

Natural Language Generation and Data-To-Text

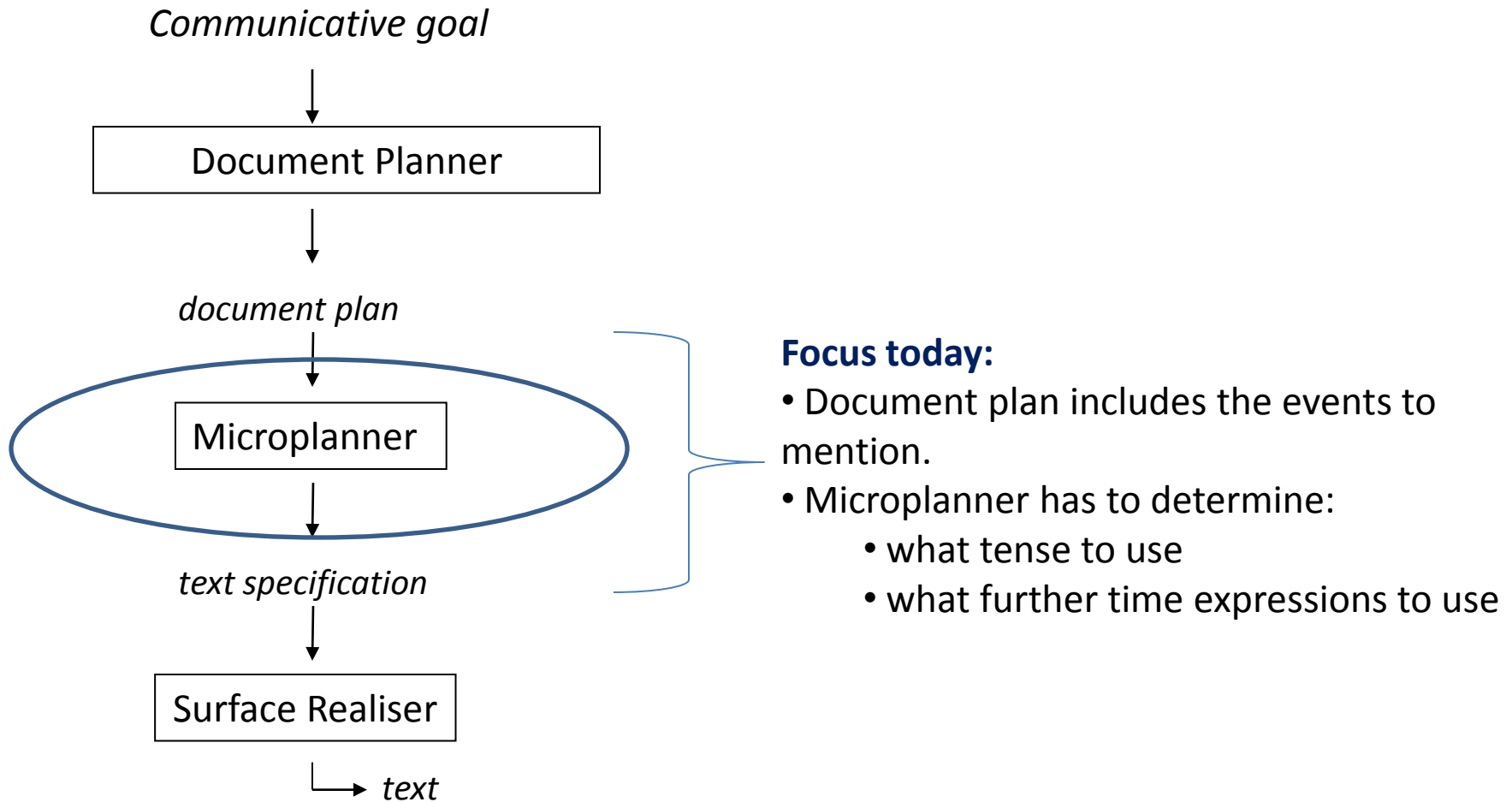
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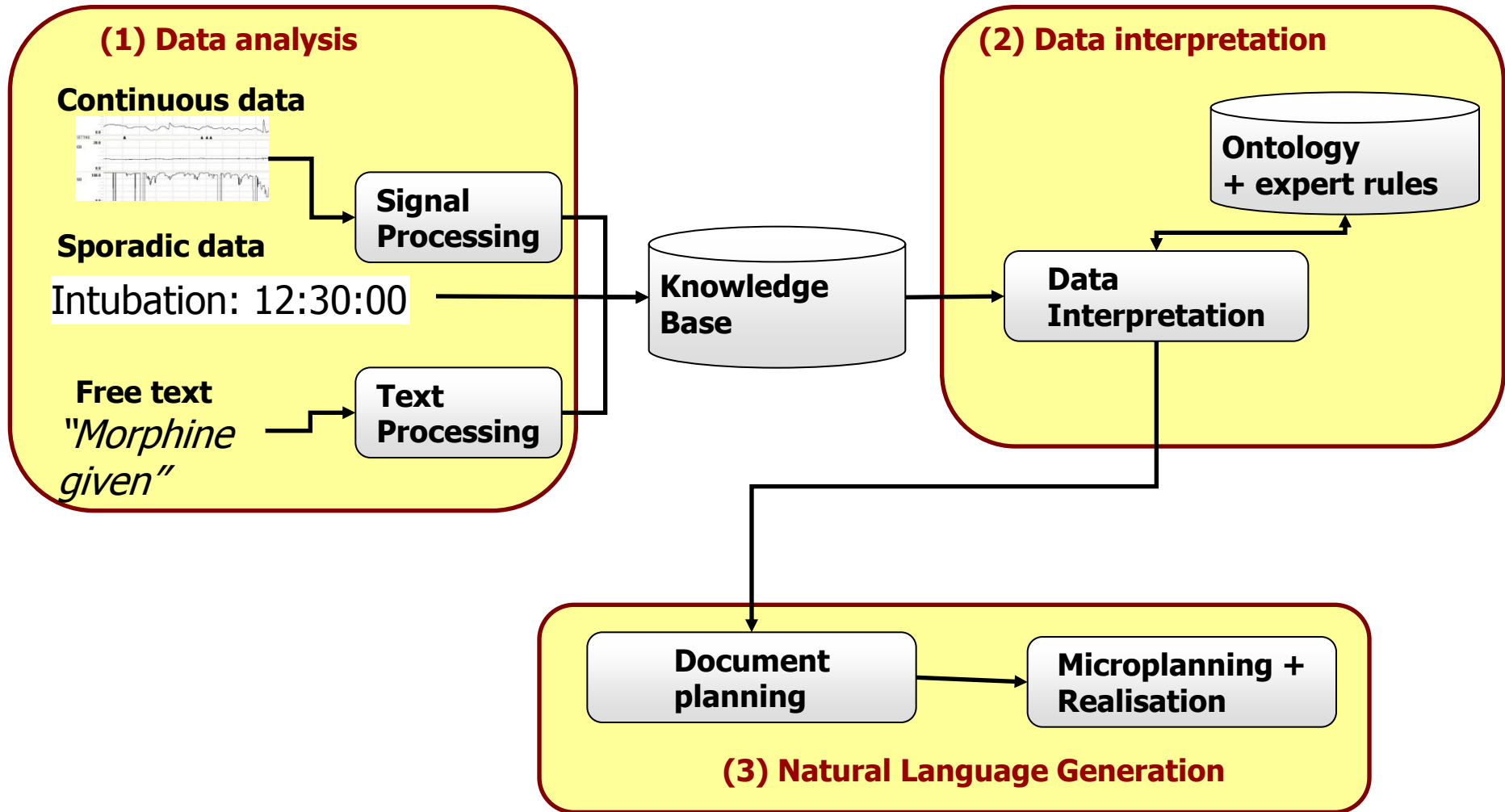
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The “consensus” architecture



