

# Requirements Conversations: A New Frontier in AI-for-RE



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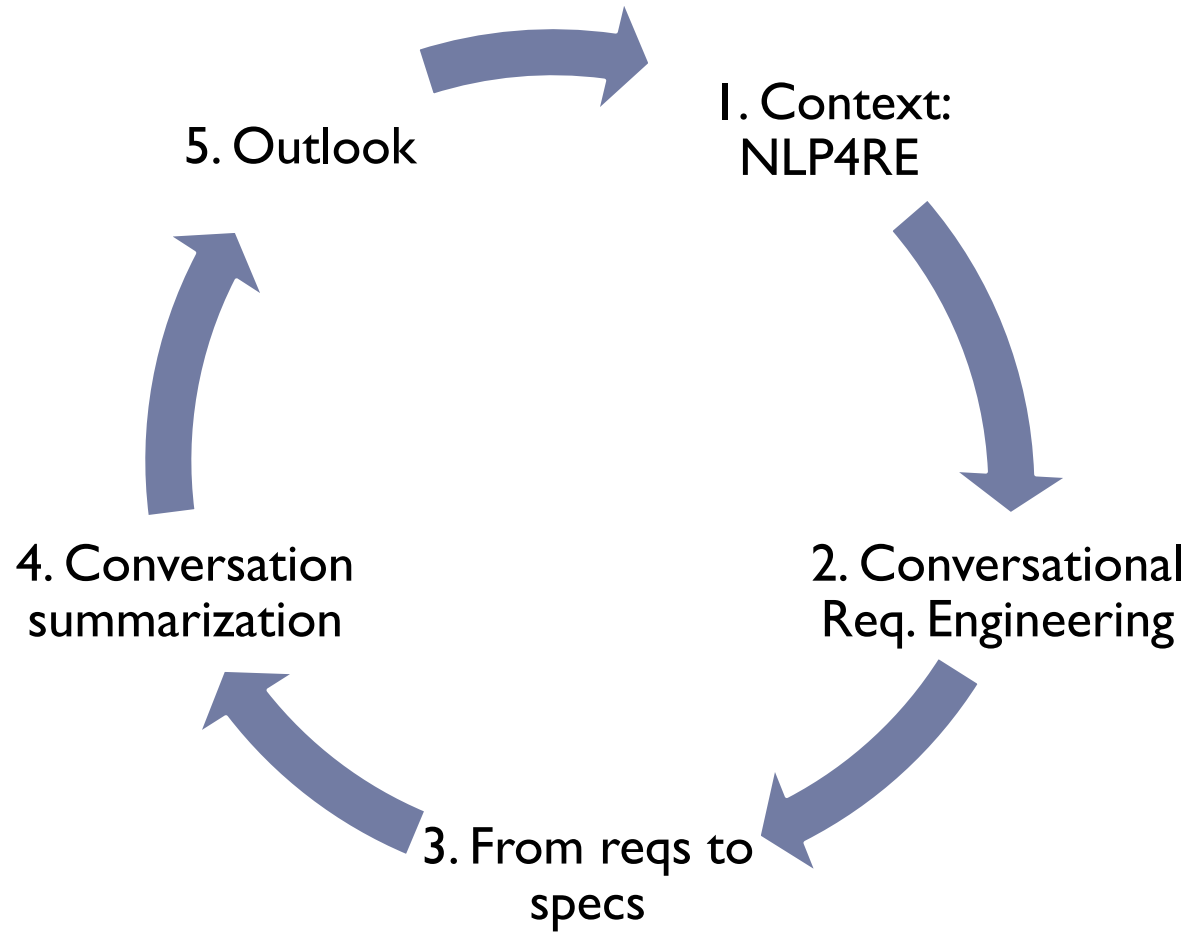
August 16, 2022

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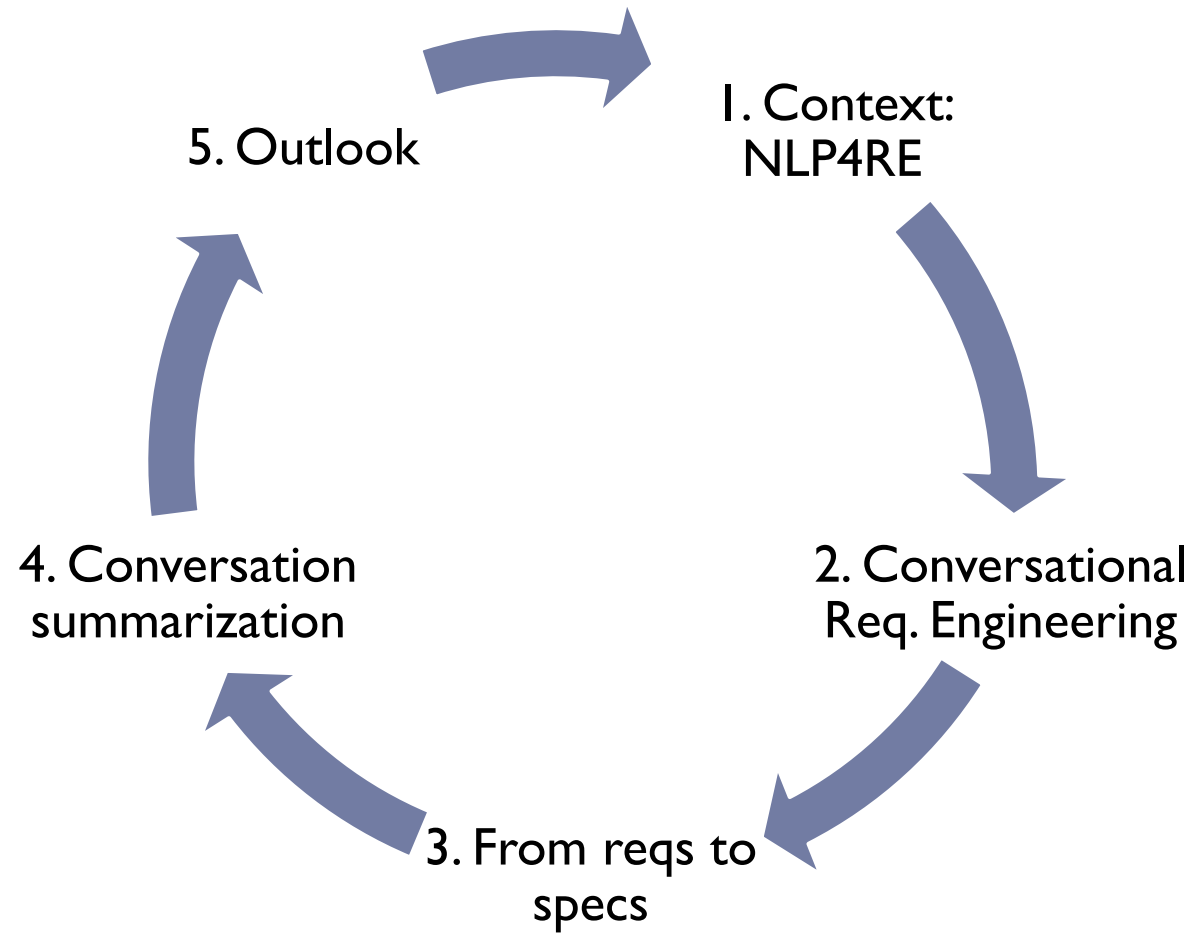
 [@FabianoDalpiaz](https://twitter.com/FabianoDalpiaz)

# Outline and Acks

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# Outline and Acks



Nikita van den Berg



Tjerk Spijkman



Sjaak Brinkkemper



Xavier de Bondt

# I. Context: NLP for Requirements Engineering (NLP4RE)

## Natural Language Processing for Requirements Engineering

The Best Is Yet to Come

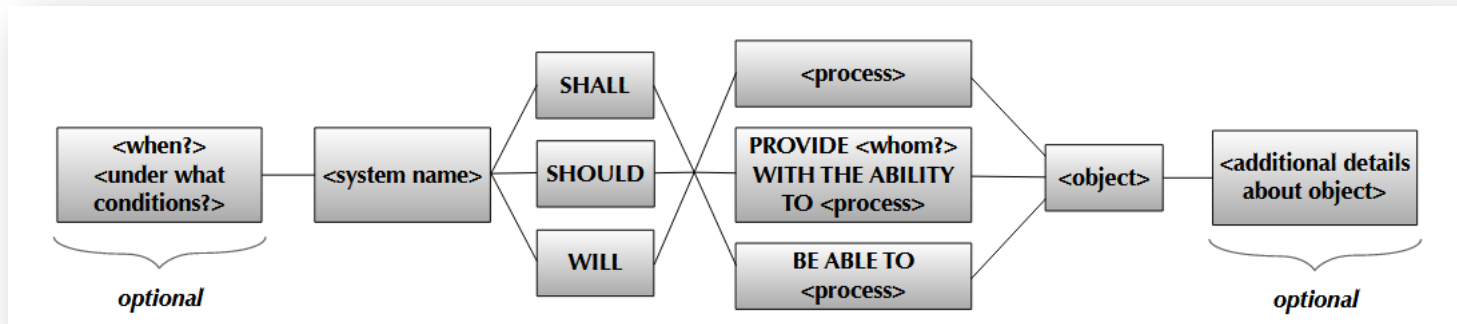
Fabiano Dalpiaz, Alessio Ferrari, Xavier Franch, and Cristina Palomares



Third Workshop on Natural Language Processing for Requirements Engineering  
REFSQ2020 Workshop, June 23rd (Online)

Fabiano Dalpiaz, Alessio Ferrari, Xavier Franch, and Cristina Palomares. "Natural language processing for requirements engineering: The best is yet to come." *IEEE Software* 35, no. 5 (2018): 115-119.

# RE practice: most reqs. are in natural language



Rupp's template & ISO/IEC/IEEE 29148

*The <system name> shall <system response>.*  
*WHILE <in a specific state> the <system name> shall <system response>*  
*WHEN <trigger> the <system name> shall <system response>*  
 ...

EARS

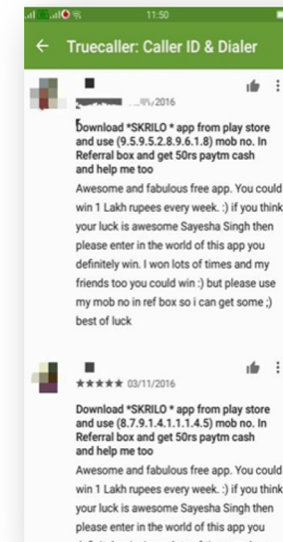
**Use Case Name**  
 Description – a brief summary of what the use case is about

Scenario	A quick summary of what is going to happen in the use case – exclude actor	
Triggering event	What the actor does in relation to the system – should be first in flow of events	
Actors	List the primary actors – the ones with their hands on the keyboard	
Related use cases	Comma separated list of related use cases	
Stakeholders	Who is interested in the result of this use case and their role in it	
Pre-condition	What needs to be in place before this use case can execute	
Post-condition	How will the system have changed as a result of this use case	
Flow of events	Actor	System
	1. The first event should be the triggering event	
Exception	<ul style="list-style-type: none"> <li>A list of things that could go wrong and how the system responds</li> </ul>	

Use cases

ID	<TITLE>		
As	<user>		
I want	<what>		
because	<value>		
Feature\Epic name\			
MoSCoW	Bus. Value	Risk	Effort

User stories



App store reviews

# RE Research: 4 categories of NLP4RE tools

## 1. Find defects / deviations from good practice

As a Consumer, I want to know that the data I am downloading is good and myself or run into annoying bugs later on.

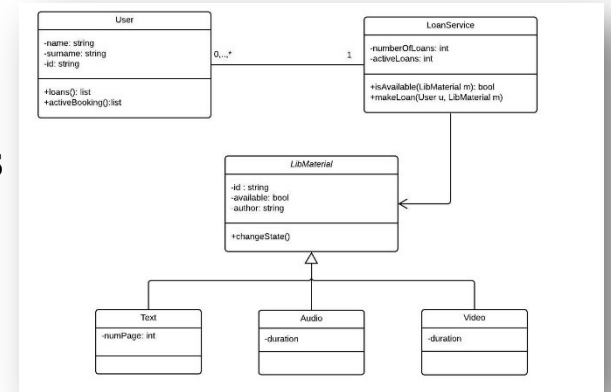
As a Consumer, I want to be able to get the data for a data package even I can still use it and my app or analysis keeps working.

As a consumer, I want to view the data package, so that I can get a sense of the data.

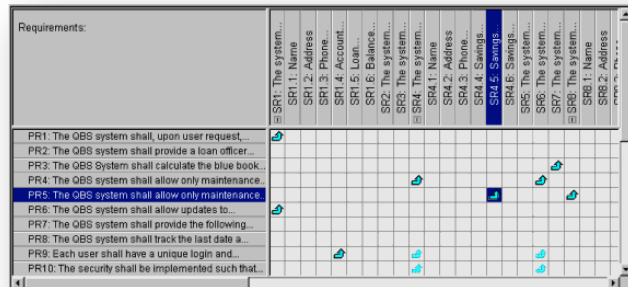
As a Developer, I want to list all DataPackages requirements for my project DataPackage that my project depends on, so that the project can be determined by the DataPackage schema changes.

As a Publisher, I want to version my Data Package and keep multiple versions so that I can break consumer systems when I change my datapackage.

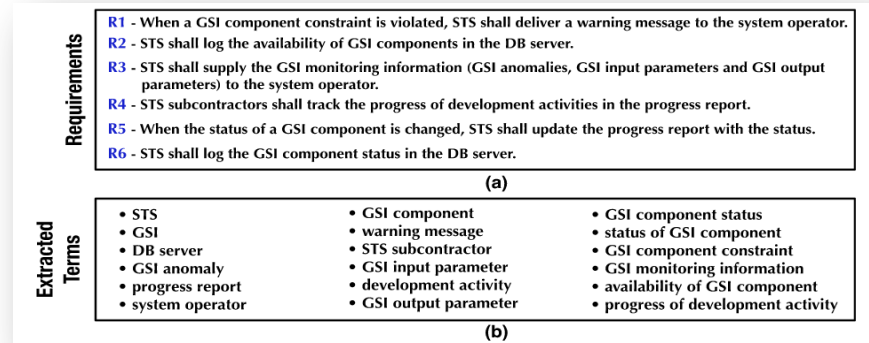
## 2. Generate models from NL requirements



## 3. Infer trace links between NL requirements and other artifacts



## 4. Identify key abstractions from NL documents



Daniel Berry, Ricardo Gacitua, Pete Sawyer, and Sri Fatimah Tjong. "The case for dumb requirements engineering tools." In *International Working Conference on Requirements Engineering: Foundation for Software Quality*, pp. 211-217. 2012.

