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Posits and Assertions LARS RÖNNBÄCK



definition of a posit and its dereferencing set set of ordered pairs, the second a data value, and the third a time ordered pair of a unique identifier and a string.

definition of an assertion **Concurrent-reliance-temporal:** An *assertion* is a predicate, $assert(P, p, \alpha, T)$, taking four arguments, where the first argument is a unique identifier, the second a posit, the third a real number in the range [-1, 1], and the fourth a time point. Uni-temporal: An *assertion* is a predicate, assert(p), taking a posit as its argument.

A posit is a triple, $[\{(i_1, r_1), \dots, (i_n, r_n)\}, v, t]$, where the first element is a point. The set is called a dereferencing set, where each member is an



It's Monday. Archie invites you to meet him and Bella for lunch on Friday.



It's *Monday*. Archie invites you to meet him and Bella for lunch on Friday.

POSITING TIME CHANGING TIME



POSITOR

POSITING TIME CHANGING TIME

It's Monday. Archie invites you to meet him and Bella for lunch on Friday.



POSITOR It's Monday. Archie invites you

POSITING TIME CHANGING TIME

It's Monday. Archie invites you to meet him and Bella for lunch on Friday.

HAPPENING TIME



POSITORMEETINGMEETING TYPEIt's Monday. Archie invites you to meet him and Bella for lunch on Friday.

POSITING TIME CHANGING TIME

HAPPENING TIME



POSITOR

POSITING TIME CHANGING TIME MEETING

MEETING TYPE

It's Monday. Archie invites you to meet him and Bella for lunch on Friday. PARTICIPANTS HAPPENING TIME



POSITOR MEETING It's Monday. Archie invites you to meet him and Bella for lunch on Friday. PARTICIPANTS HAPPENING TIME

POSITING TIME CHANGING TIME

{(Archie, [{(#42, (Archie, [{(#42, (The Database, [{(#42, attendees)}, 2, monday], 1, MONDAY)} {(Archie, [{(#42, meeting), (#1, participant)}, accepted, monday], 1, MONDAY),

(You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, MONDAY)}

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MEETING TYPE

ASSERT (P, p, α, T)

POSIT $p = [\{(i_1, r_1), ..., (i_n, r_n)\}, v, t?]$

-], 1, MONDAY), Friday], 1, MONDAY),

lunch

- type)}, date)},
- (Bella, [{(#42, meeting), (#2, participant)}, accepted, monday], 1, MONDAY),



POSITOR MEETING **MEETING TYPE** It's Monday. Archie invites you to meet him and Bella for lunch on Friday. **POSITING TIME** PARTICIPANTS HAPPENING TIME

CHANGING TIME

IDENTITIES

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		(Archie,	[{(#42	2,
	(The D	atabase,	[{(#42	2, at
(Archie,	[{ (#42 ,	meeting),	(#1,	part
(Bella,	[{ (#42 ,	<pre>meeting),</pre>	(#2,	part
(You,	[{ (#42 ,	meeting),	(#3,	part

L,	MONDAY),)
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- MONDAY), 2, monday], 1, MONDAY)}
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- lunch Friday
- type)}, date)}, tendees)},
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IDENTITIES

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	(The	Database,	[{(#42	2, at
hie,	[{(#42,	<pre>meeting),</pre>	(#1,	part
lla,	[{(#42,	<pre>meeting),</pre>	(#2,	part

(You, [{(#42, *meeting*), (#3, *participant*)}, pending, monday], 1, MONDAY)}

MEETING

MEETING TYPE

It's Monday. Archie invites you to meet him and Bella for lunch on Friday. PARTICIPANTS HAPPENING TIME

ROLES

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POSITOR MEETING It's Monday. Archie invites you to meet him and Bella for lunch on Friday. **POSITING TIME** PARTICIPANTS HAPPENING TIME

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	(The	Database,	[{(#42	2, at
(Archie,	[{(#42,	meeting),	(#1,	part
(Bella,	[{(#42,	meeting),	(#2,	part
(You,	[{(#42,	meeting),	(#3,	part