BabyTalk architecture



Note

- The following is based on work in progress.
Comments and complaints are very welcome!

Part 1

REPRESENTING TIME IN LANGUAGE

A couple of distinctions

- In Narratology, a distinction is usually made between **what is actually said**, and **what is being recounted**.

Story

- What really happened, in the order in which it happened.
- We can represent the story on a **timeline**.

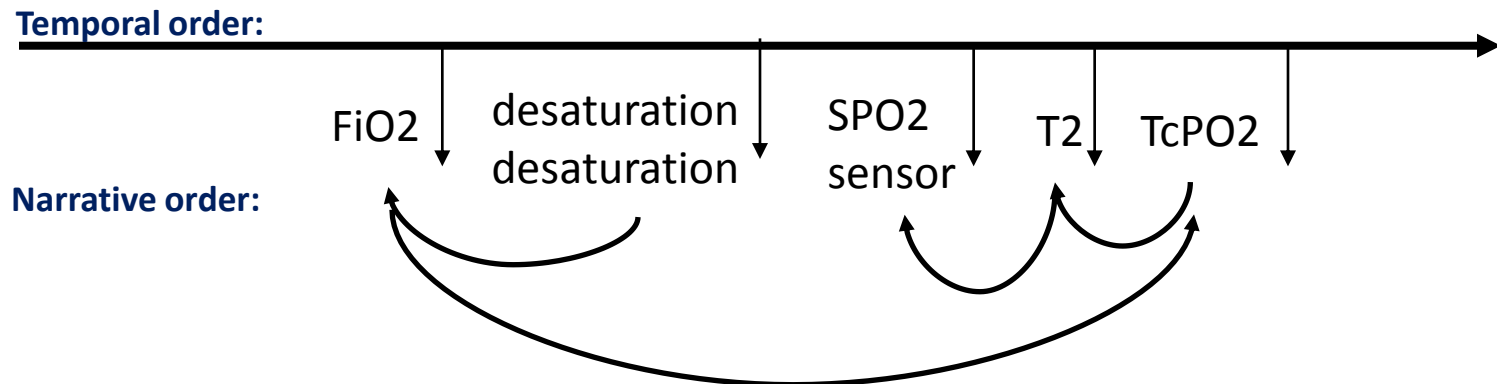
Discourse

- The way the story is narrated.
- Order may be different from the order in which it happened.

The BT-45 example

- The Bt-45 prototype evaluation showed up some problems with handling time.
- Doc planner heuristic:
 - Mention important events first in paragraph
 - Mention related events after.

By 14:40 **there had been 2 successive desaturations** down to 68. **Previously** FIO2 had been raised to 32%. Tcpo2 decreased to 5.0. T2 **had suddenly increased** to 33.9. **Previously** the SPO2 sensor had been re-sited.



Chronological narrative

1. It was Saturday morning at 9:15. Mary and John arrived home after getting last minute supplies for their home improvement project.

2. After organizing their supplies, they got started on the bedroom. It took them until after noon to get the room painted and the new door jams installed.

3. Finally, at 13:30 they were ready to hang the new door. It was heavy and a little too big for the stairwell, but they finally got it upstairs.

4. The next step in their project was the kitchen. With Mary giving the directions, John installed the new kitchen cabinets.

5. It was nearly 7 PM when they finished the final touches on the bathroom, hanging the mirror and other fixtures.

6. John and Mary rested up for a while, had a nice dinner and toasted their success. The house looked beautiful.



1



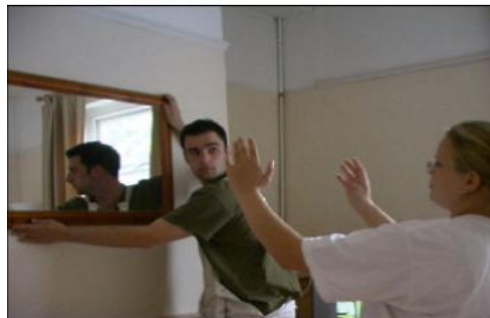
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3



4



5



6

Non-Chronological narrative

6. Marjorie and Derek finally finished moving into their new home in Surrey late in the evening.

1. They started almost 12 h previously moving boxes into the house and readying their supplies for the day ahead.

2. Crazy! They decided it would be a good idea to give the spare room a quick freshen up with new paint - and regretted their decision as soon as they started!

3. They even had to replace a new door on the bathroom so that they all matched.

4. They also decided to change the doors in the kitchen before moving in their food and white goods.

5. Once all the DIY was done they started with the finishing touches.



6



1



2



3



4



5

Temporal vs narrative order

- Temporal order (STORY)
 - What happened, in the order in which it happened.
- Narrative order (DISCOURSE)
 - What happened, but possibly told in a different order from the way it happened.

Time and language, examples

Chronological

(e1) Mary and John **arrived** home...

(e6) John and Mary **rested** up for a while, had a nice dinner and toasted their success.

Non-chronological – original example

(e6) Marjorie and Derek **finally finished** moving into their new home in Surrey late in the evening...

(e1) They **started almost 12h previously**...

Non-chronological – alternative example

(e6) Marjorie and Derek **finished** moving into their new home in Surrey late in the evening...

(e1) They **had started** that morning...

Time and language

- Languages contain various mechanisms to handle time and indicate temporal relationships:
 - tense (past, present, future...)
 - aspect (event, state, ...)
 - temporal expressions (*previously, at 10:00*)
 - ...
- Not all languages have the same mechanisms.
- But we need some model of:
 - Time and events in language
 - How time works in different types of discourse.

Tense across languages

English:

- Uses inflection on the verb (e.g. I open, I opened, I will open)

Maltese:

- Uses inflection on the main verb or temporal particles.