# An active area of research!

Tool Type	Tool Name (Study ID)	No. Tools	Percent
<b>Modeling</b>	OICSI (S678), NL-OOPS (S553), EA-Miner (S499), CM-Builder (S343), Circe (S34), LIDA (S623), NIBA Toolset (S272), RETNA (S108), aToucan (S909), DBDT (S31), Cico (S34), NL2UMLviaSBVR (S70), RADD-NLI (S121), SUGAR (S190), GRACE (S208), AREMCD (S219), RUCM (S227), RSLingo (S266), Zen-ReqConfig (S482), TREx (S496), NAPLES (S499), GeNLangUML (S551), ConstraintSoup (S600), C&L (S707), AnModeler (S799), SBEAVER (S813), KCMP Dynamisch (S272), Xtext (S20), Kheops (S35), Visual Narrator (S683), ProcGap (S800), FeatureX (S772), CMT & FDE (S261), VoiceToModel (S765)	34	26.15%
<b>Detection</b>	ARM (S861), SREE (S812), RQA (S903), AnaCon (S41), REGICE (S55), NARCIA (S56), LELIE (S75), SRRDirector (S86), MIA (S114), KROSA (S178), NAI (S226), QuARS (S232), CAR (S252), CARL (S298), RAVEN (S303), ReqSAC (S370), RAT (S376), MaramaAIC (S395), RESI (S432), RECAA (S447), DeNom (S448), RETA (S450), AQUASA (S501), Dowser (S644), QAMiner (S661), LeCA (S701), S-HTC (S258), CNLP(S464), Pragmatic Ambiguity Detector (S256), ReqAligner (S663), REAssistant (S662)	31	23.85%
<b>Extraction</b>	findphrases (S13), AbstFinder (S307), FENL (S71), NAT2TESTSCR (S131), NLP-KAOS (S132), SAFE (S385), AUTOANNOTATOR (S433), UCTD (S453), GUEST (S598), Guidance Tool (S688), SpecQua (S743), NAT2TEST (S744), semMet (S777), Test2UseCase (S810), OCLgen (S845), Text2Policy (S872), GaiusT (S888), SNACC (S891), Doc2Spec (S897), ARSENAL (S915), MaTREx tool (S284), ELICA (S2), CHOReOS (S520), GuideGen (S907)	24	18.46%
<b>Classification</b>	ASUM (S129), RUBRIC (S223), WCC (S257), NFR2AC tool (S306), ALERTme (S332), PUMConf (337), FFRE (S341), AUR-BoW (S500), SEMIOS (S550), CRISTAL (S629), CoReq (S672), SD (S674), ACRE (S757), SOVA R-TC (S778), SMAA (S788), CSLabel (S892), HeRA (S718), NFR Locator (S758), SURF (S910), NFRFinder (S647)	20	15.38%
<b>Tracing &amp; Relating</b>	Coparvo (S24), Trustrace (S25), Histrace (S25), CoChaIR (S26), HYPERDOCSY (S38), ReqSimile (S171), LGRTL (S198), CQV-UML (S400), TiQi (S651), REVERE (S717), LiMonE (S723), ESPRET (S792), COCAR (S805), RETRO (S934), WATson (S302)	15	11.54%
<b>Search &amp; Retrieval</b>	RE-SWOT (S174), IntelliReq (S602), ReqWiki (S711), iMapper (S784), PriF (S802), WIKINA (S686)	6	4.62%
<b>Total</b>		<b>130</b>	<b>100%</b>

Liping Zhao, Waad Alhoshan, Alessio Ferrari, Keletso J. Letsholo, Muideen A. Ajagbe, Erol-Valeriu Chioasca, and Riza T. Batista-Navarro. "Natural Language Processing (NLP) for Requirements Engineering: A Systematic Mapping Study." *ACM Computing Surveys* 54:3, 2022

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Main artifact for AI-based tools

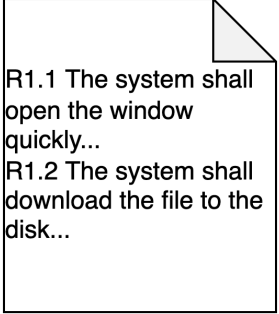
R1.1 The system shall open the window quickly...  
R1.2 The system shall download the file to the disk...

Specification



# Elicitation: the root of (all) NL requirements

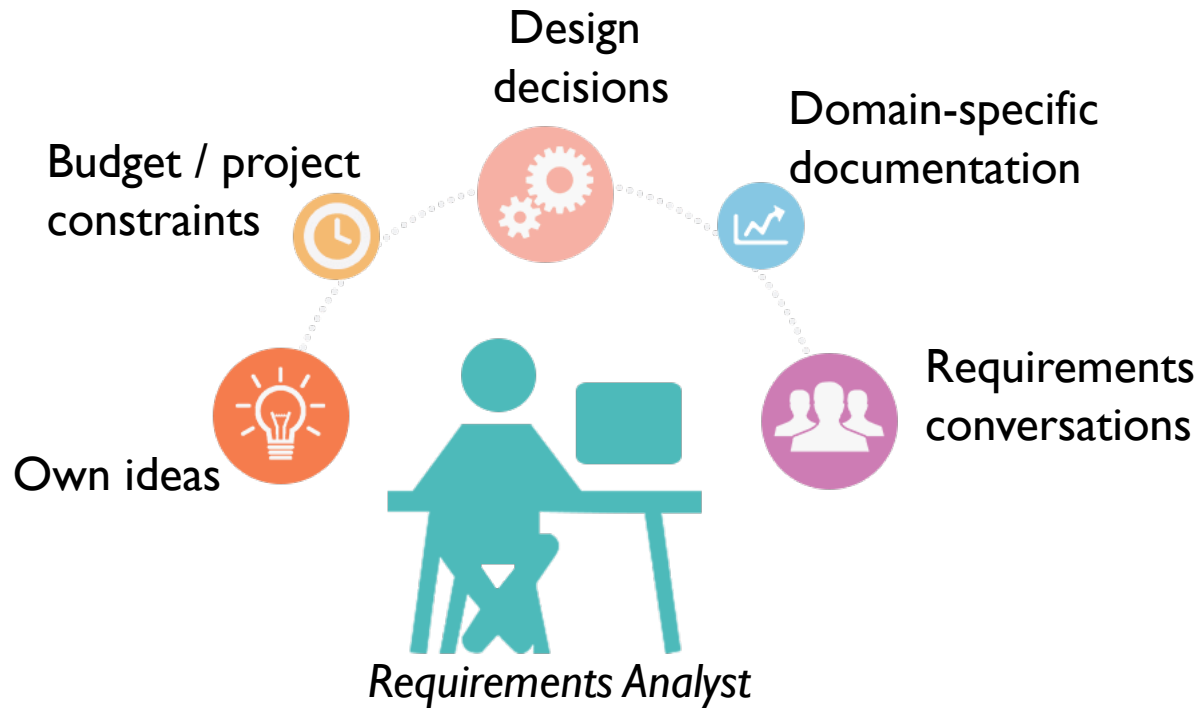
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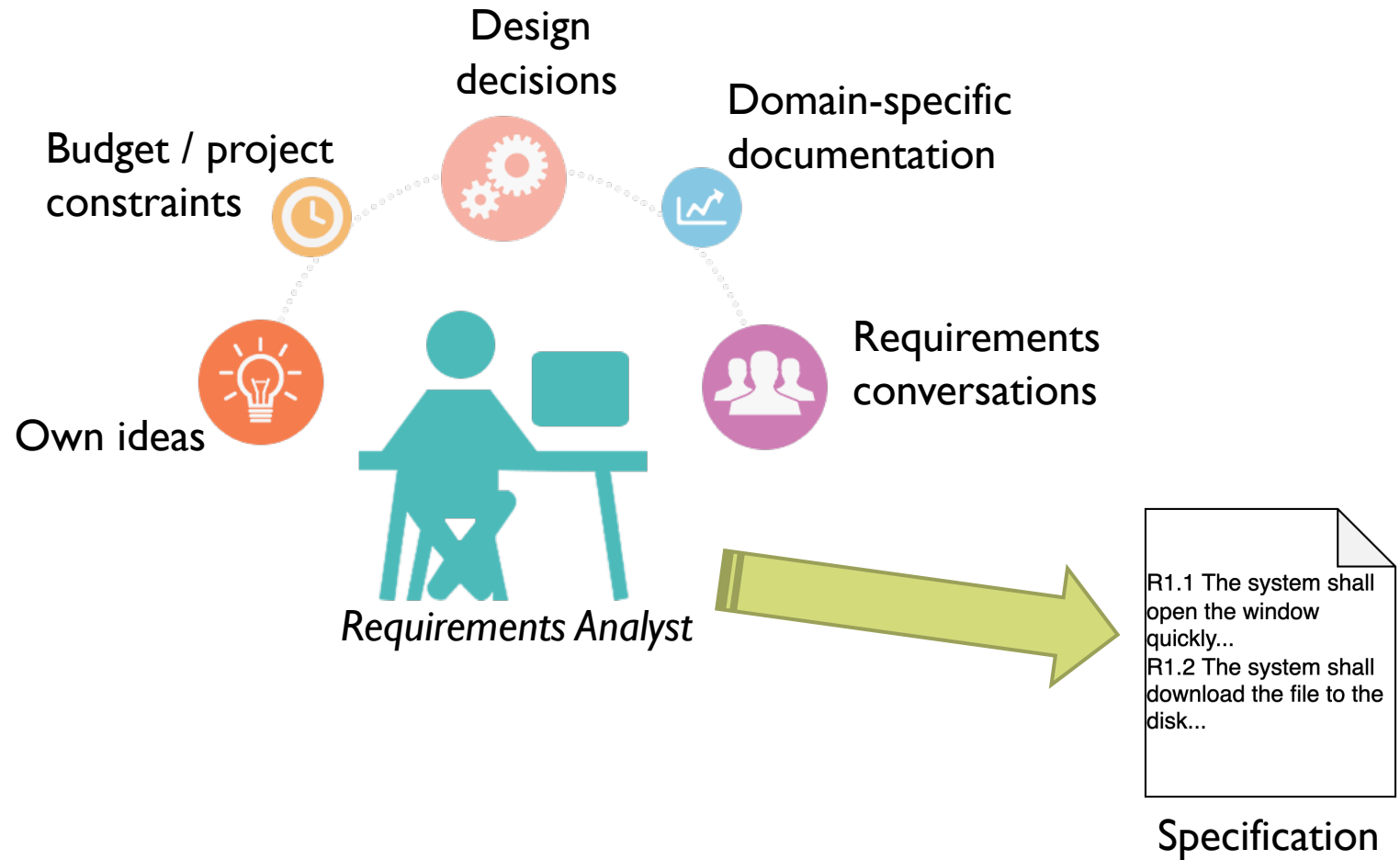
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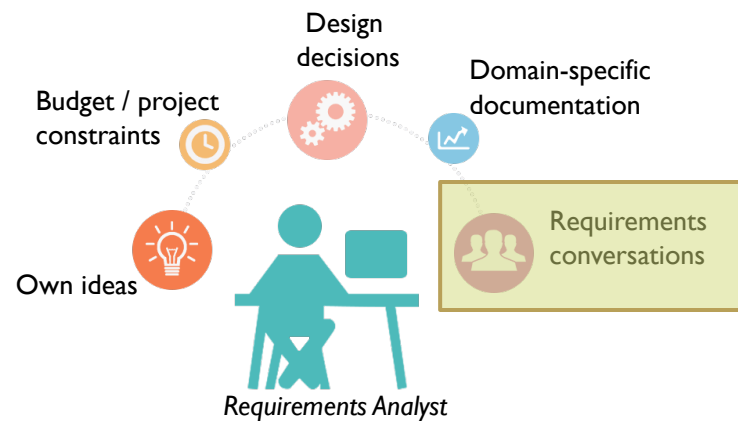
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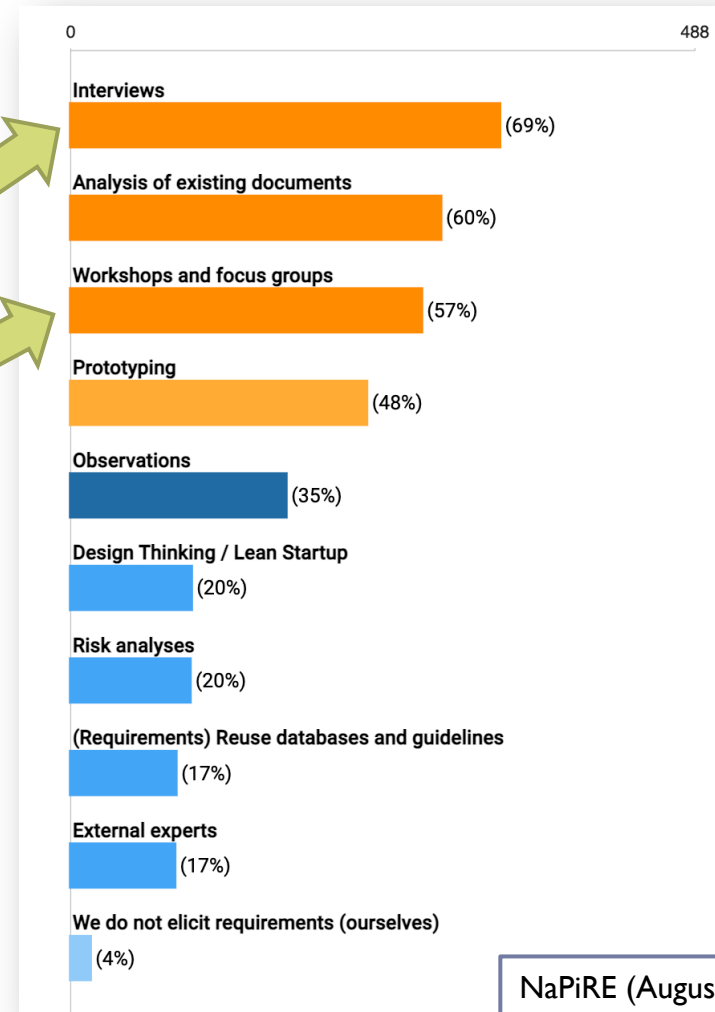
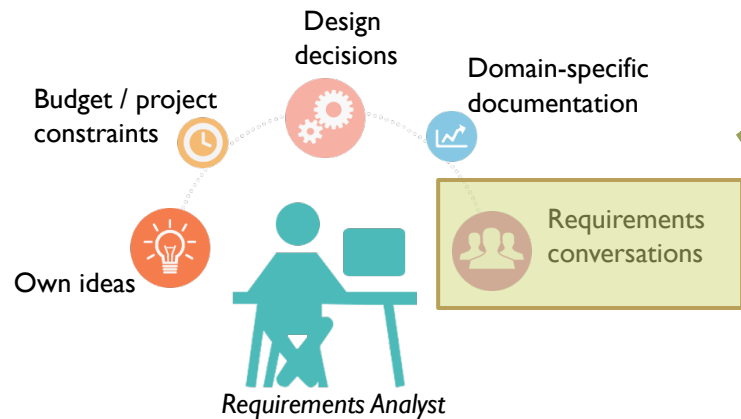
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# Elicitation is heavily centered on conversations!