MEETING TYPE

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- lunch Friday

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POSITOR

POSITING TIME CHANGING TIME

IDENTITIES

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	(The	Database,	[{(#42	2, at
(Archie,	[{(#42,	meeting),	(#1,	part
(Bella,	[{(#42,	meeting),	(#2,	part
(You,	[{(#42,	meeting),	(#3,	part

MEETING

MEETING TYPE

It's Monday. Archie invites you to meet him and Bella for lunch on Friday. PARTICIPANTS HAPPENING TIME

RELIABILITIES

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-], 1, MONDAY),
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VALUES

- lunch Friday

ROLES

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POSITOR

POSITING TIME CHANGING TIME

IDENTITIES

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(Archie,	[{(#42,	meeting),	(#1,	part
(Bella,	[{(#42,	meeting),	(#2,	part
(You,	[{(#42,	meeting),	(#3,	part

MEETING

MEETING TYPE

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It's Monday. Archie invites you to meet him and Bella for lunch on Friday. PARTICIPANTS HAPPENING TIME

RELIABILITIES

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- 2, monday], 1, MONDAY)}

VALUES

- lunch Friday

ROLES

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icipant)}, accepted, monday], 1, MONDAY), icipant)}, accepted, monday], 1, MONDAY), icipant)}, pending, monday], 1, MONDAY)}



POSITOR MEETING **MEETING TYPE** It's Monday. Archie invites you to meet him and Bella for lunch on Friday.

POSITING TIME CHANGING TIME

IDENTITIES

		{(Archie,	[{(#42	2,
		(Archie,	[{(#42	2,
	(The	Database,	[{(#42	2, at
(Archie,	[{(#42,	meeting),	(#1,	part
(Bella,	[{(#42,	meeting),	(#2,	part
(You,	[{(#42,	meeting),	(#3,	part

],

PARTICIPANTS

HAPPENING TIME

RELIABILITIES

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-], 1, MONDAY),
- 2, monday], 1, MONDAY)}

- VALUES lunch
- Friday

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- type)}, date)}, tendees)},
- icipant)}, accepted, monday], 1, MONDAY), icipant)}, accepted, monday], 1, MONDAY), icipant)}, pending, monday], 1, MONDAY)}



POSITOR MEETING It's Monday. Archie invites you to meet him and Bella for lunch on Friday.

POSITING TIME CHANGING TIME

Concurrent-reliance-temporal Anchor Modeling

Someone is at some time somewhat sure about something (or its opposite).

IDENTITIES

		{(Archie,	[{(#42	2,
		(Archie,	[{(#42	2,
	(The I	Database,	[{(#42	2, at
Archie,	[{(#42,	meeting),	(#1,	part
(Bella,	[{(#42,	meeting),	(#2,	part
(You,	[{(#42,	meeting),	(#3,	part

MEETING TYPE

PARTICIPANTS

HAPPENING TIME

RELIABILITIES

$\mathbf{T}_{\mathbf{T}}$, mondary,	1,	MONDAY)	,
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-], 1, MONDAY),
- 2, monday], 1, MONDAY)}

VALUES

- lunch Friday

ROLES

type)}, date)}, ttendees)},

ticipant)}, accepted, monday], 1, MONDAY), ticipant)}, accepted, monday], 1, MONDAY), ticipant)}, pending, monday], 1, MONDAY)}



POSITOR It's Monday. Archie invites you to meet him and Bella for lunch on Friday. **POSITING TIME** PARTICIPANTS HAPPENING TIME **CHANGING TIME**

Uni-temporal Anchor Modeling

Everyone is always completely sure about all the same things (and no opposites).