Present	Past	Future
niftaħ open.PRES.1SG 'I open'	rajt open.PAST.1SG 'I opened'	se nara FUT open.PRES.1SG 'I will open'

Mandarin Chinese:

- Apparently Relies on context and temporal markers:

Past	Present/Future
tamen ba-dian-zhong kai-men de <i>they eight-o'clock open-door prt</i> 'they opened at eight o'clock'	tamen ba-dian-zhong kai-men <i>they eight-o'clock open-door</i> 'they (will) open at eight o'clock'

Open question

Given differences in the way time is expressed across languages, can we assume that there is one underlying model of time, which is realised differently in different languages?

(Answer: I don't know)

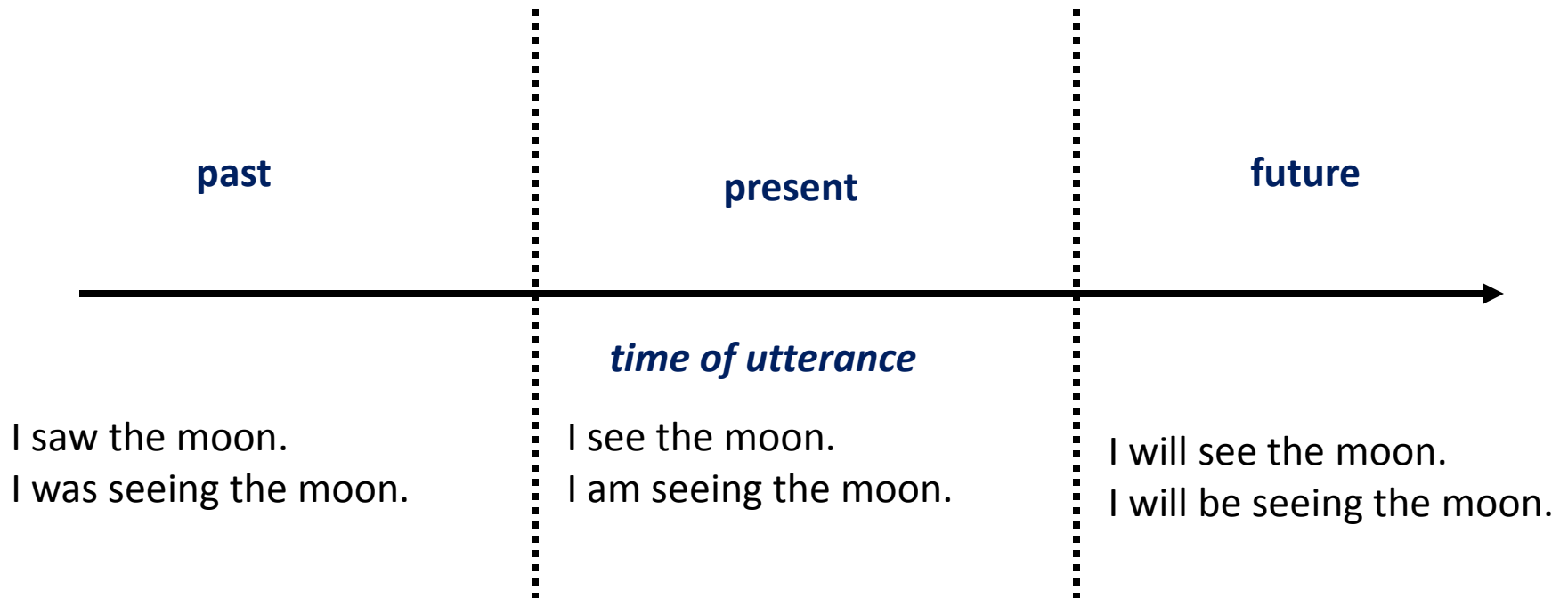
Tense

- The tense system provides grammatical mechanisms to locate events in time.
- Essentially, this is a **relational** view. Tense relates an event to some **reference point**:
 - a time
 - another event.

Absolute tense

- Absolute tenses are those which relate events to the moment of speaking, or **utterance time**.
- Classic distinction between:
 - past
 - present
 - Future

Absolute tense: Graphical characterisation



Absolute tenses and iconicity

*Mary and John arrived home. They started to paint the walls.
They fixed a new door.*

Principle of iconicity

- In the absence of information to the contrary, assume that temporal order = narrative order.
- It seems that if a narrative is formulated using only an absolute tense, a reader will assume by default that the temporal order and narrative order coincide.

Narrative order

arrive home

paint walls

fix door

Temporal order

arrive home

paint walls

fix door



Relative tense

*Mary and John arrived home. They painted the walls.
They **had fixed** a new door (previously).*

Reference points from context

- Instead of relating an event to the speech time, there may be a salient time in context (e.g. Webber '88)
- An event can be related to this time.
- Often, this time is supplied by another event, previously mentioned.
- This is a way of overriding the iconicity default.

Narrative order

arrive home

paint walls

fix door

Temporal order

arrive home

fix door

paint walls

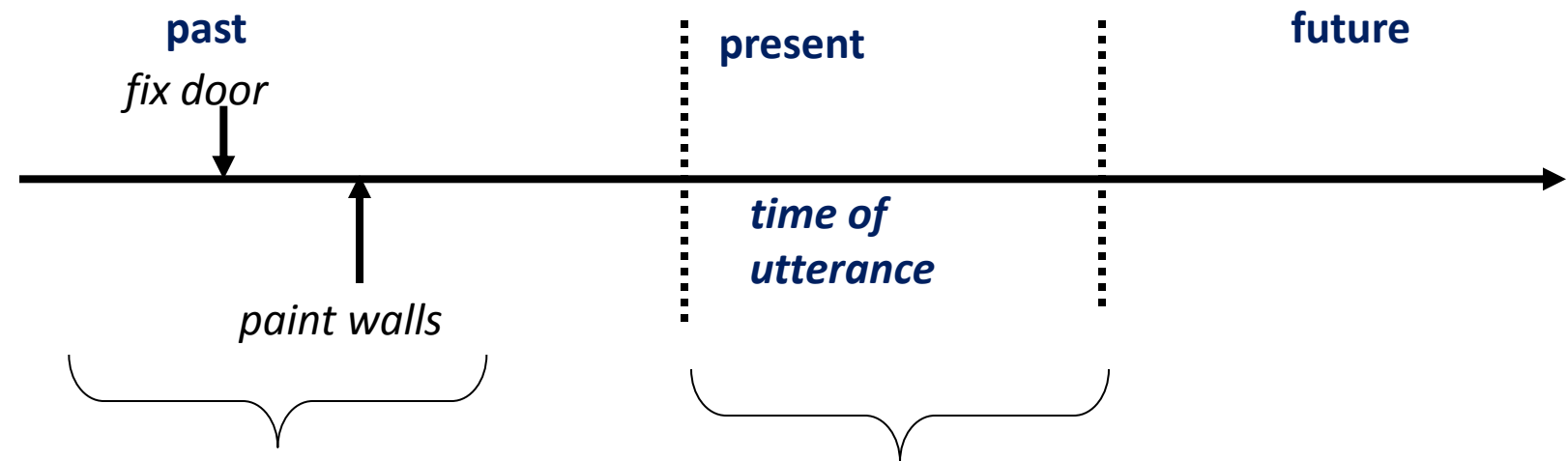


Relative tenses in English

The Perfect in English

- *They painted the walls. They had fixed a new door.*
 - Main reference point: now, moment of speaking
 - Two events: *paint walls* and *fix door*.
 - Relationship to moment of speaking: Both in the past.
 - Relationship to each other: Within the past time, one occurs before the other.