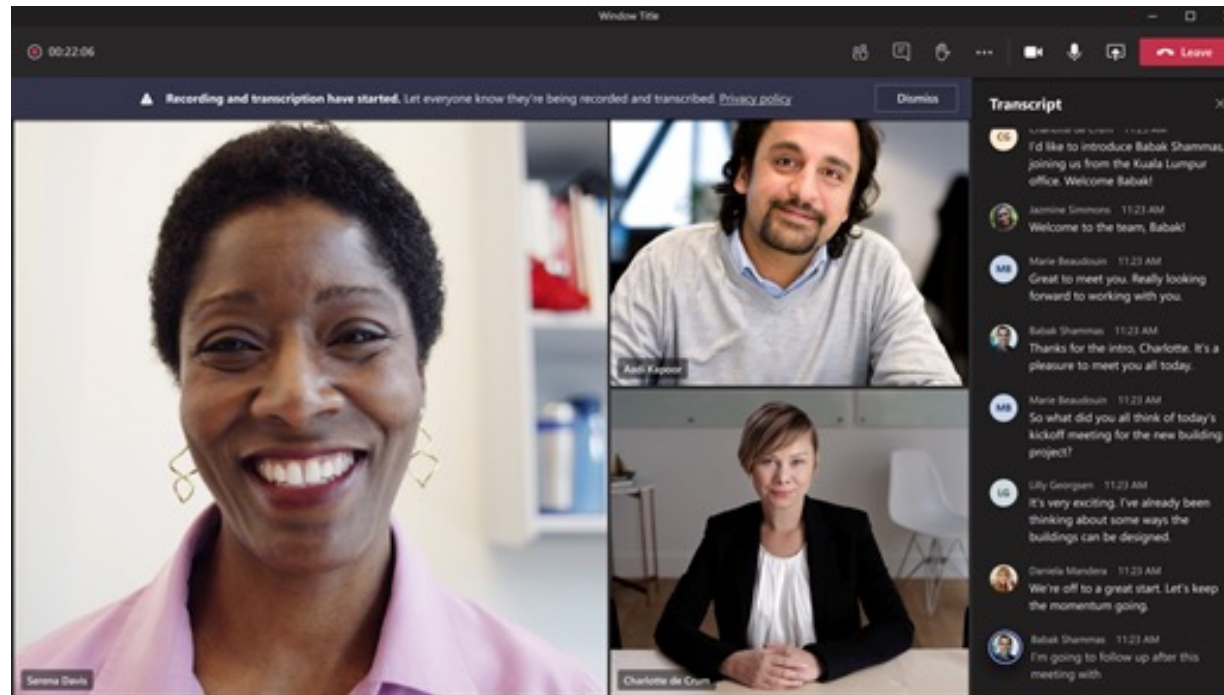


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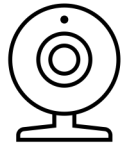


NaPiRE (August 8, 2022)  
<http://www.re-survey.org/#/explore>

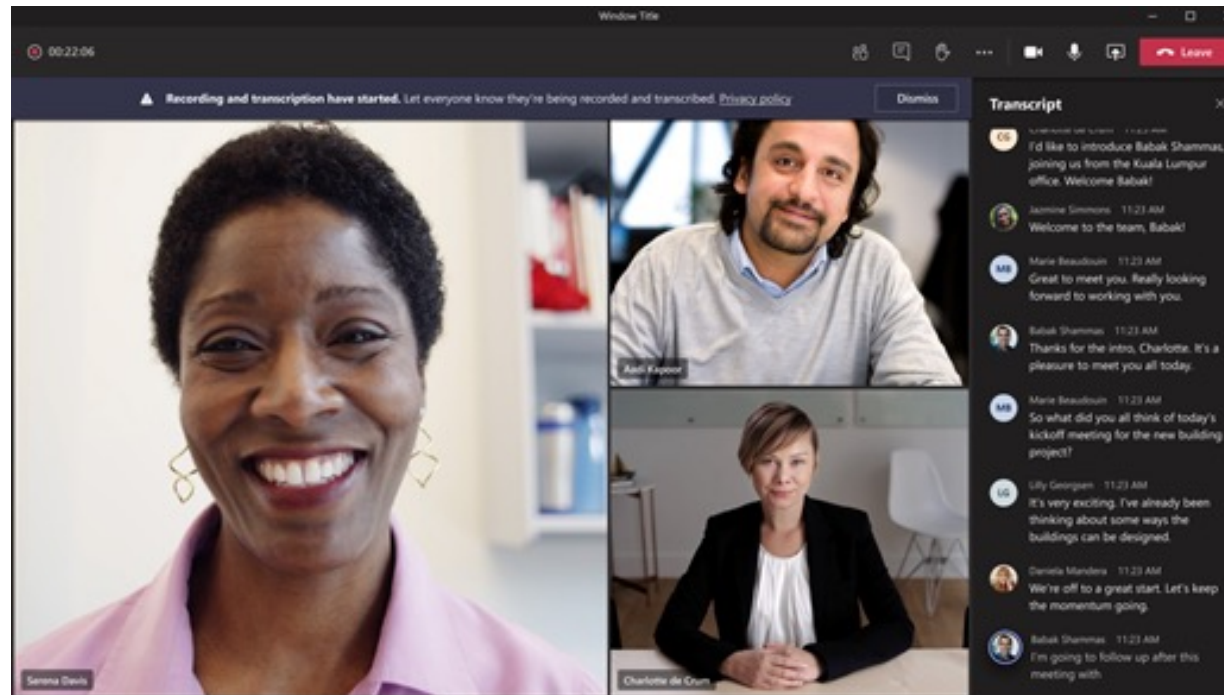
# Timeliness: why researching conversations now?



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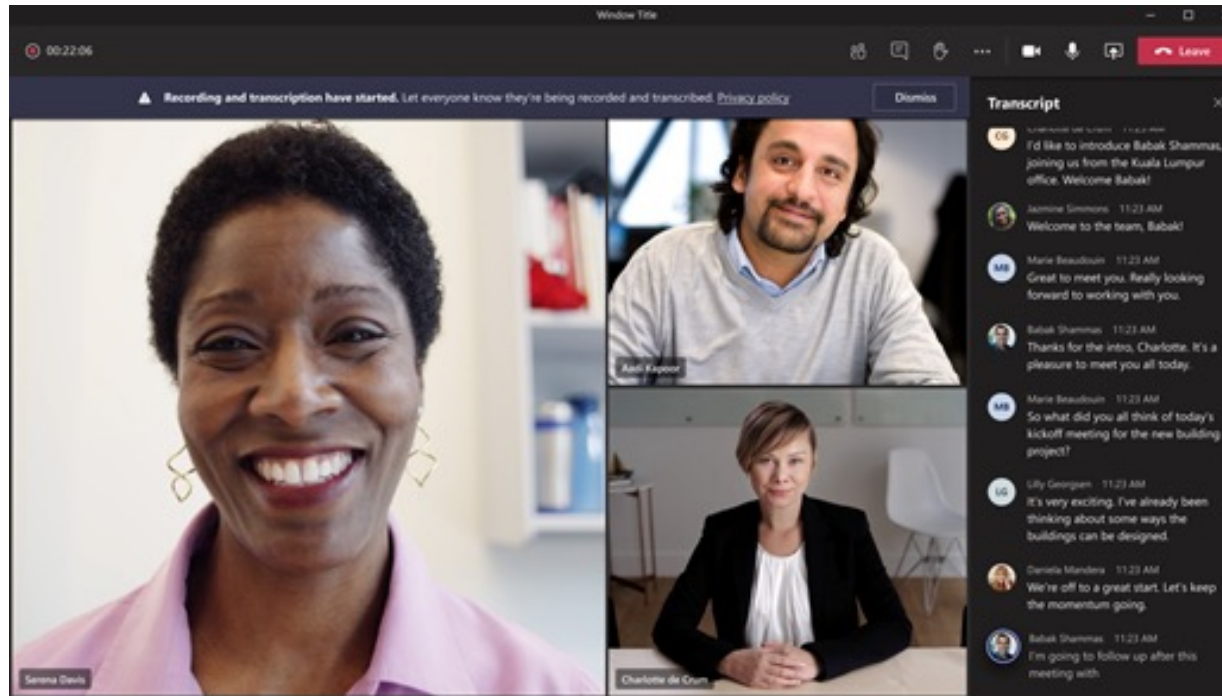
Increased remote work  
and collaboration



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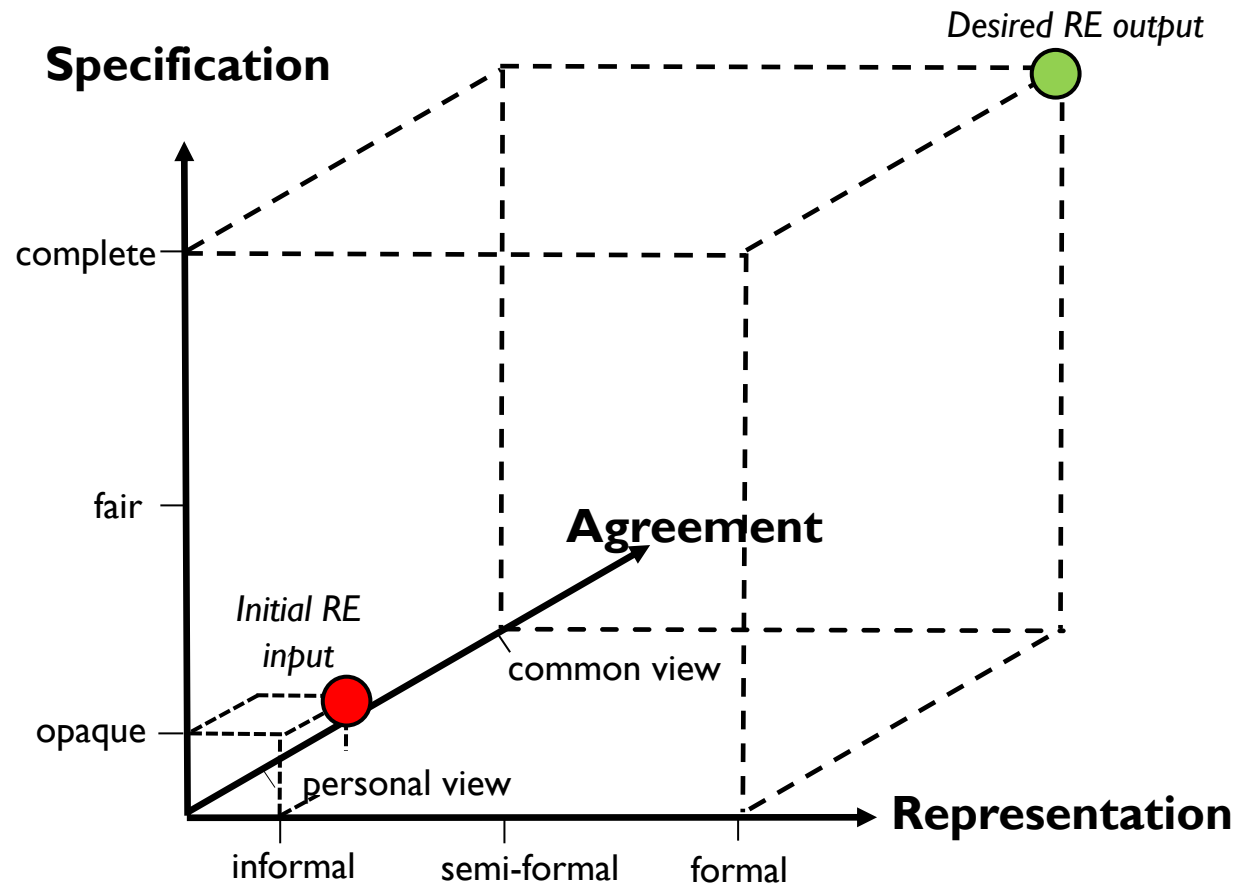
Automated  
transcription



