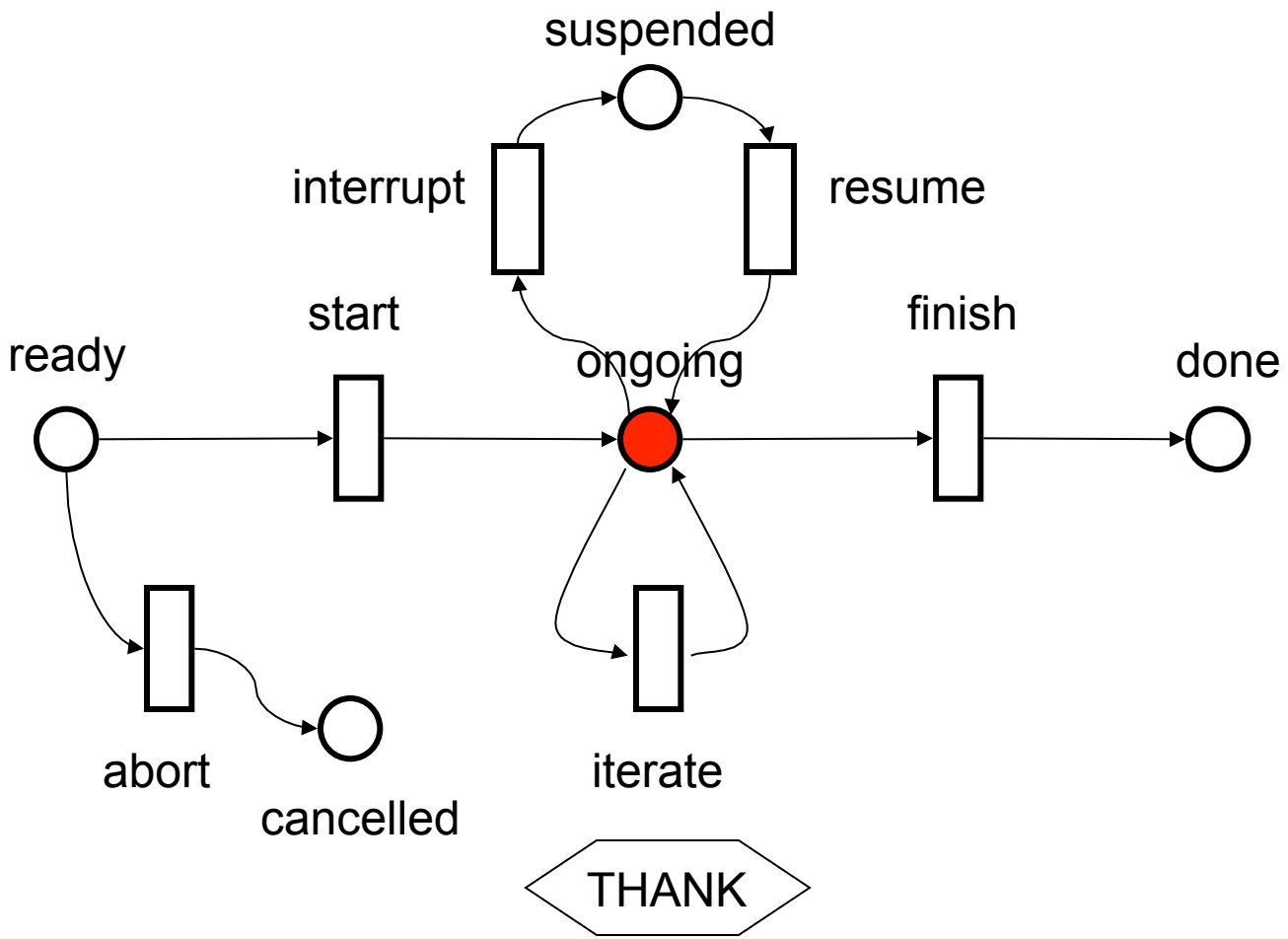
- Simulation-based account of aspectual composition
  - Links embodiment, constructions and context
  - Rich event representation allows precise definition of array of distinctions in literature (and in languages)
    - Compatible with classes/features, but much more expressive

- Toward a "universal" basis for tense-aspect markers
  - Where do conceptual/semantic categories come from?
  - Candidate for salient distinctions available to language learners (child and otherwise)