They painted the walls. They had fixed a new door.



time of *fix door* acts as
reference for *paint walls*

main reference point for
past tense is the time of
utterance

Relative tenses in English

The Perfect in English

- *They painted the walls. They had fixed a new door.*
 - Main reference point: now, moment of speaking
 - Two events: *paint walls* and *fix door*.
 - Relationship to moment of speaking: Both in the past.
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Other ways of supplying time points in context

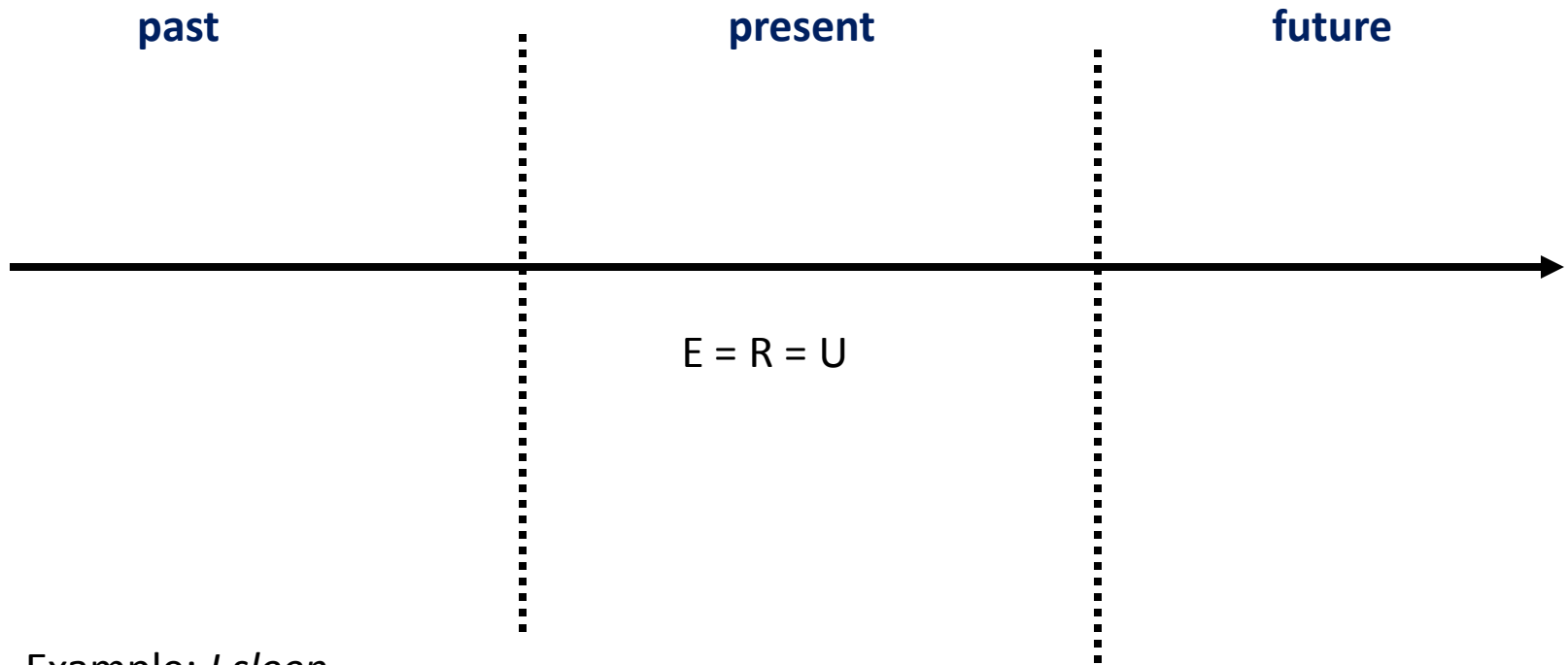
(e6) Marjorie and Derek **finally finished** moving into their new home in Surrey late in the evening...

(e1) They **started almost 12h previously**...

Reichenbach's theory of time

- Hans Reichenbach (1966):
 - proposed a theory to account for both simple and perfect tenses
- System uses three different times:
 - actual event time (**E**)
 - reference time to which event is related (**R**)
 - utterance time (= moment of speaking) (**U**)