## 2. Conversational RE

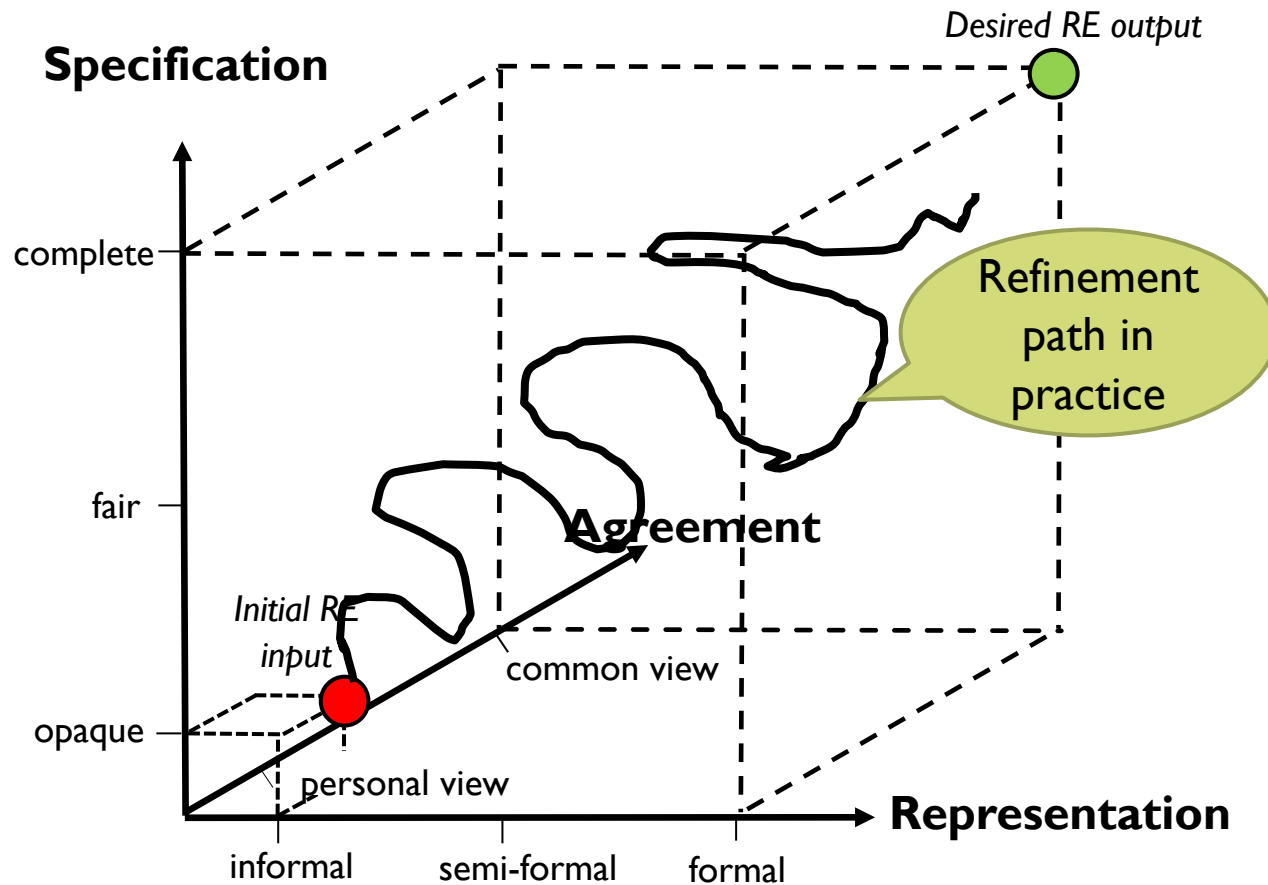


# Background theory: Refinement in RE



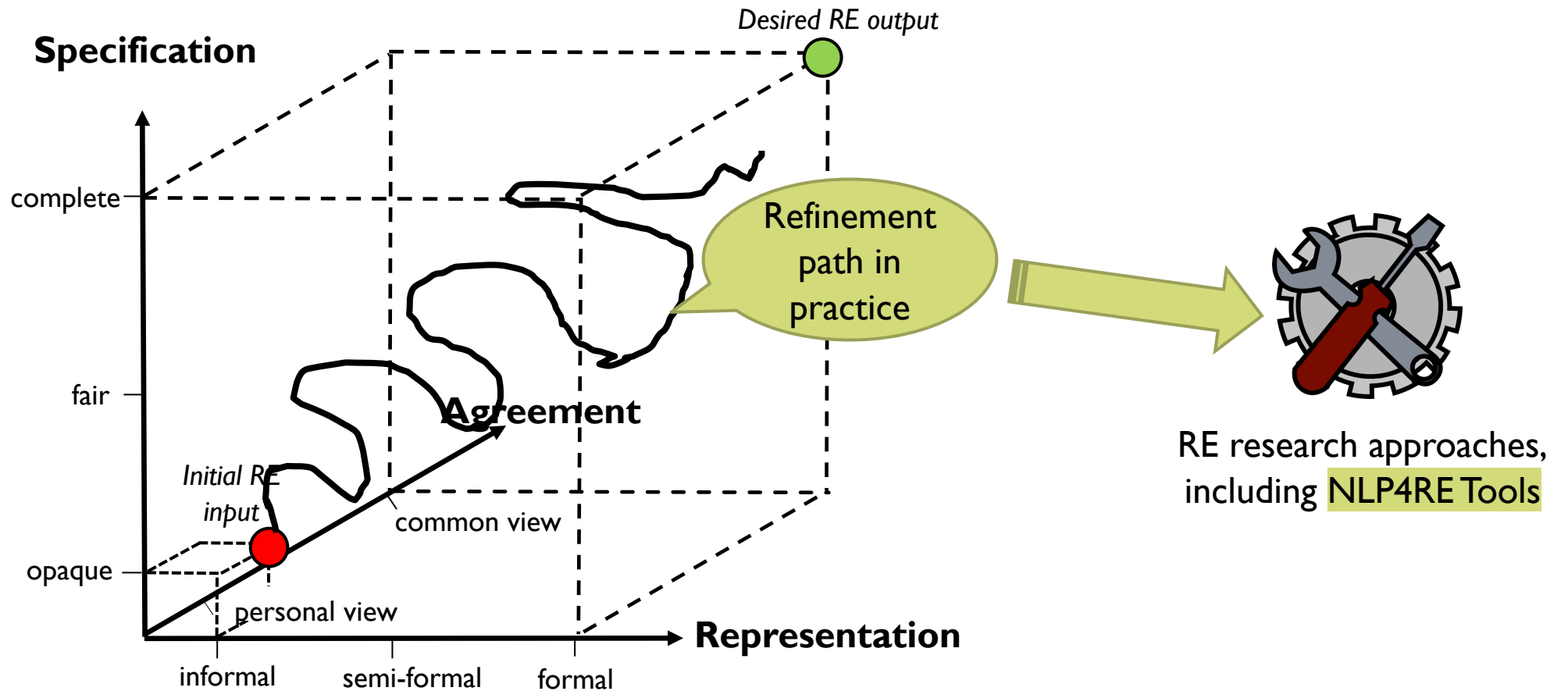
Pohl, Klaus. "The three dimensions of requirements engineering: a framework and its applications." *Information systems* 19.3 (1994): 243-258.

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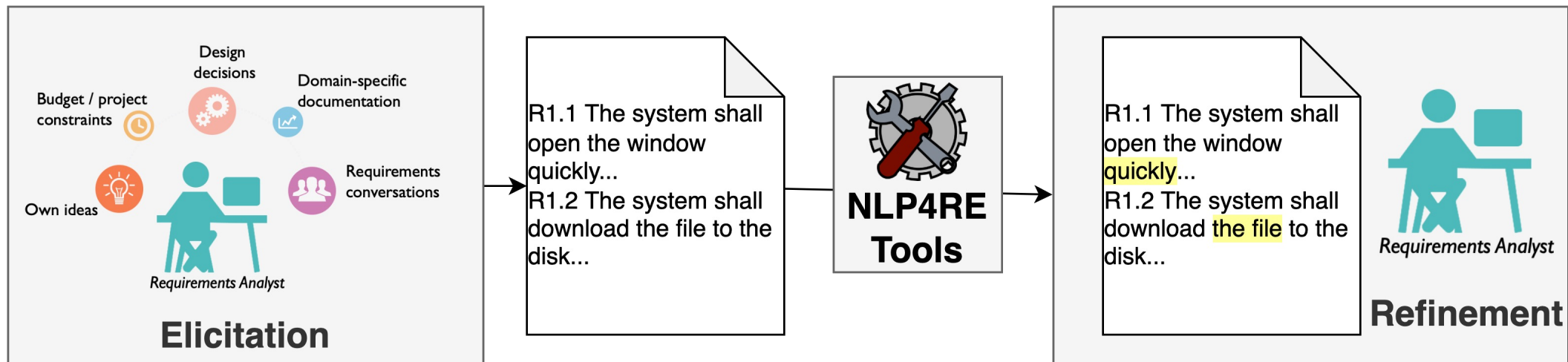
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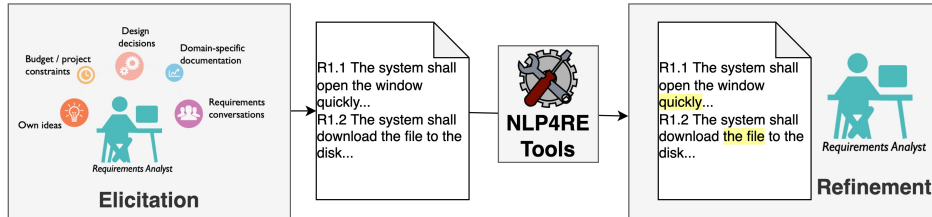


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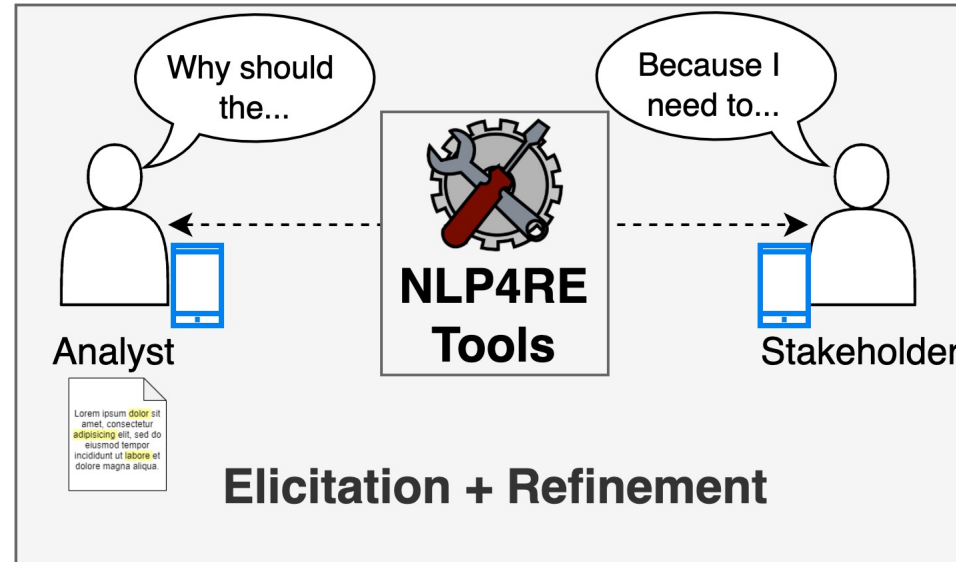
# How do current NLP4RE tools work?



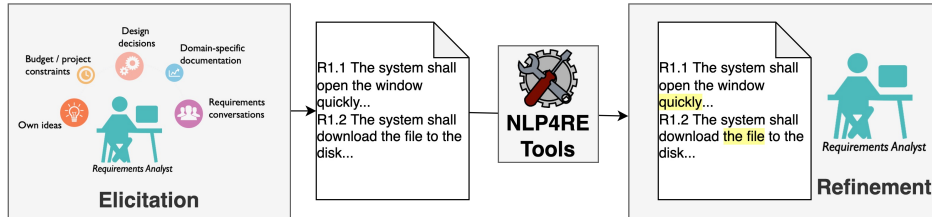
# NLP4RE Tools for Conversational RE



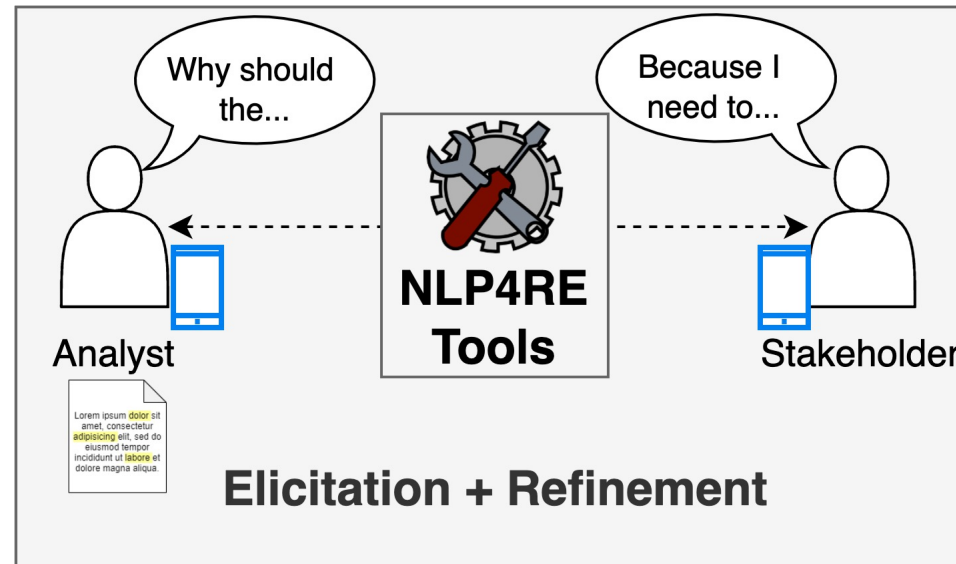
VS.



# NLP4RE Tools for Conversational RE

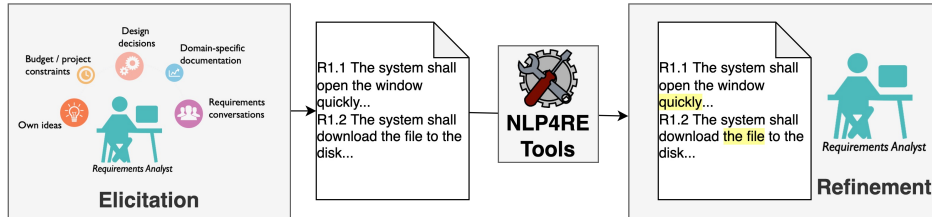


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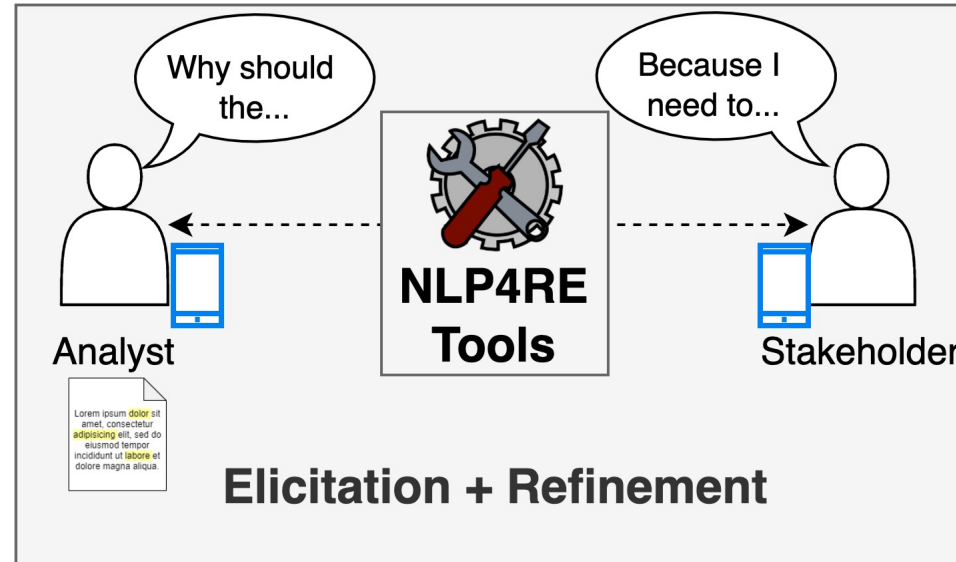


- ▶ The tool supports the conversation between analyst and stakeholders

# NLP4RE Tools for Conversational RE



VS.



- ▶ The tool supports the conversation between analyst and stakeholders
- ▶ Elicitation and refinement as concurrent activities



# Conversational RE

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“The (automated) analysis of requirements elicitation conversations aimed at identifying and extracting requirements-relevant information”



# (Requirements) conversations vs. specifications

Speaker: Utterance
A : What is the main goal of the system? : What would you like for us to focus on?
S : Let me think... : the system shall be customizable... : hmm, no, configurable!
A : Configurable, you said. : Hmm, what do you exactly mean by that?
S : Oh yes, sorry... : the developers must be able to adjust parameters A and B so to serve different clients
A : I see, clear. : Should we use file format XYZ?
S : Yes, absolutely. ...

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Informal: no "shall" statements, user stories, glossary

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S : Yes, absolutely. ...