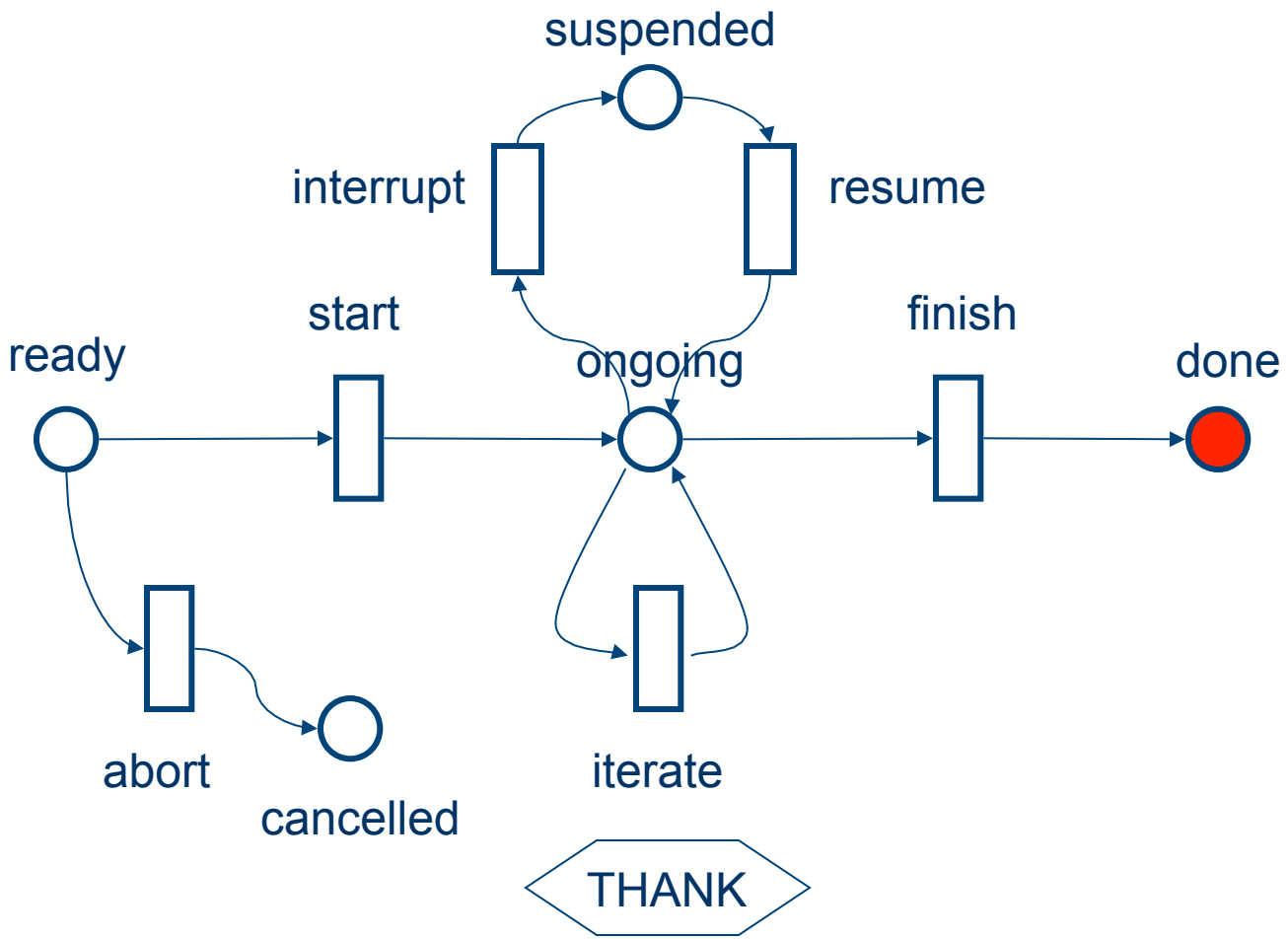
# I *am about to* thank the lovely audience.



# I *am* thank*ing* the lovely audience.



# I *have* thanked the lovely audience.



# …with additional thanks to:

- Srini Narayanan
- Daniel Gildea
- John Bryant
- James Thomas
- Ben Bergen
- Katerina Gerasymova
- Michael Ellsworth
- Carlos Subirats

# p.s. Turing's take…

**"Of all the above fields the learning of languages would be the most impressive, since it is the most human of these activities.**

**This field seems however to depend rather too much on sense organs and locomotion to be feasible."**

Alan M. Turing
Intelligent Machinery (1948)