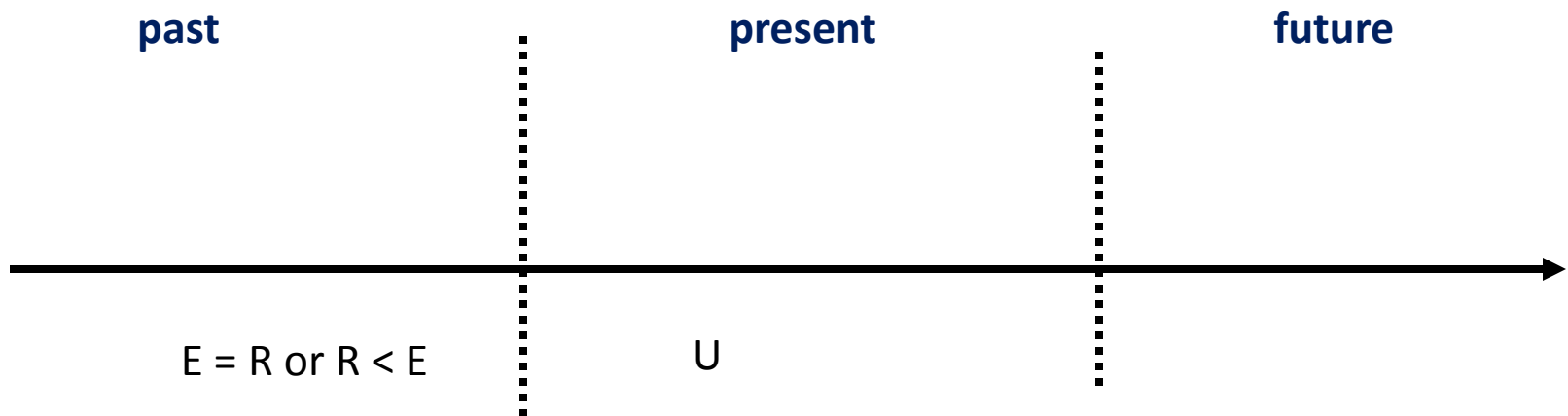
Simple present



Example: *I sleep*

Reference time, utterance time and event time are the same

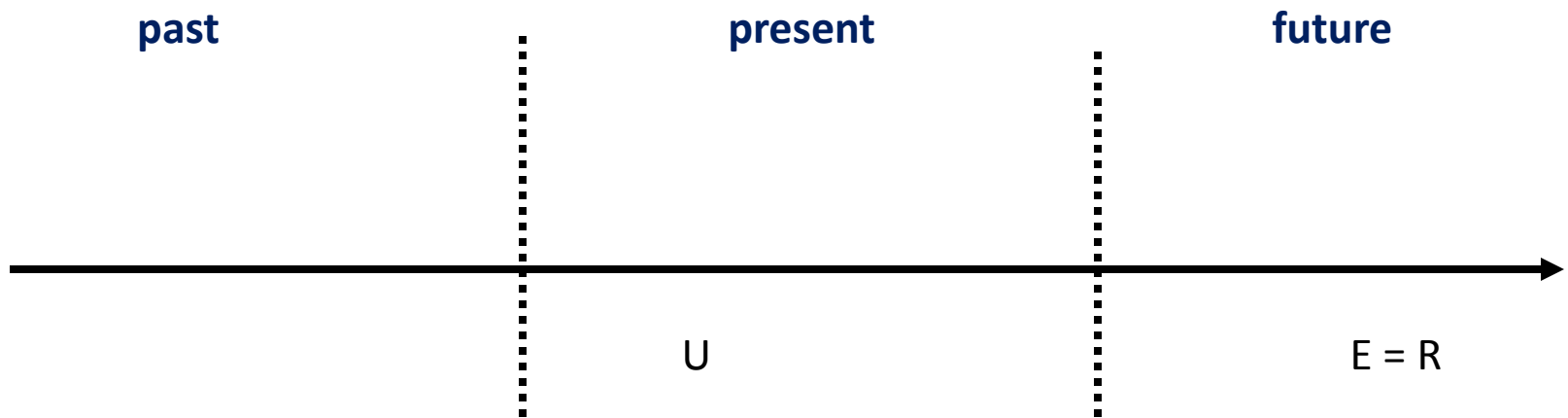
Simple past



Example: *I slept*

- E before U (therefore past)
- R = E (no secondary relation)

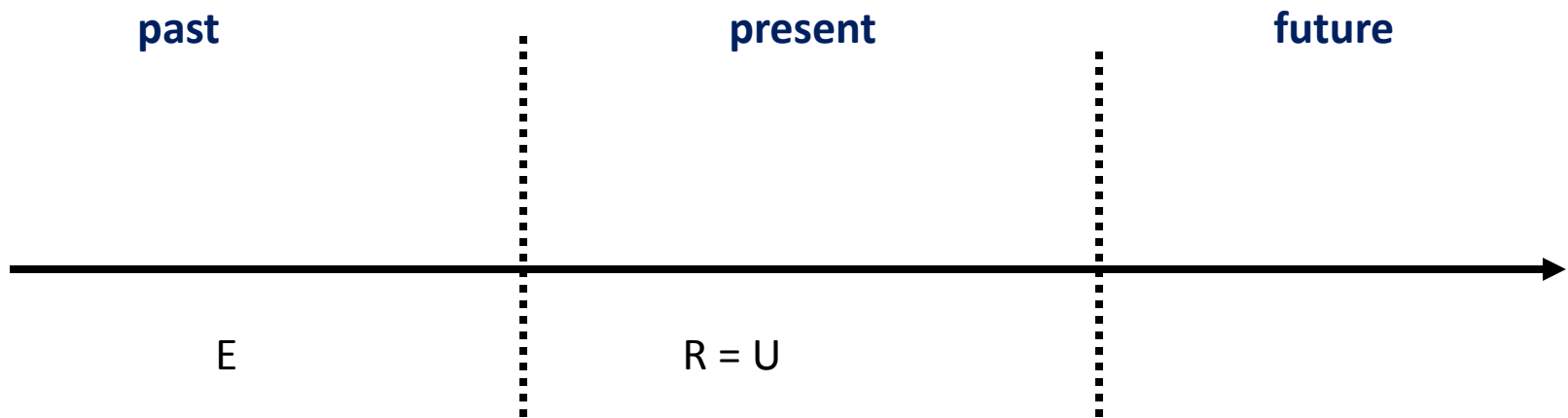
Simple future



Example: *I will sleep*

- E is after U (therefore future)
- R = E (no secondary relation)

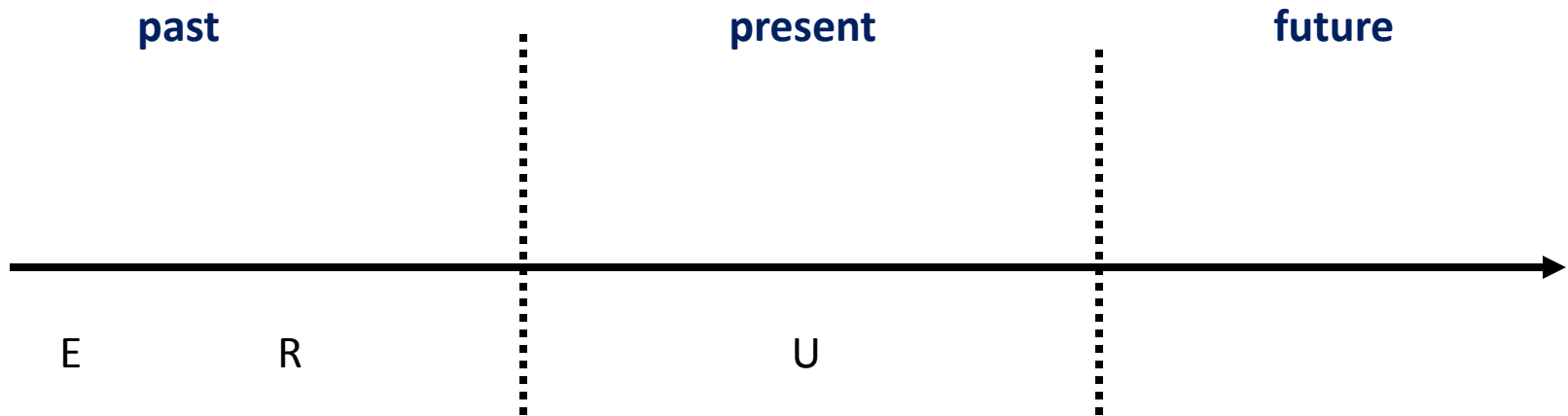
Present perfect



Example: *I have slept*

- E before U (therefore, event understood as having already occurred)
- R = U
- **Relating a past event explicitly to the present**