2+ parties (here Analyst and Stakeholder)

Relevant information may be sparse

Informal: no "shall" statements, user stories, glossary

Includes persuasion, uncertainty, misunderstandings

# Dissecting a conversation: turns and grounding acts

Speaker: Utterance	Turn	Grounding
A : What is the main goal of the system?	1.1	Initiate
: What would you like for us to focus on?	1.2	Continue
S : Let me think...	2.1	Acknowledge
: the system shall be customizable...	2.2	Initiate
: hmm, no, configurable!	2.3	Repair
A : Configurable, you said.	3.1	Acknowledge
: Hmmm, what do you exactly mean by that?	3.2	Initiate
S : Oh yes, sorry...	4.1	Acknowledge
: the developers must be able to adjust parameters A and B so to serve different clients	4.2	Initiate
A : I see, clear.	5.1	Acknowledge
: Should we use file format XYZ?	5.2	Initiate
S : Yes, absolutely.	6.1	Acknowledge
...		

Traum, David R., and Elizabeth A. Hinkelman.  
"Conversation acts in task-oriented spoken dialogue."  
*Computational intelligence* 8.3 (1992): 575-599.



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...you exactly mean by that?	3.2	Initiate
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Turns and utterance units as atomic entities

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Turns and utterance units as atomic entities

Grounding acts determine the effect of an utterance unit

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# Dissecting a conversation: discourse units

Speaker: Utterance	Turn	Grounding	Discourse
A : What is the main goal of the system?	1.1	Initiate	DU1: WHQ, Check
: What would you like for us to focus on?	1.2	Continue	
S : Let me think...	2.1	Acknowledge	DU2: Inform, Check
: the system shall be customizable...	2.2	Initiate	
: hmm, no, configurable!	2.3	Repair	
A : Configurable, you said.	3.1	Acknowledge	DU3: WHQ, Check
: Hmmm, what do you exactly mean by that?	3.2	Initiate	
S : Oh yes, sorry...	4.1	Acknowledge	DU4: Inform, Check
: the developers must be able to adjust parameters A and B so to serve different clients	4.2	Initiate	
A : I see, clear.	5.1	Acknowledge	
: Should we use file format XYZ?	5.2	Initiate	DU5: Request(Eval), Eval
S : Yes, absolutely.	6.1	Acknowledge	
...			

Traum, David R., and Elizabeth A. Hinkelman.  
 "Conversation acts in task-oriented spoken dialogue."  
*Computational intelligence* 8.3 (1992): 575-599.

# Dissecting a conversation: discourse units

Speaker: Utterance	Turn	Grounding	Discourse
A : What is the main goal of the system?	1.1	Initiate	DU1: WHQ, Check
: What would you like for us to focus on?	1.2	Continue	
S : Let me think...	2.1	Acknowledge	DU2: Inform, Check
: the system shall be customizable...	2.2	Initiate	
: hmm, no, configurable!	2.3	Repair	
A : Configurable, you said.	3.1	Acknowledge	DU3: WHQ, Check
: Hmmm, what do you exactly mean by that?	3.2	Initiate	
S : Oh yes, sorry...	4.1	Acknowledge	DU4: Inform, Check
: the developers must be able to adjust parameters A and B so to serve different clients	4.2	Initiate	
A : I see, clear.	5.1	Acknowledge	DU5: Request(Eval), Eval
: Should we use file format XYZ?	5.2	Initiate	
S : Yes, absolutely.	6.1	Acknowledge	
...			

Cross-speaker interaction defines the meaning

Traum, David R., and Elizabeth A. Hinkelman. "Conversation acts in task-oriented spoken dialogue." *Computational intelligence* 8.3 (1992): 575-599.

# Dissecting a conversation: argumentation acts

Speaker: Utterance	Turn	Grounding	Discourse	Argumentation
A : What is the main goal of the system?	1.1	Initiate	DU1: WHQ, Check	Q&A
: What would you like for us to focus on?	1.2	Continue		
S : Let me think...	2.1	Acknowledge	DU2: Inform, Check	Q&A
: the system shall be customizable...	2.2	Initiate		
: hmm, no, configurable!	2.3	Repair		
A : Configurable, you said.	3.1	Acknowledge	DU3: WHQ, Check	Q&A Clarify
: Hmmm, what do you exactly mean by that?	3.2	Initiate		
S : Oh yes, sorry...	4.1	Acknowledge	DU4: Inform, Check	Q&A
: the developers must be able to adjust parameters A and B so to serve different clients	4.2	Initiate		
A : I see, clear.	5.1	Acknowledge	DU5: Request(Eval), Eval	Q&A
: Should we use file format XYZ?	5.2	Initiate		
S : Yes, absolutely.	6.1	Acknowledge		
...				

© Elizabeth A. Hinkelman.  
 "Conversation acts in task-oriented spoken dialogue."  
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: the system shall be customizable...	2.2	Initiate		
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A : Configurable, you said.	3.1	Acknowledge	DU3: WHQ, Check	Q&A Clarify
: Hmmm, what do you exactly mean by that?	3.2	Initiate		
S : Oh yes, sorry...	4.1	Acknowledge	DU4: Inform, Check	Q&A
: the developers must be able to adjust parameters A and B so to serve different clients	4.2	Initiate		
A : I see, clear.	5.1	Acknowledge	DU5: Request(Eval), Eval	Q&A
: Should we use file format XYZ?	5.2	Initiate		
S : Yes, absolutely.	6.1	Acknowledge		
...				

The purpose of a conversation across multiple turns: *argumentation acts*

Elizabeth A. Hinkelman.  
 Conversation acts in task-oriented spoken dialogue."  
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...				

The purpose of a conversation across multiple turns: *argumentation acts*

Q&A as a basic interaction, clarifications, summary, persuasion, ...

Elizabeth A. Hinkelman.  
"Conversation acts in task-oriented spoken dialogue."  
*Computational intelligence* 8.3 (1992): 575-599.

# Conversations vs. Specifications: not quite the same

Speaker: Utterance	Turn	Grounding	Discourse	Argumentation
A : What is the main goal of the system?	1.1	Initiate	DU1: WHQ, Check	Q&A
: What would you like for us to focus on?	1.2	Continue		
S : Let me think...	2.1	Acknowledge	DU2: Inform, Check	Q&A
: the system shall be customizable...	2.2	Initiate		
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: Should we use file format XYZ?	5.2	Initiate		
S : Yes, absolutely.	6.1	Acknowledge		
...				

The parameters A and B shall be configured via a configuration file in format XYZ

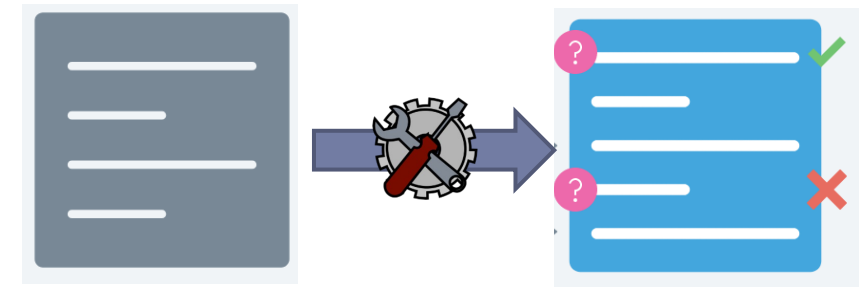
[conversation]

[specification]

# Tools for Conversational RE: Two Examples

The screenshot shows the Trace2Conv interface. At the top, there's a navigation bar with 'Login', 'Manual', 'Validation Requirements', and 'Transcripts'. Below that, a system message states: 'The system automatically sends an e-mail to the contact person of every vendor that is imported through the connection with JD Edwards so that he receives a link where he can create his password'. The main area displays a grid of entity occurrences, each with a 'VIEW SPEAKER TURNS' button. The entities listed are: system, sends, e-mail, contact, person, vendor, imported, connection, JD, Edwards, receives, link, create, and password. Below the grid, there are two tabs: 'MULTIPLE (SINGLE) TOKEN OCCURRENCES' and 'SCORING MECHANISM MULTIPLE TOKENS'. The 'MULTIPLE (SINGLE) TOKEN OCCURRENCES' tab is active, showing a speaker turn with the text: 'i would say that it's so that **vendor**s can easily access information, we get a lot of phone calls right now within either accounts payable or the departments and **vendor**s want to know whether or not we received the invoice, is it being processed, hasn't been paid. so we're hoping that this will eliminate a lot of those conversations and make it much easier for them to get information as well as um like you said that the address book thing, the history, um and hopefully maybe choose, like being able to upload their invoices through that process, yeah, leslie said, so moving toward electronic, i think is gonna be a big objective, um kind of a big undertaking for us, we've got about 6000 **vendor**s in je, a couple 1000 of them are active, so first off, we're gonna clean up, but that's really the target, ideally we would have as many of those **vendor**s as possible, sending us either emailing electronic invoices are uploading them through the portal. so that's a that's a big part of our success'.

Trace2Conv:  
pre-RS traceability



Requirements Conversation  
Summarizer



### **3. Trace2Conv: Tracing requirements to conversations**



# 3. Trace2Conv: Tracing requirements to conversations

## Back to the Roots: Linking User Stories to Requirements Elicitation Conversations

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**Abstract**—Pre-requirements specification (pre-RS) traceability focuses on tracing requirements back to their sources. In comparison with post-RS traceability, pre-RS traceability is an under-explored area of research. Likely reasons for the limited studies are the scarcity of pre-RS resources, e.g., recorded requirements elicitation conversations such as interviews or workshops, and the challenges of linking requirements to informal, unstructured text. Building on the increasing use of digital communication tools that allow the recording and transcription of conversations, we explore the opportunity of linking requirements to the transcript of a requirements elicitation conversation. We introduce TRACE2CONV, a prototype tool that aims at tracing user story requirements back to the relevant speaker turns in a conversation. TRACE2CONV makes use of NLP techniques to determine the relevant speaker turns. As an initial validation, we take automatically generated transcripts from real-world requirements conversations, and we assess the effectiveness of TRACE2CONV in supporting the process of identifying additional context for the requirements. The validation serves as a formative evaluation that guides the evolution of TRACE2CONV and as an inspiration for future research in the field of *conversational RE*.  
**Keywords**—Requirements Elicitation, User Stories, Natural Language Processing, Conversational RE.

The increasing use of digital communication tools (e.g., video-conferencing software with recording and automated captioning), also accelerated by the increased remote work and collaboration that resulted from the COVID-19 pandemic, creates an opportunity to revitalize the research in this area.

We present ongoing research that is part of *conversational RE*: the analysis of requirements elicitation conversations (in short form, requirements conversations) aimed at identifying and extracting requirements-relevant information. Conversational RE sets requirements elicitation conversations as central RE artifacts, in contrast with traditionally studied artifacts such as requirements specification documents [5].

We focus on how to use the verbal communication that is so important in real-world projects but that is largely overlooked in RE research. A few exceptions are the analysis of interview recordings in projects regarding information systems [6], [7] and the analysis of simulated interviews in RE education [8], [9]. Yet, we are not aware of any studies that trace requirements back to requirements conversations.

In this paper, we design and report on TRACE2CONV, a prototype tool that aims at automatically tracing user story requirements [10], [11] back to the segments of a requirements interview that are likely to justify that requirement. In particular, we make the following contributions to the RE field:

- We describe TRACE2CONV and the NLP heuristics that we implemented in order for the tool to determine which speaker turns are relevant to a given requirement.
- Through collaboration with a partner in the software consultancy, we present an early validation of our implemented algorithms on automatically generated transcripts of requirements interviews.

We provide qualitative observations on search strategies in backward traceability, we reflect on goals & use-cases, and we position initial approaches for ranking relevance. Additionally, the reported validation serves not only as a formative evaluation that guides the evolution of TRACE2CONV, but also as a kick-off for future research in the field of *conversational RE*.

**Organization.** We motivate our work with reference to the existing literature in Sec. II. Then, we present the design of TRACE2CONV and provide an overview in Sec. III. We report

### I. INTRODUCTION

Requirements traceability (RT) refers to the ability to describe and follow the life of a requirement, both forward and backward [1]. Conducting RT is important to identify the sources of a requirement [2], to analyze the impact of a requirement on software engineering artifacts such as code and test cases [3], and to determine dependencies between requirements, also known as horizontal traceability [4].

Depending on whether we look backward or forward from a requirements specification document, we can distinguish between [1]: *Pre-RS* traceability, referring to linking the requirements in a specification to the sources that justify their existence; and *Post-RS* traceability, concerned with the life cycle of a requirement after its inclusion in the specification.

Although the high(er) potential of pre-RS traceability has been recognized already in the 1990s by Gøtel [1], Pre-RS traceability is a significantly less explored area of research than post-RS traceability [2]. We agree with Krause *et al.* [2] and argue that this is due to the easier availability of and accessibility to the artifacts. For example, code and test cases

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Natural Language Processing for RE at Dibbler

RE@Next! Papers / Journal-First

Chair(s): **Tong Li** Beijing University of Technology

11:20 20m ☆

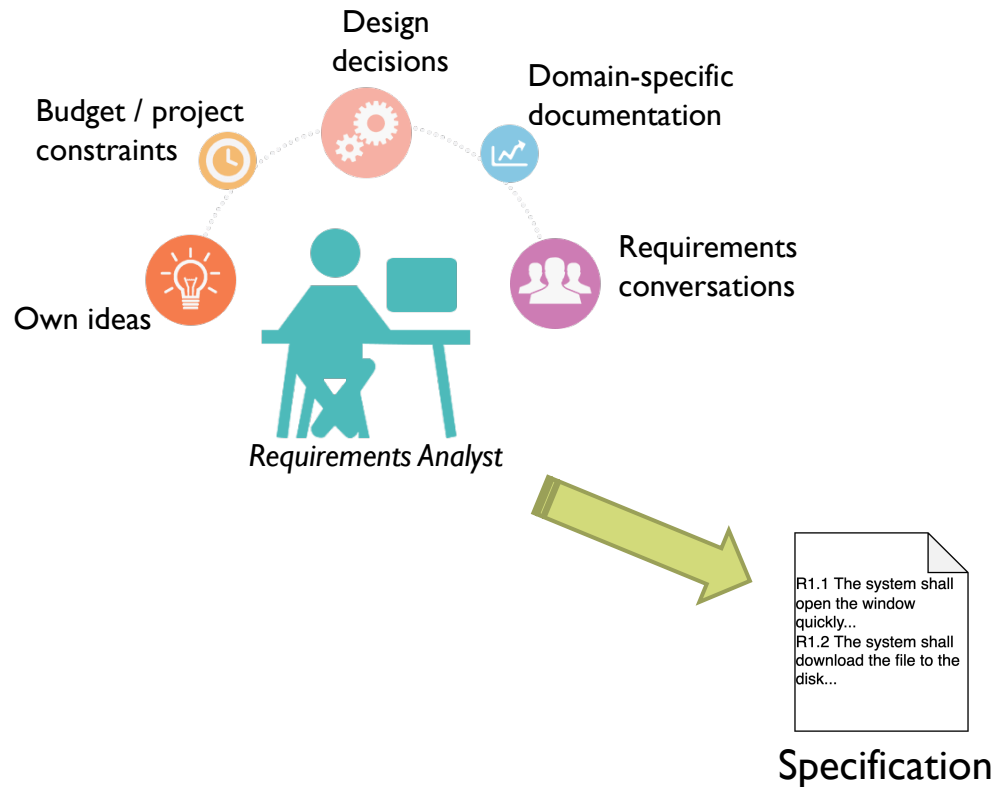
**Back to the Roots: Linking User Stories to Requirements Elicitation Conversations**