IDENTITIES

{(Archie, [{(#42, (Archie, [{(#42, (The Database, [{(#42, attended)

{(Archie, [{(#42, meeting), (#1, participa (Bella, [{(#42, meeting), (#2, participa (You, [{(#42, meeting), (#3, participa

MEETING

MEETING TYPE

OLES	VALUES	RELIABILITIES
<pre>/pe)}, ate)}, ees)},</pre>	lunch Friday 2,	<pre>], 1, MONDAY),], 1, MONDAY), monday], 1, MONDAY)}</pre>
ant)}, ant)}, ant)},	<pre>accepted, accepted, pending,</pre>	<pre>monday], 1, MONDAY), monday], 1, MONDAY), monday], 1, MONDAY)}</pre>



An assertion is called *positive* when the reliability is above zero. (Archie, [{(#42, *date*)}, Friday], 1, MONDAY)

{(Archie, [{(#42, (Archie, [{(#42, (The Database, [{(#42, attendees)}, 2, monday], 1, MONDAY)} {(Archie, [{(#42, meeting), (#1, participant)}, accepted, monday], 1, MONDAY), (Bella, [{(#42, meeting), (#2, participant)}, accepted, monday], 1, MONDAY), (You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, MONDAY)}

Archie is completely certain that the lunch is on Friday.

L ,	MONDAY),	
1	MONDAV)	

- MONDAY),

- ,

- lunch Friday
- type)}, date)},



An assertion is called *negative* when the reliability is below zero. (Archie, [{(#42, date)}, Friday], -1, MONDAY)

{(Arch	ie, [{(#42,
(Arch	ie, [{(#42,
(The Databas	se, [{(#42, at
{(Archie, [{(#42, meeting)	ng), (#1, part
(Bella, [{(#42, meeting)	ng), (#2, part
(You, [{(#42, meeting)	ng), (#3, part

Archie is completely certain that the lunch is not on Friday.

1,	MONDAY)	>
1.	MONDAY)	

- 2, monday], 1, MONDAY)}

- lunch Friday
- type)}, date)}, tendees)},
- icipant)}, accepted, monday], 1, MONDAY), :icipant)}, accepted, monday], 1, MONDAY), icipant)}, pending, monday], 1, MONDAY)}



An assertion is called *completely uncertain* when the reliability is zero. (Archie, [{(#42, date)}, Friday], 0, MONDAY)

		{(Archie,	[{(#42	2,
		(Archie,	[{(#42	2,
	(The I	Database,	[{(#42	2, at
{(Archie,	[{(#42,	meeting),	(#1,	part
(Bella,	[{(#42,	meeting),	(#2,	part
(You,	[{(#42,	meeting),	(#3,	part

Archie has absolutely no idea when the lunch is supposed to be held.

L ,	MONDAY),	
	MONDAV)	

- 2, monday], 1, MONDAY)}

- lunch Friday
- type)}, date)}, tendees)},
- icipant)}, accepted, monday], 1, MONDAY), icipant)}, accepted, monday], 1, MONDAY), icipant)}, pending, monday], 1, MONDAY)}



This symmetry shows how to translate assertions with complements to canonical form.

{(Archie, [{(#42, type)}, (Archie, [{(#42, date)}, (The Database, [{(#42, attendees)}, 2, monday] {(Archie, [{(#42, meeting), (#1, participant)}, accepted, monday] (Bella, [{(#42, meeting), (#2, participant)}, accepted, monday], 1, MONDAY), (You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, MONDAY)}

not v

Assertions without complements are in canonical form. (Archie, [{(#42, date)}, not Friday], 1, MONDAY) (Archie, [{(#42, *date*)}, Friday], -1, MONDAY)

We assume canonical form hereafter.

,	1,	MONDAY),
,	1,	MONDAY),
,	1,	MONDAY) }
)	1,	MONDAY),

- lunch Friday



{(Archie, [{(#42, type)}, (Archie, [{(#42, (The Database, [{(#42, attendees)}, 2, monday], {(Archie, [{(#42, meeting), (#1, participant)}, accepted, monday], 1, MONDAY), (Bella, [{(#42, meeting), (#2, participant)}, accepted, monday], 1, MONDAY), (You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, MONDAY)}

A *reassertion* asserts a posit and its reliability again at a later positing time. (You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, TUESDAY)

On Tuesday you state that you are still pending since Monday.