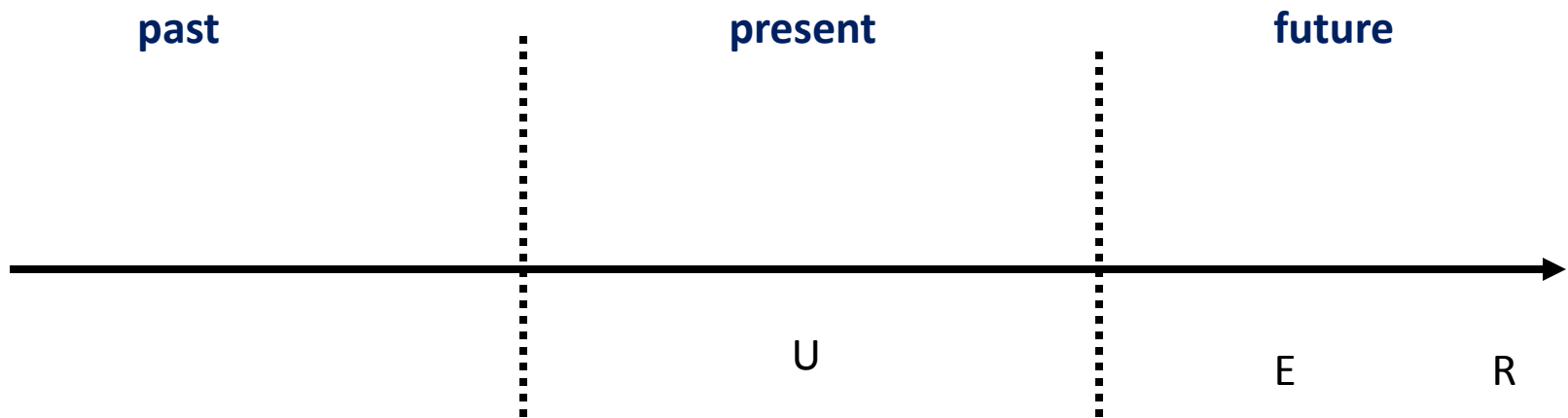
Past perfect



Example: *By the time you arrived, I had slept*

- E before U
- R before U
- R after E
- Relates a past event explicitly to another event that occurred after it, but also in the past.

Future perfect



Example: *By the time you arrive tonight, I will have slept*

- U before E (therefore future)
- U before R
- E before R
- Relates a future event explicitly to another event in the future which occurs after it

Interim summary

- Tense is a way of locating events in time. It is relational. Events are related to:
 - the utterance or speech time
 - a time that is made salient in context.
- Distinction between:
 - absolute tenses
 - relative tenses
- Reichenbach's model uses three temporal parameters to describe the semantics of different tenses.

Part 2

HANDLING TIME IN BT-NURSE

The challenge for NLG

- In the generation of complex, “narrative” texts, the ordering of information may not be based on time.
 - BabyTalk doc planning is a case in point.
- The microplanner needs to ensure that:
 - even though temporal order and narrative order don’t coincide,
 - the reader can **still understand the temporal order**
 - We will look at a way of implementing Reichenbach’s theory.

A computational problem

Aims

- We want to implement a system to generate narrative text using:
 - The right tenses to indicate temporal order
 - The right temporal expressions.

But...

- If we want to implement Reichenbach's theory, we need to work out where the three times come from.

Some assumptions

Structure of events

- We assume that events consist minimally of:
 - A type (e.g. DRUG_ADMIN)
 - A start and end time

DRUG_ADMIN	
<i>start</i>	12:31
<i>end</i>	12:31
<i>patient</i>	baby_001
<i>drug_given</i>	dopamine_001
<i>drug_amount</i>	10mg

Types of events

- We also assume a basic distinction between:
 - **Events**: *the baby was given dopamine*
 - **States**: *the baby is on dopamine*

A computational problem

- Based on our assumptions, we know we have:
 - Event time (given in the event representation)
 - Utterance time (this is just the time at which we're generating a text).
- But what about reference time?
 - We will see that this depends on what kind of discourse we are generating.

Human summary, BT-Nurse domain

Current assessment

Respiratory effort reasonably good, his total resp rate being 40–50 breaths/minute while the ventilator rate is 20. [...]

Events during the shift

[...] After blood gas at 23:00 ventilation pressure reduced to 14/4. CO₂ was 4.1 and tidal volumes were 3.8–4 ml at that time. After a desaturation 3 hours later down to 65% pressures were put back to 16/4. He has had an oxygen requirement of 26% since this episode.

Potential problems

Small ETT could become blocked or dislodged – ongoing assessment of need for suction; ensure ETT is secure.

Corpus summary

- Shift summary written by a senior neonatal nurse;

Main properties

- Several events;
- Summary tells a “story” relating events during shift to current state.

Challenges for NLG

- Ensuring that narrative is coherent.

Challenges for NLG I: Discourse Mode

Current assessment

Respiratory effort reasonably good, his total resp rate being 40–50 breaths/minute while the ventilator rate is 20. [...]

Events during the shift

[...] After blood gas at 23:00 ventilation pressure reduced to 14/4. CO₂ was 4.1 and tidal volumes were 3.8–4 ml at that time. After a desaturation 3 hours later down to 65% pressures were put back to 16/4. He has had an oxygen requirement of 26% since this episode.

Potential problems

Small ETT could become blocked or dislodged – ongoing assessment of need for suction; ensure ETT is secure.

Background mode

- static: mostly states or observations
- All events related to the utterance time (**absolute**)

Challenges for NLG I: Discourse Mode

Current assessment

Respiratory effort reasonably good, his total resp rate being 40–50 breaths/minute while the ventilator rate is 20. [...]

Events during the shift

[...] After blood gas at 23:00 ventilation pressure reduced to 14/4. CO₂ was 4.1 and tidal volumes were 3.8–4 ml at that time. After a desaturation 3 hours later down to 65% pressures were put back to 16/4. He has had an oxygen requirement of 26% since this episode.

Potential problems

Small ETT could become blocked or dislodged – ongoing assessment of need for suction; ensure ETT is secure.

Background mode

- static: mostly states or observations
- All events related to the utterance time (**absolute**)

Narrative mode

- dynamic: the narrative time moves forward;
- events are related to each other in time (**relative**)

Challenges for NLG II: Temporal anchoring

Current assessment

Respiratory effort reasonably good, his total resp rate being 40–50 breaths/minute while the ventilator rate is 20. [...]

Events during the shift

[...] **After blood gas at 23:00** ventilation pressure reduced to 14/4. CO2 was 4.1 and tidal volumes were 3.8–4 ml **at that time**. After a desaturation **3 hours later** down to 65% pressures were put back to 16/4. He has had an oxygen requirement of 26% **since this episode**.

Potential problems

Small ETT could become blocked or dislodged – ongoing assessment of need for suction; ensure ETT is secure.

- In narrative mode, events need not be reported in temporal order.
- Located in time via:
 - temporal relations using tense;
 - explicit timestamps.

Challenges for NLG III: Temporal focus

Current assessment

Respiratory effort reasonably good, his total resp rate being 40–50 breaths/minute while the ventilator rate is 20. [...]