RE@Next! Papers

Tjerk Spijkman Utrecht University, Fabiano Dalpiaz Utrecht University, Sjaak Brinkkemper Utrecht University

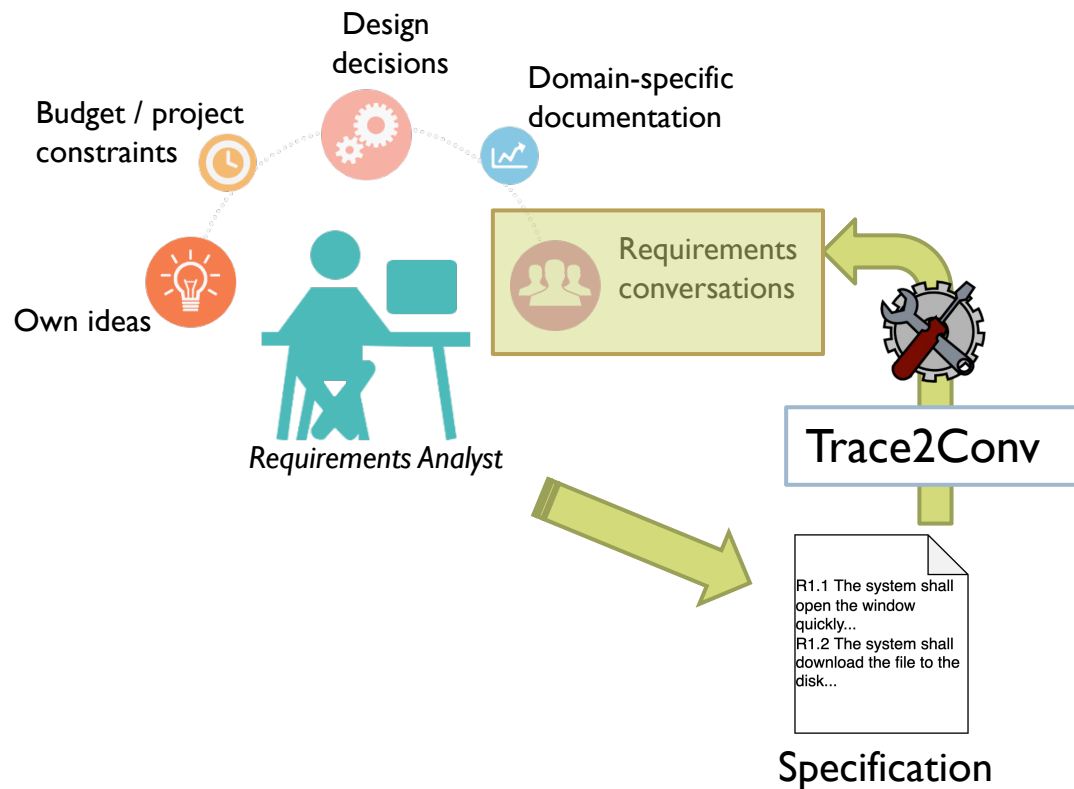
# Trace2Conv: Key Idea

---

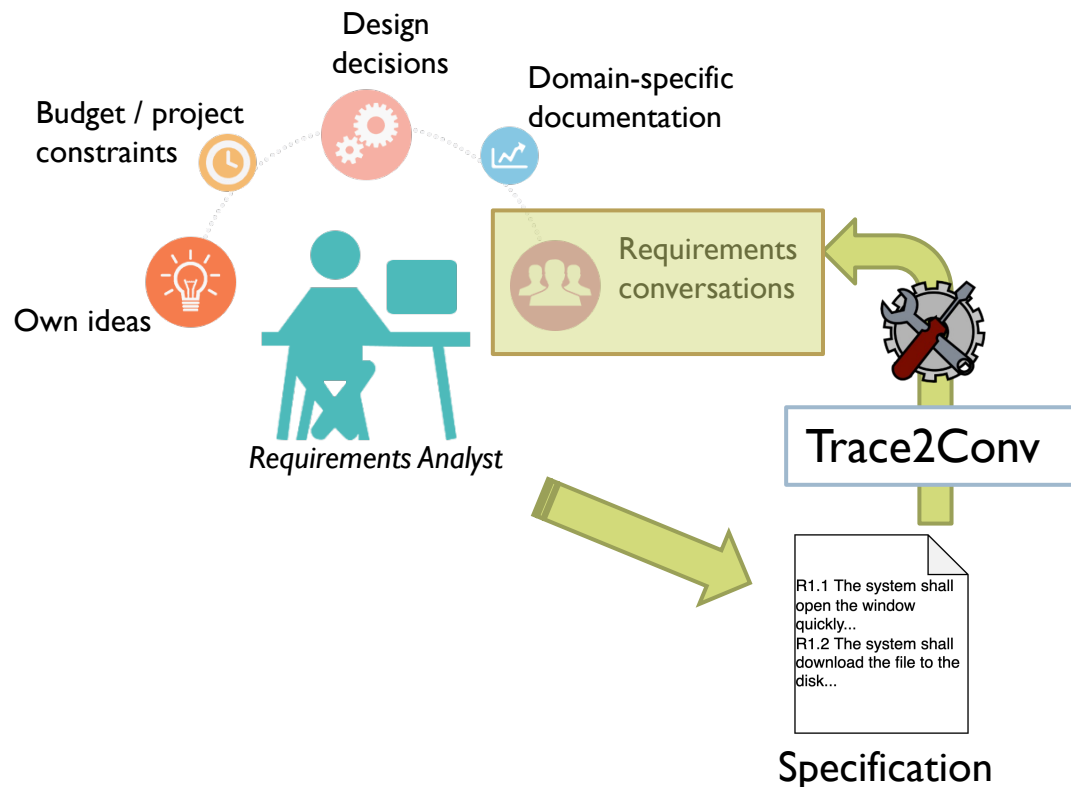


# Trace2Conv: Key Idea

- ▶ Supports backward, pre-RS traceability
- ▶ Largely overlooked area of research

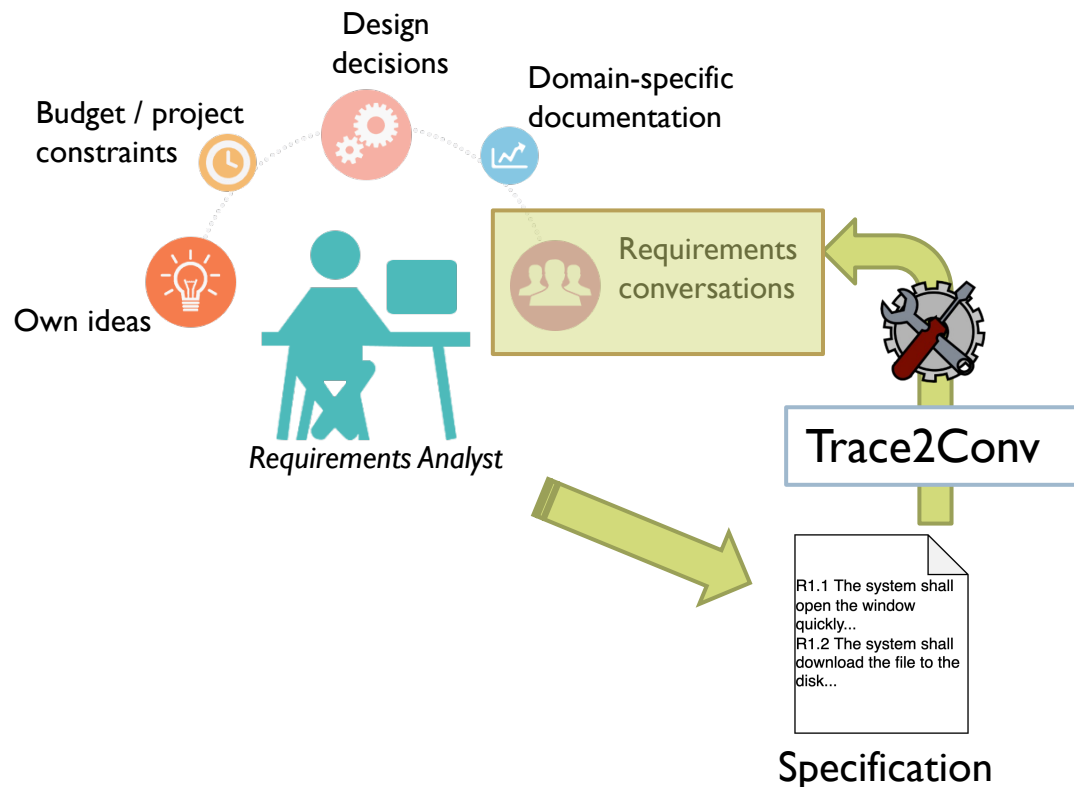


# Trace2Conv: Key Idea



- ▶ Supports backward, pre-RS traceability
  - ▶ Largely overlooked area of research
- ▶ Aims to find information that provides **additional context** to a requirement

# Trace2Conv: Key Idea



- ▶ Supports backward, pre-RS traceability
  - ▶ Largely overlooked area of research
- ▶ Aims to find information that provides **additional context** to a requirement
- ▶ Has to cope with an *abstraction gap*
  - ▶ Formal to informal

# What can we achieve with Trace2Conv?

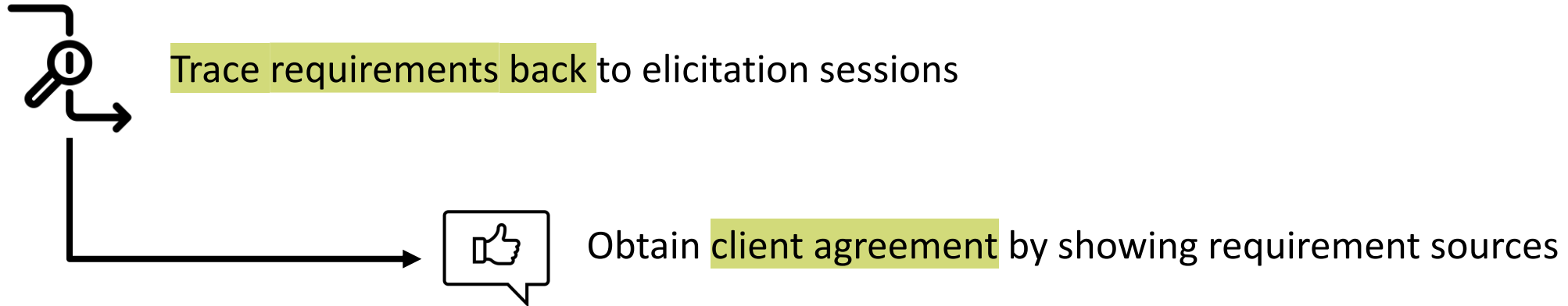
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Trace requirements back to elicitation sessions