1,	MONDAY),
1,	MONDAY),
1,	MONDAY) }

- lunch Friday
- date)},



{(Archie, [{(#42, type)}, (Archie, [{(#42, (The Database, [{(#42, attendees)}, 2, monday], 1, MONDAY)} {(Archie, [{(#42, meeting), (#1, participant)}, accepted, monday], 1, MONDAY), (Bella, [{(#42, meeting), (#2, participant)}, accepted, monday], 1, MONDAY), (You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, MONDAY)}

A *revaluation* asserts a posit to a different reliability at a later positing time. (Bella, [{(#42, meeting), (#2, participant)}, accepted, monday], 0.5, TUESDAY)

On Tuesday Bella states that what she said on Monday was that she only might attend on Friday.

1,	MONDAY)	,
1,	MONDAY)	,

,

- lunch Friday
- date)},



{(Archie, [{(#42, type)}, (Archie, [{(#42, (The Database, [{(#42, attendees)}, 2, monday], 1, MONDAY)} {(Archie, [{(#42, meeting), (#1, participant)}, accepted, monday], 1, MONDAY), (Bella, [{(#42, meeting), (#2, participant)}, accepted, monday], 1, MONDAY), (You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, MONDAY)}

A *restatement* is when the preceding value over changing time is the same. (The Database, [{(#42, attendees)}, 2, tuesday], 1, WEDNESDAY)

On Wednesday the Database states that there still were two attendees on Tuesday.

1,	MONDAY),
1,	MONDAY),

- lunch Friday
- date)},



{(Archie, [{(#42, (Archie, [{(#42, (The Database, [{(#42, at {(Archie, [{(#42, meeting), (#1, part (Bella, [{(#42, meeting), (#2, part (You, [{(#42, meeting), (#3, part

A *change* is when the preceding value over changing time is different. (You, [{(#42, meeting), (#3, participant)}, accepted, wednesday], 1, WEDNESDAY)

You accepted the meeting on Wednesday.

(The Database, [{(#42, attendees)}, 3, wednesday], 1, THURSDAY)

The Database states that the number of attendees has changed to three since Wednesday.

type)},	lunch],	1,	MONDAY),
<pre>date)},</pre>	Friday],	1,	MONDAY),
<pre>tendees)},</pre>	2,	<pre>monday],</pre>	1,	MONDAY) }
<pre>icipant)},</pre>	accepted,	<pre>monday],</pre>	1,	MONDAY),
<pre>icipant)},</pre>	accepted,	<pre>monday],</pre>	1,	MONDAY),
<pre>icipant)},</pre>	pending,	<pre>monday],</pre>	1,	MONDAY)}



{(Archie, [{(#42, (Archie, [{(#42, (The Database, [{(#42, attendees)}, 2, monday], {(Archie, [{(#42, meeting), (#1, participant)}, accepted, monday], 1, MONDAY), (Bella, [{(#42, meeting), (#2, participant)}, accepted, monday], 1, MONDAY), (You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, MONDAY)}

A *retraction* is when a reliable posit is now considered completely unreliable. (Archie, [{(#42, type)}, lunch], 0, THURSDAY)

On Thursday Archie cancels the lunch altogether.

1,	MONDAY),
1,	MONDAY),
1.	MONDAV)}

_ ,

- lunch Friday
- type)}, date)},



A *correction* is a retraction of the erroneous posit and a simultaneous assertion. (Archie, [{(#42, type)}, lunch], 0, THURSDAY) (Archie, [{(#42, type)}, dinner], 1, THURSDAY)

{(Archie, [{(#42, type)}, (Archie, [{(#42, (The Database, [{(#42, attendees)}, 2, monday], 1, MONDAY)} {(Archie, [{(#42, meeting), (#1, participant)}, accepted, monday], 1, MONDAY), (Bella, [{(#42, meeting), (#2, participant)}, accepted, monday], 1, MONDAY), (You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, MONDAY)}

these contain citro

On Thursday Archie realises that he intended to meet for dinner instead of lunch.

1,	MONDAY),	
1,	MONDAY),	

- lunch Friday
- date)},



With *decisiveness* only one value for each identity, role, and time may be asserted.