Events during the shift

[...] After blood gas at 23:00 ventilation pressure reduced to 14/4. CO₂ was 4.1 and tidal volumes were 3.8–4 ml at that time. After a desaturation 3 hours later down to 65% pressures were put back to 16/4. **He has had an oxygen requirement of 26% since this episode.**

Potential problems

Small ETT could become blocked or dislodged – ongoing assessment of need for suction; ensure ETT is secure.

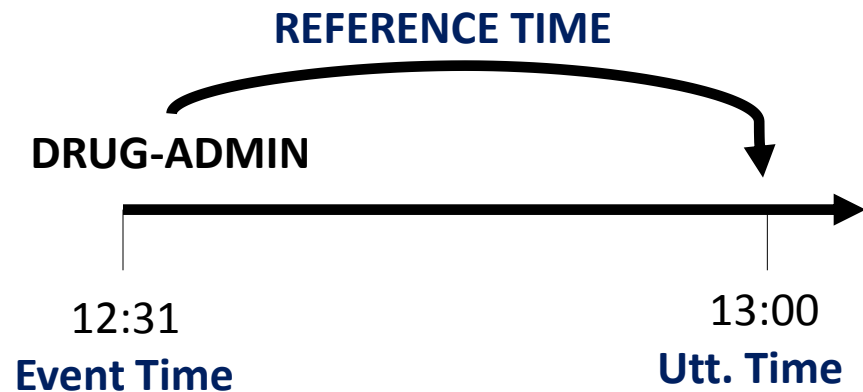
- Focusing mechanisms highlight different parts of an event.
- Simple “nuclear” focus:
 - His oxygen was raised to 26%.
- End/consequent state focus:
 - He has been on 26% oxygen since then.

The temporal model: Reference time

In background mode: Case 1

- We assume that reference time is equal to the utterance time.
- This gives rise to the “static” effect of this kind of discourse.

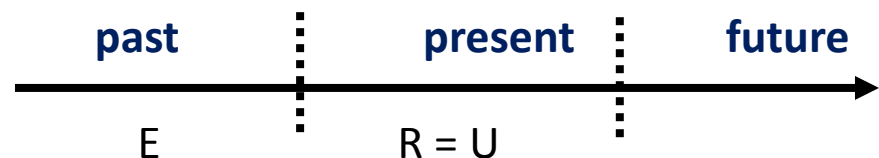
DRUG_ADMIN	
<i>start</i>	12:31
<i>end</i>	12:31
<i>patient</i>	baby_001
<i>drug_given</i>	dopamine_001
<i>drug_amount</i>	10mg



In this example:

- Reichenbach’s model would predict we use present perfect.

He has been given dopamine



The temporal model: Reference time

In background mode: Case 2

- Suppose we have a state, rather than an event.
- The state is true at the present time.

<i>CMV</i>	
<i>start</i>	12:31
<i>end</i>	12:31
<i>patient</i>	baby_001

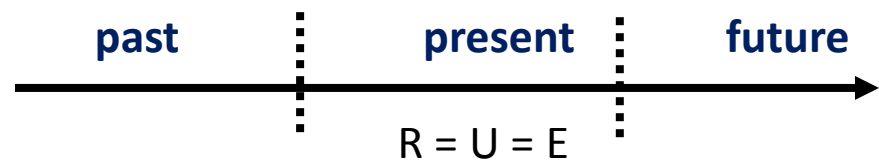
CMV
12:31
Event Time
Utt. Time

REFERENCE TIME

In this example:

- Reichenbach's model would predict we use simple present.

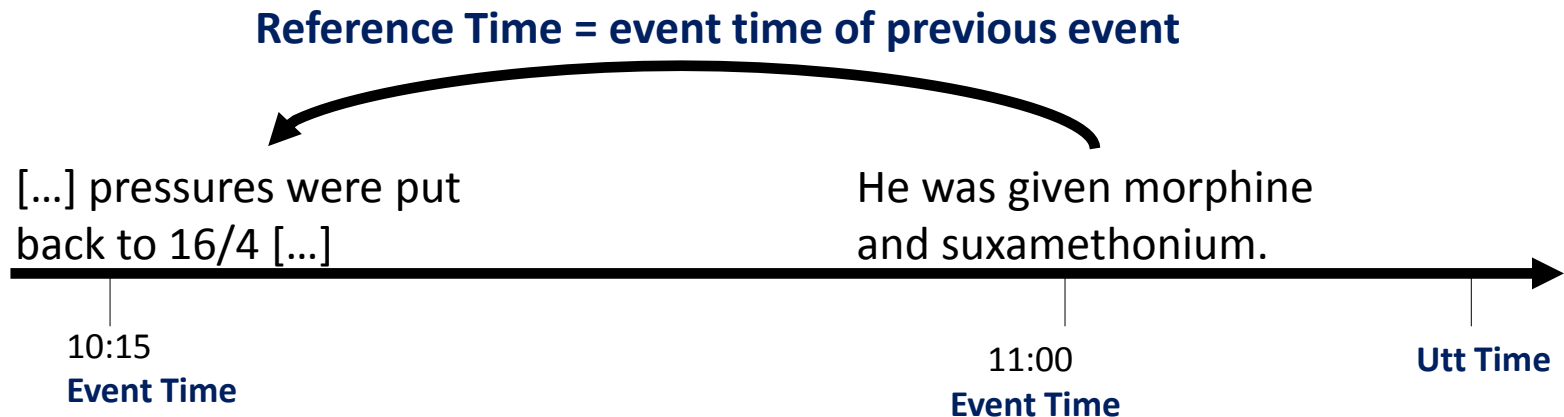
He is on CMV.



The temporal model: Reference time

In narrative mode: Case 1

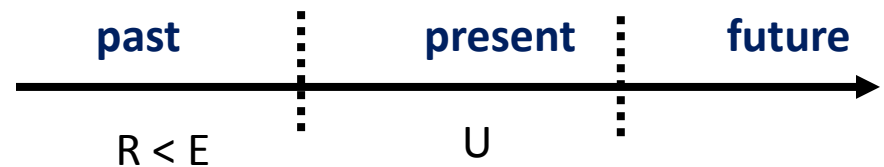
- Here, events are not related to the present, but to each other.



In this example:

- Reichenbach's model would predict we use simple past.