# What can we achieve with Trace2Conv?

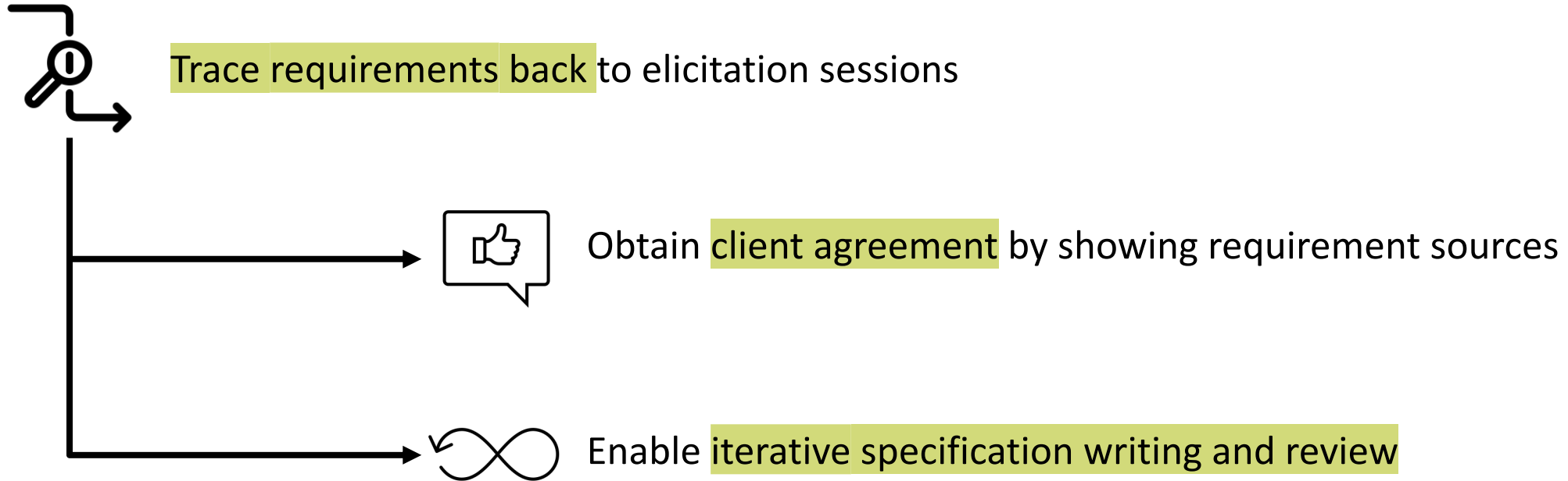
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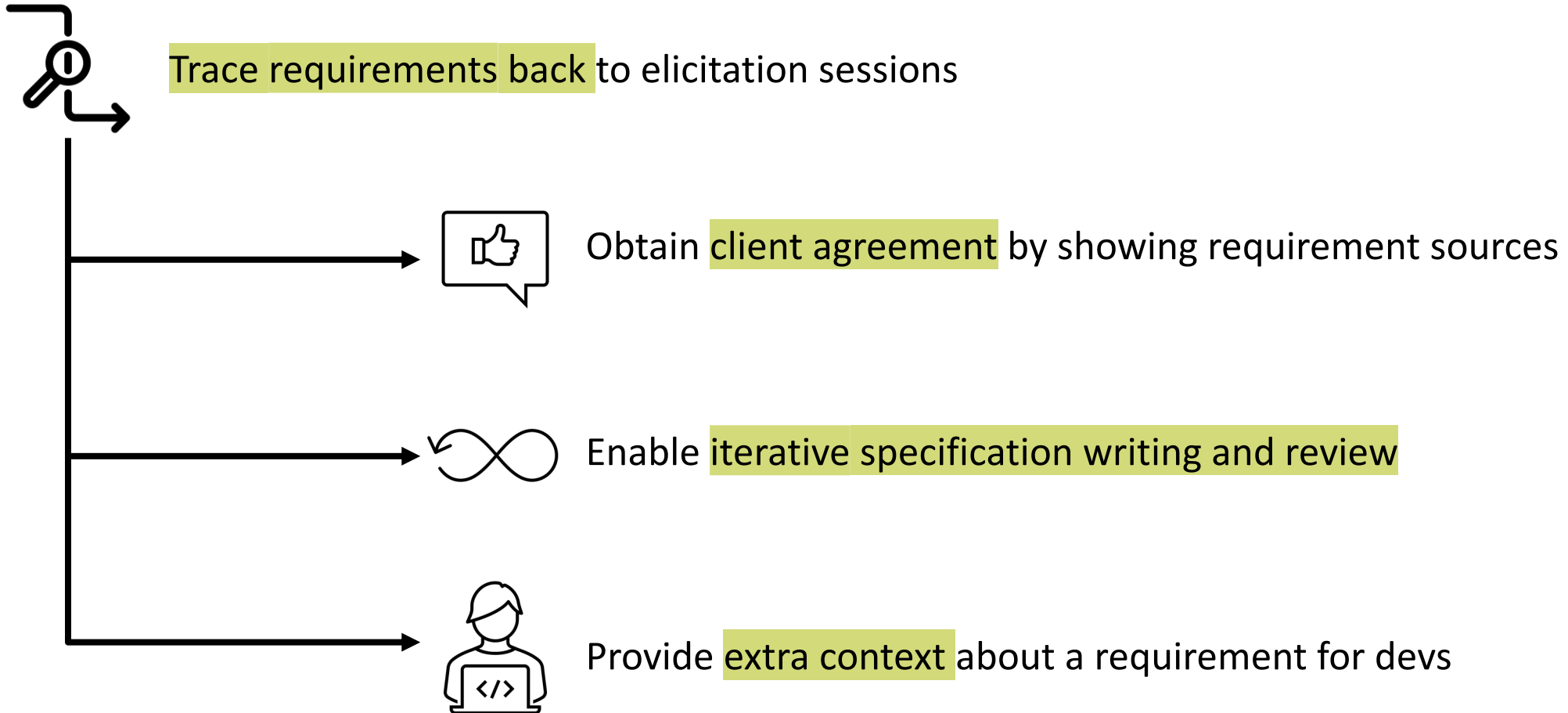
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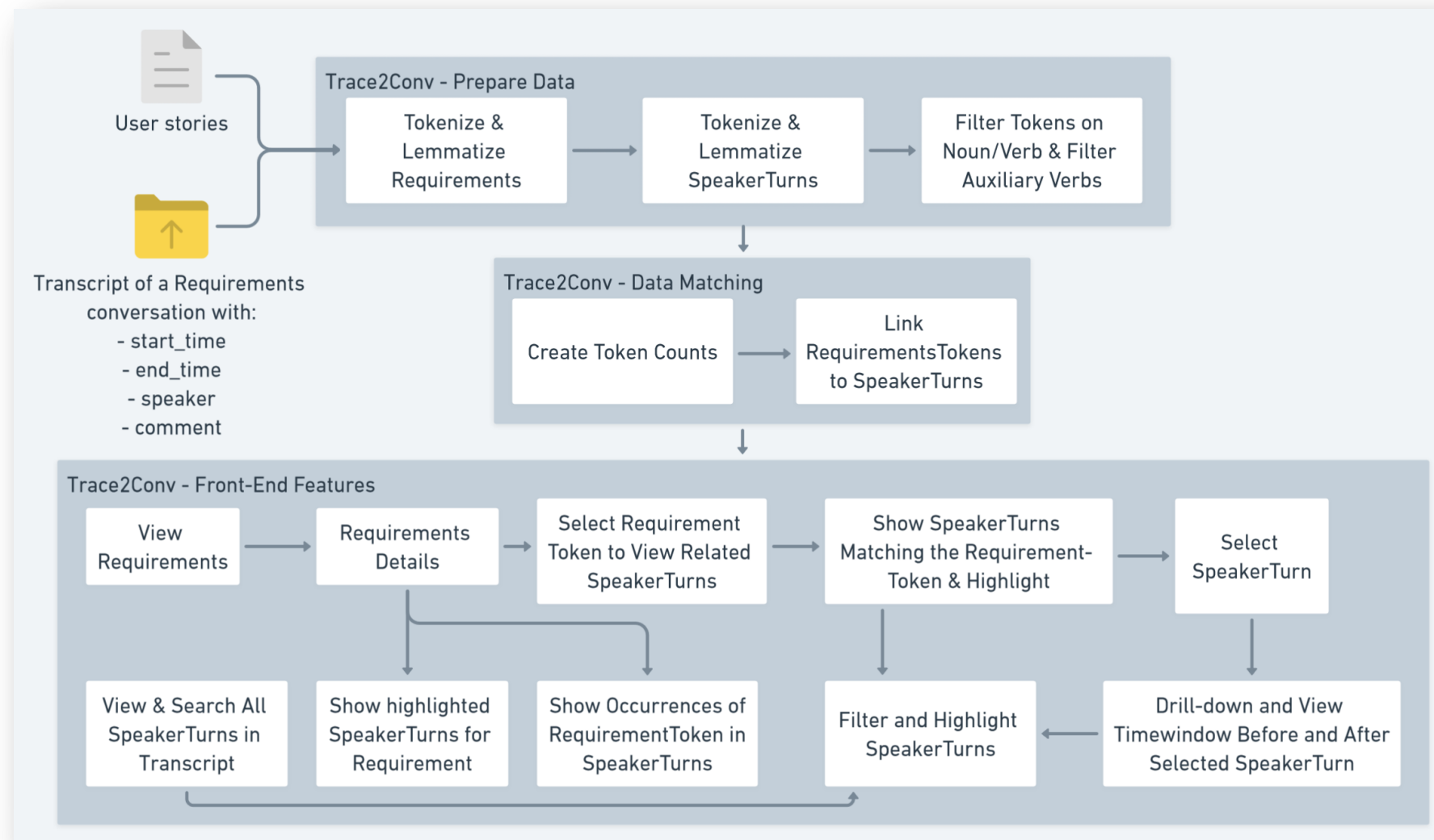


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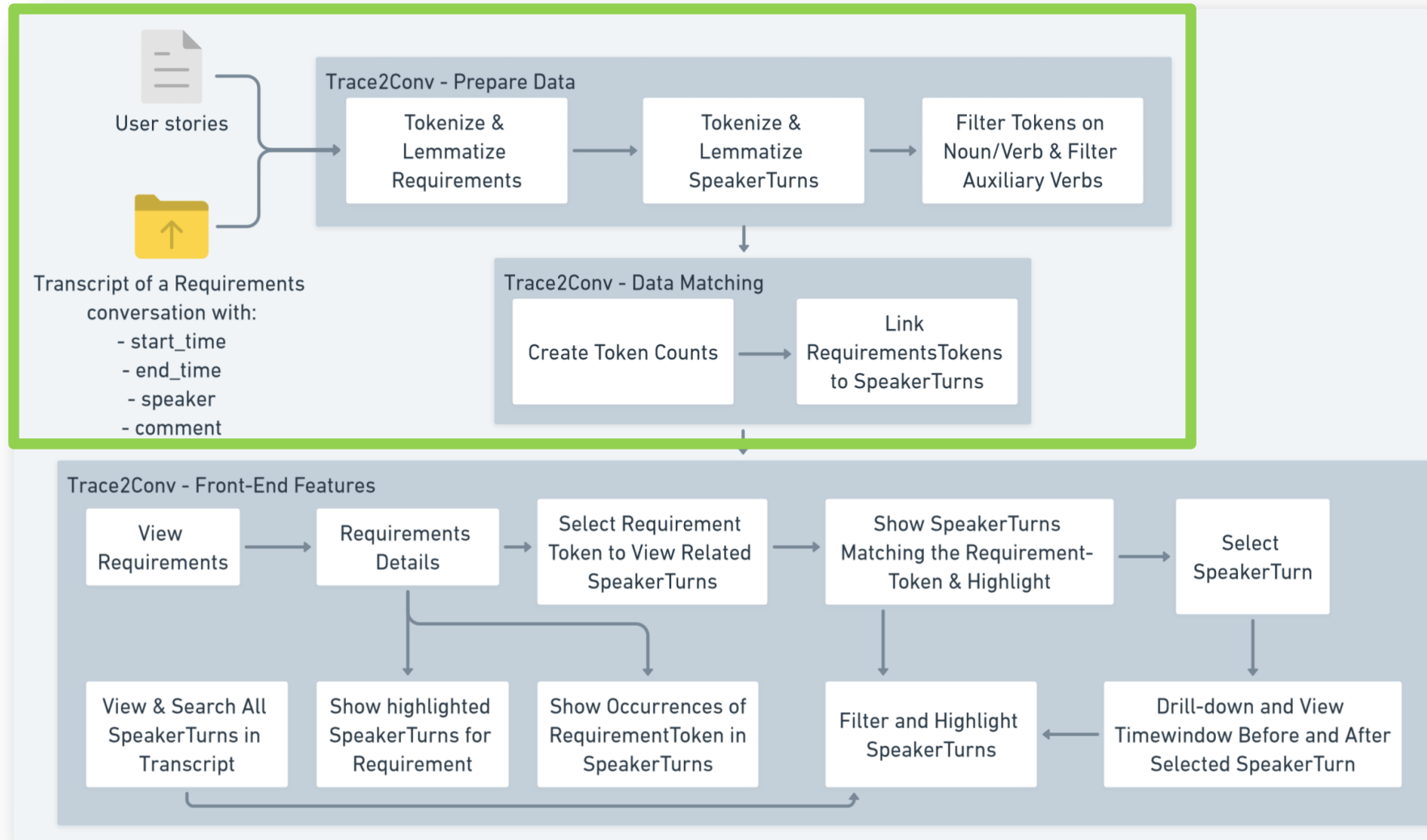
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# Architectural Design – Inputs and Backend



# Architectural Design – Inputs and Backend



# Pre-processing and matching

---

---

**Algorithm 1** Data Preparation and Data Matching

---

**Input:**  $R$  a set of requirements,

$C$  a set of speaker turns,

**Output:** a set of tokens  $AllTokens$ , linked to their occurrences in requirements and speaker turns

```
1: function PREPROCESSANDMATCH( $R, C$ )
2:   for all  $sent \in R \cup C$  do
3:      $T_{sent} \leftarrow \text{TOKENIZE}(sent)$ 
4:      $T_{sent} \leftarrow \text{LEMMATIZE}(T_{sent})$ 
5:      $T_{sent} \leftarrow \{t \in T_{sent} \mid \text{POS\_TAG}(t) \in \{\text{NOUN}, \text{VERB}\}\}$ 
6:      $T_{sent} \leftarrow \{t \in T_{sent} \mid \text{POS\_TAG}(t) \notin \{\text{AUX}\}\}$ 
7:    $AllTokens \leftarrow \bigcup_{sent \in R \cup C} T_{sent}$ 
8:   for all  $t \in AllTokens$  do
9:      $t.req \leftarrow \{req \in R \mid t \in T_{req}\}$ 
10:     $t.turn \leftarrow \{sturn \in C \mid t \in T_{sturn}\}$ 
11:  return  $AllTokens$ 
```

---

As a vendor user, I can use the password forgotten functionality whenever I forgot or want to reset my password, so that I always have a way to create a new password

# Pre-processing and matching

---

**Algorithm 1** Data Preparation and Data Matching

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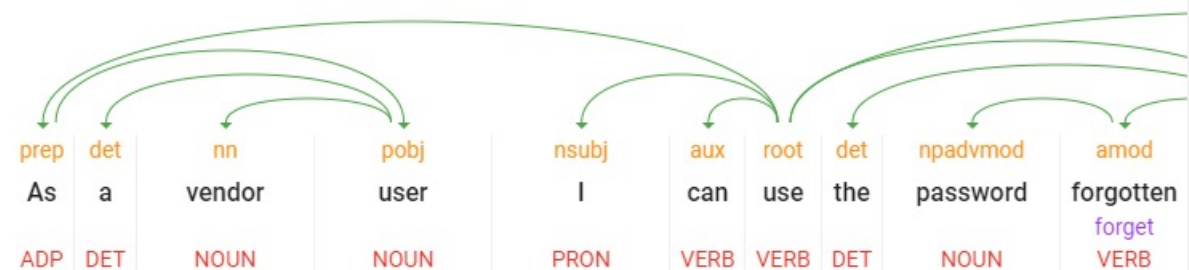
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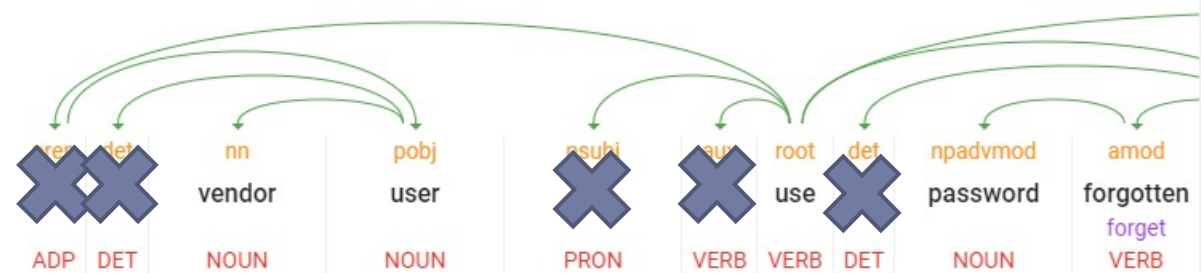
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# Pre-processing and matching

---

## Algorithm 1 Data Preparation and Data Matching

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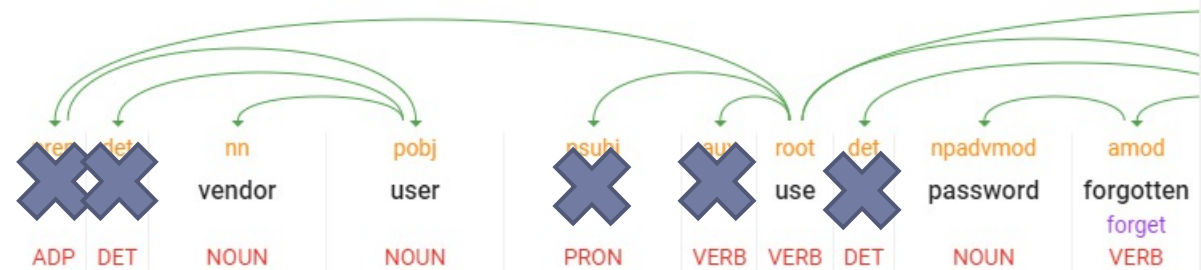
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$C$  a set of speaker turns,