{(Archie, [{(#42, type)}, (Archie, [{(#42, date)}, (The Database, [{(#42, attendees)}, {(Archie, [{(#42, meeting), (#1, participant)}, accepted, mon (Bella, [{(#42, meeting), (#2, participant)}, accepted, mon (You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, MONDAY)}

This excludes complete uncertainty, for which a positor may be oblivious to arbitrarily many posits.

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],	1,	MONDAY),
nday],	1,	MONDAY) }
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nday],	1,	MONDAY),
Iveba	1	ΜΟΝΠΑΥΊΙ

lunch Friday 2,

mor



With *indecisiveness* many values for each identity, role, and time may be asserted.

{(Archie, [{(#42, type)}, breakfast], 0.2, THURSDAY), (Archie, [{(#42, *type*)}, lunch], 0.3, THURSDAY), (Archie, [{(#42, *type*)}, dinner], 0.5, THURSDAY)}

As long as the reliabilities obey: $\frac{1}{2} \sum_{i=1}^{n} \left[1 - \alpha_i |\alpha_i|^{-1} \right] + \sum_{i=1}^{n} \alpha_i \le 1$

the axiom of non-contradiction.

{(Archie, [{(#42, type)}, lunch], (Archie, [{(#42, (The Database, [{(#42, attendees)}, 2, monday], {(Archie, [{(#42, meeting), (#1, participant)}, accepted, monday], 1, MONDAY) (Bella, [{(#42, meeting), (#2, participant)}, accepted, monday], 1, MONDAY), (You, [{(#42, meeting), (#3, participant)}, pending, monday], 1, MONDAY)}

Archie is not sure which meal the invitation was for.

0.5(1-0.2/|0.2|+1-0.3/|0.3|+1-0.5/|0.5|) + (0.2+0.3+0.5) = 1

1,	MONDAY),
1,	MONDAY),
1,	MONDAY) }
1,	MONDAY),

- Friday

- date)},



definition of an anchor Concurrent-reliance-temporal: An *anchor* is a predicate, anchor (P, a, c, α , T), taking five arguments, where the first argument is a unique identifier, the second an assertion, the third a string, and the fourth a real number in the range [-1, 1], and the fourth a time point.

Uni-temporal:

An *anchor* is a predicate, anchor(*a*, *c*), taking two arguments, where the first argument is an assertion and the second a string.



It's Monday. Archie invites you to meet him and Bella for lunch on Friday.

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Anchors provide a classification of posits and a set of anchors become a model.

			POSI	Γр
			[
a1 =		(Archie,	[{(#42,	
a ₂ =		(Archie,	[{(#42,	
a ₃ =	(The	Database,	[{(#42,	a

One	Modeler,	a1,	Appointment,	1,	MONDAY
One	Modeler,	a ₂ ,	Appointment,	1,	MONDAY
One	Modeler,	a ₃ ,	Appointment,	1,	MONDAY
ner	Modeler,	a1,	Invitation,	0.5,	MONDAY
ner	Modeler,	a ₂ ,	Invitation,	0.5,	MONDAY
ner	Modeler,	a ₃ ,	Response,	0.5,	MONDAY

ANCHOR (P,a,c, α ,T)

ASSERT (P,p, α ,T)



It's Monday. Archie invites you to meet him and Bella for lunch on Friday.

In uni-temporal Anchor modeling the theory becomes much simpler, with one implicit modeler and one certain model.

a1 =	(Archie,	[{(#42,
$a_2 =$	(Archie,	[{(#42,
a ₃ =	(The Database,	[{(#42, c

(Another Modeler, (Another Mo **a**₃,

(One Modeler, a₁, Appointment, 1, MONDAY) (One Modeler, a₂, Appointment, (One Modeler, a₃, Appointment, (Another Modeler, a1, Invitation, A a_2 , Invitation, 0.5,

Response, 0.5, Monday

ANCHOR (a,c)

ASSERT (p)

POSIT $p = [\{(i_1, r_1), ..., (i_n, r_n)\}, v, t?]$

type)}, attendees)},

lunch

MONDAY date)}, Friday], 1, MONDAY) 2, monday], 1, MONDAY)

MONDAY)

MONDAY

MONDAY)

MONDAY