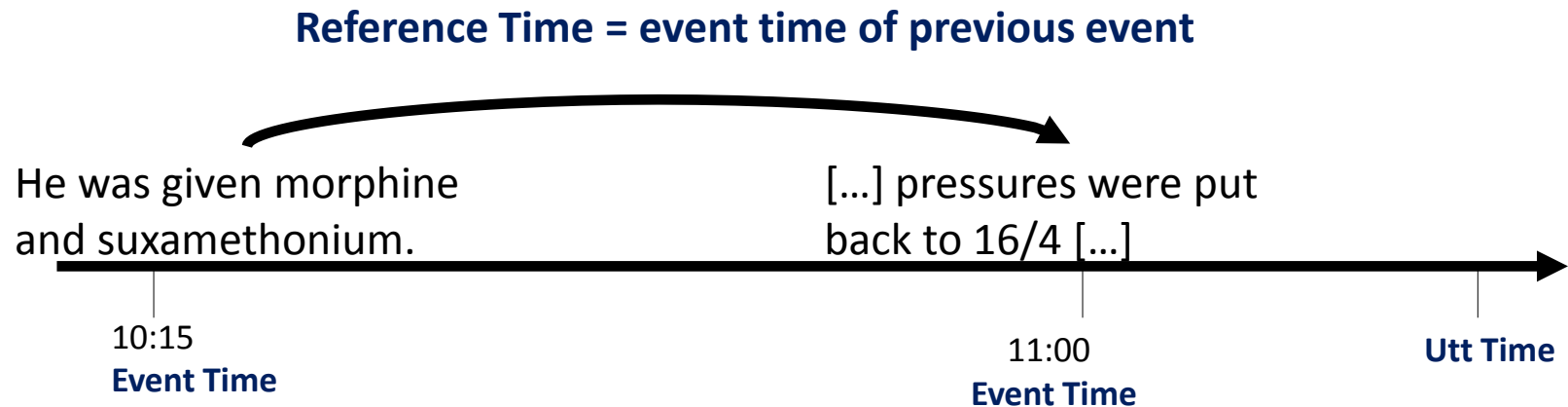
He was given morphine...



The temporal model: Reference time

In narrative mode: Case 2

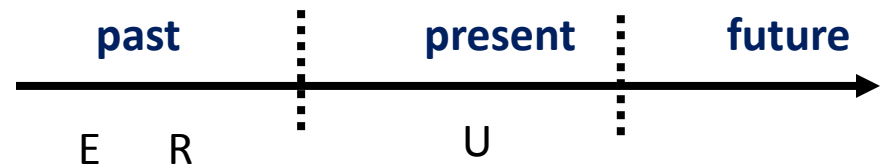
- What happens when temporal and narrative order conflict?



In this example:

- We want to mention pressures before morphine...
- Reichenbach's model would predict we use past perfect.

Pressures were put back... He had been given morphine...



The event model

Focus mechanism (Moens & Steedman '88)

- We can think of an event as consisting of:
 - start state
 - nucleus
 - consequence/end state

[DRUG_ADMIN	
<i>start</i>	12:31
<i>end</i>	12:31
<i>patient</i>	baby_001
<i>drug_given</i>	dopamine_001
<i>drug_amount</i>	10mg

Nucleus

actual administration
of the drug

Consequent state

baby's being on the drug

Partly a knowledge-
based inference!
Not all drugs have this
consequent state.

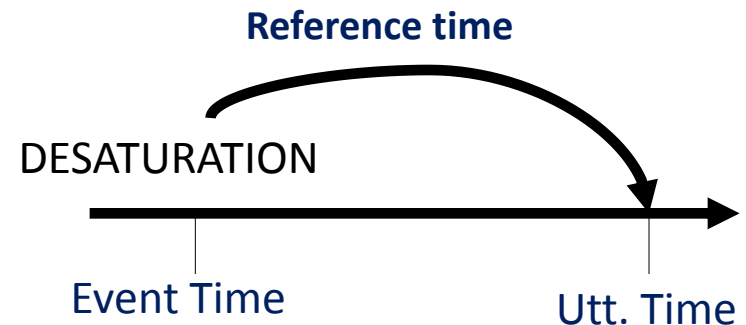
Discourse Mode

Background mode

- discourse provides reference time (= time of utterance)
- Events and states related to moment of speaking.
 - Present or Present Perfect tense
- Implies current relevance.
(Caenepeel '95, Smith '06)

BT-Nurse text

SaO2 is variable within the acceptable range and **there have been some desaturations** down to 38.



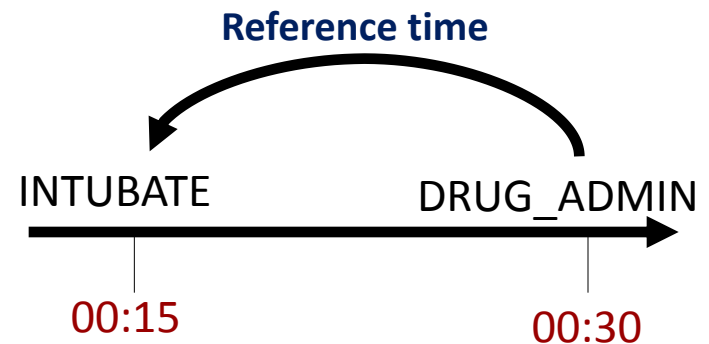
Discourse Mode

Narrative mode

- Last-mentioned event in discourse provides the Reference Time.
 - Simple Past or Past Perfect tenses
- Narrative time moves forward.
 - Implies continuity.(Caenepeel '95, Smith '06)

BT-Nurse text


The baby **was intubated** at 00:15 and was on CMV. [...] He **was given morphine and suxamethonium**.



Timestamps

Background mode

- Modifiers relate event to time of utterance.
- States
 - reported as holding in the present.
- Events:
 - reported in terms of proximity to the present.



Currently, the baby is on CMV in 27 % O2.

The last ET suction was done at around 05:15.

Timestamps

Narrative mode

- Short-term vs. long-term trends/abstractions.
- Events vs. consequent states.

2 short trends (aggregated)

At around 23:30, urine output rate rose [...] and had dropped by around 05:15.

1 long trend

Between 00:00 and 07:45, HR decreased

Simple event

At around 15:00, he was given suxamethonium.

Consequent state

He has been on suxamethonium since this morning.

Temporal relations

General strategy

- Use domain knowledge to merge events which are of the same type.

At around 23:30, urine output rate rose from 4.4 ml/kg/hour to 5.86 ml/kg/hour and had dropped to 2.84 ml/kg/hour by around 05:15.

- Can give rise to implicit causal inferences.

The baby was intubated and was put on CMV.

→

(CMV only used after intubation)

Temporal focus

Focus mechanism

- Focus can be on the entire occurrence (nucleus) or just the consequence.
 - Depends on type of event
- This interacts with argument structure.

Nuclear focus

The baby was given suxamethonium at 10:00.

End state focus

The baby has been on suxamethonium since 10:00.

Nuclear focus

Urine output rate rose from 4.4 ml/kg/hour to 5.86 ml/kg/hour.

End state focus

Urine output rate rose to 5.86 ml/kg/hour.

Summary

- Scaling up to full shift summaries required a stronger focus on temporal issues in text.
 - Discourse in long texts is not uniform. There are “modes” in which time works differently.
 - Because events can be recounted in many orders, it is crucial to locate them in time using time stamps and relations.
 - Focusing mechanisms are required to shift the viewpoint from a whole event to its consequences (“coercion”).