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- 1: **function** PREPROCESSANDMATCH( $R, C$ )
  - 2: **for all**  $sent \in R \cup C$  **do**
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  - 8: **for all**  $t \in AllTokens$  **do**
  - 9:    $t.reqs \leftarrow \{req \in R \mid t \in T_{req}\}$
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- 

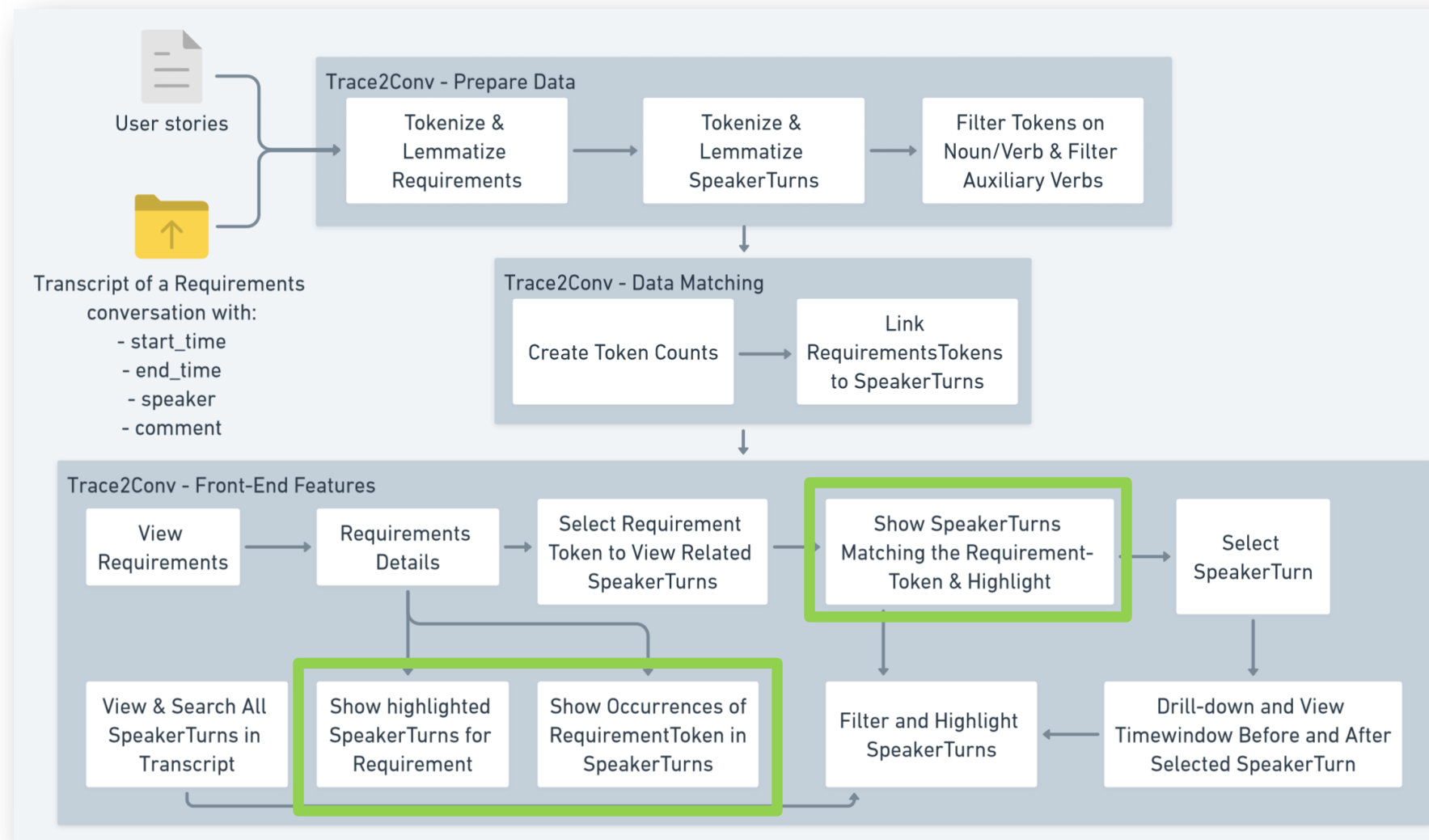
As a vendor user, I can use the password forgotten functionality whenever I forgot or want to reset my password, so that I always have a way to create a new password



content	speaker_text
<input type="checkbox"/> here, are there are two genders that you would not want in the, I was gonna say see we because we have not been, I should ...	spk_3
<input type="checkbox"/> Oh. Um I mean I guess if you provide them like a secure link to click on and then they just put a new password in um As long ...	spk_2
<input type="checkbox"/> Like how do you securely do that take one email for one Vendor and allow them to create one or more named email accounts?	spk_2
<input type="checkbox"/> I think you should always be there or you should put your you can can you have multiple, Vendor	spk_4
<input type="checkbox"/> him. I think I don't know that master Vendor	spk_3



# Architectural Design - Frontend



# Short demo of the Trace2Conv frontend







---

# Short demo of the Trace2Conv frontend

Trace2Conv Login Manual Validation Requirements Transcripts


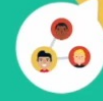




## Overview

Search



**Transcript 1**  
Subheader  
Description

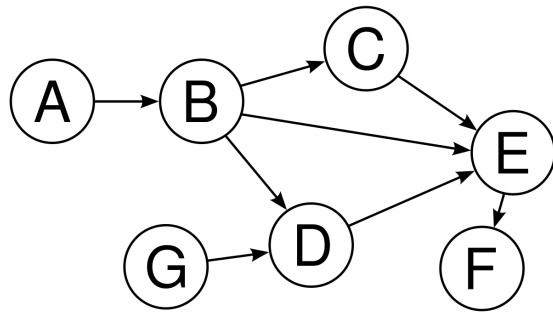
[> Speaker Turns](#) [> Requirements](#)



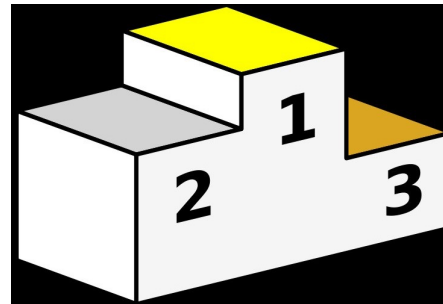
**Transcript 2**  
Subheader  
Description

[> Speaker Turns](#) [> Requirements](#)

# Trace2Conv: Next Steps



Requirements **evolution** over multiple conversations

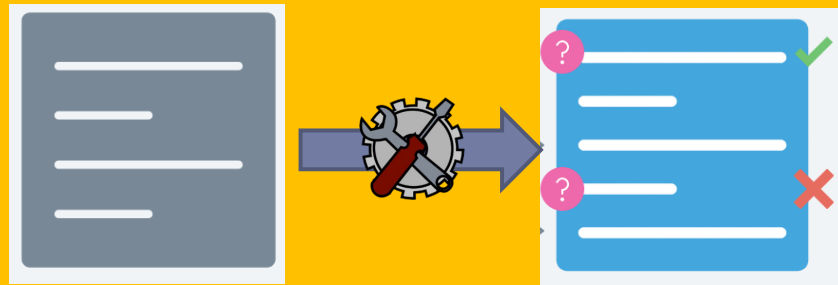


More advanced **heuristics**: what are the most likely matches?

Speaker: Utterance	Turn	Grounding	Discourse	Argumentation
A : What is the main goal of the system?	1.1	Initiate	DU1: WHQ, Check	Q&A
: What would you like for us to focus on?	1.2	Continue		
S : Let me think...	2.1	Acknowledge	DU2: Inform, Check	Q&A
: the system shall be customizable...	2.2	Initiate		
: hmm, no, configurable!	2.3	Repair		
A : Configurable, you said.	3.1	Acknowledge	DU3: WHQ, Check	Q&A
: Hmm, what do you exactly mean by that?	3.2	Initiate		
S : Oh yes, sorry...	4.1	Acknowledge	DU4: Inform, Check	Clarify
: the developers must be able to adjust parameters A and B so to serve different clients	4.2	Initiate		
A : I see, clear.	5.1	Acknowledge	DU5: Request(Eval), Eval	Q&A
: Should we use file format XYZ?	5.2	Initiate		
S : Yes, absolutely.	6.1	Acknowledge		
...				

**Matching segments** rather than speaker turns

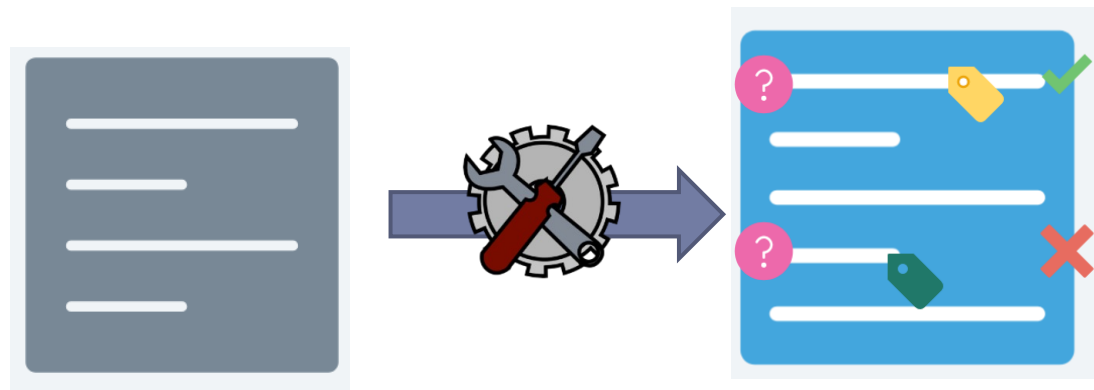
# 4. Requirements Conversations Summarizer



# Summarizing a transcript: ideas

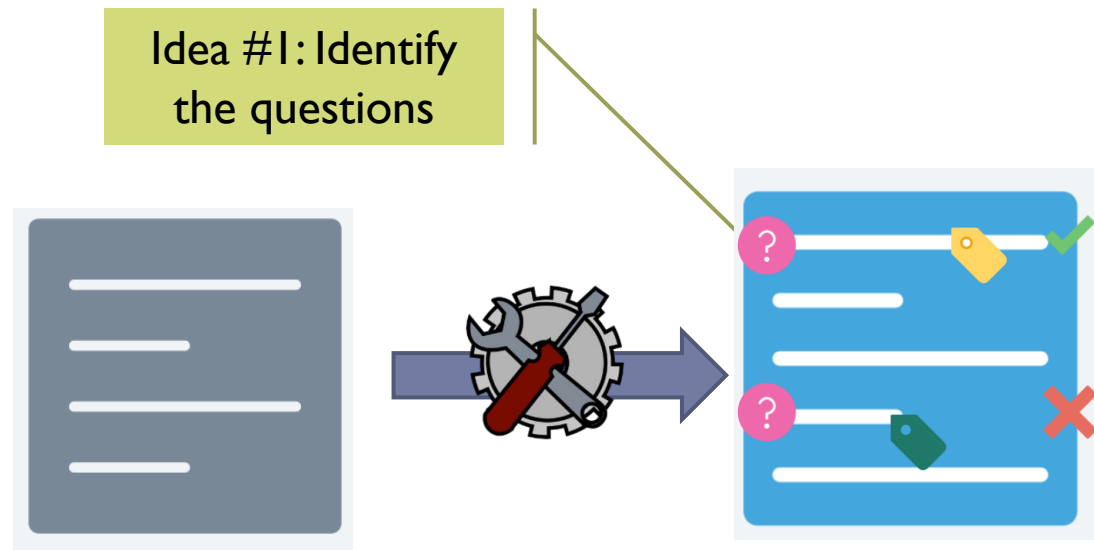
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- ▶ Aim: summarization before a specification exists
- ▶ Trigger: long recorded conversations, spanning over multiple hours
  - ▶ How to facilitate the analyst in exploring the transcript?



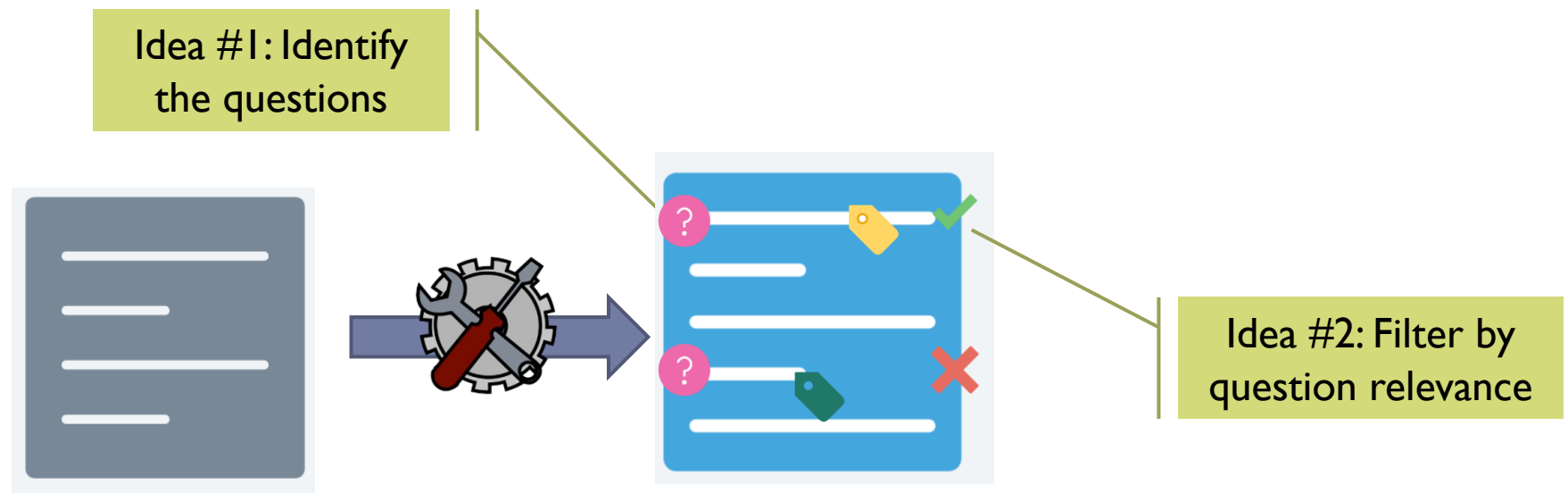
# Summarizing a transcript: ideas

- ▶ Aim: summarization before a specification exists
- ▶ Trigger: long recorded conversations, spanning over multiple hours
  - ▶ How to facilitate the analyst in exploring the transcript?



# Summarizing a transcript: ideas

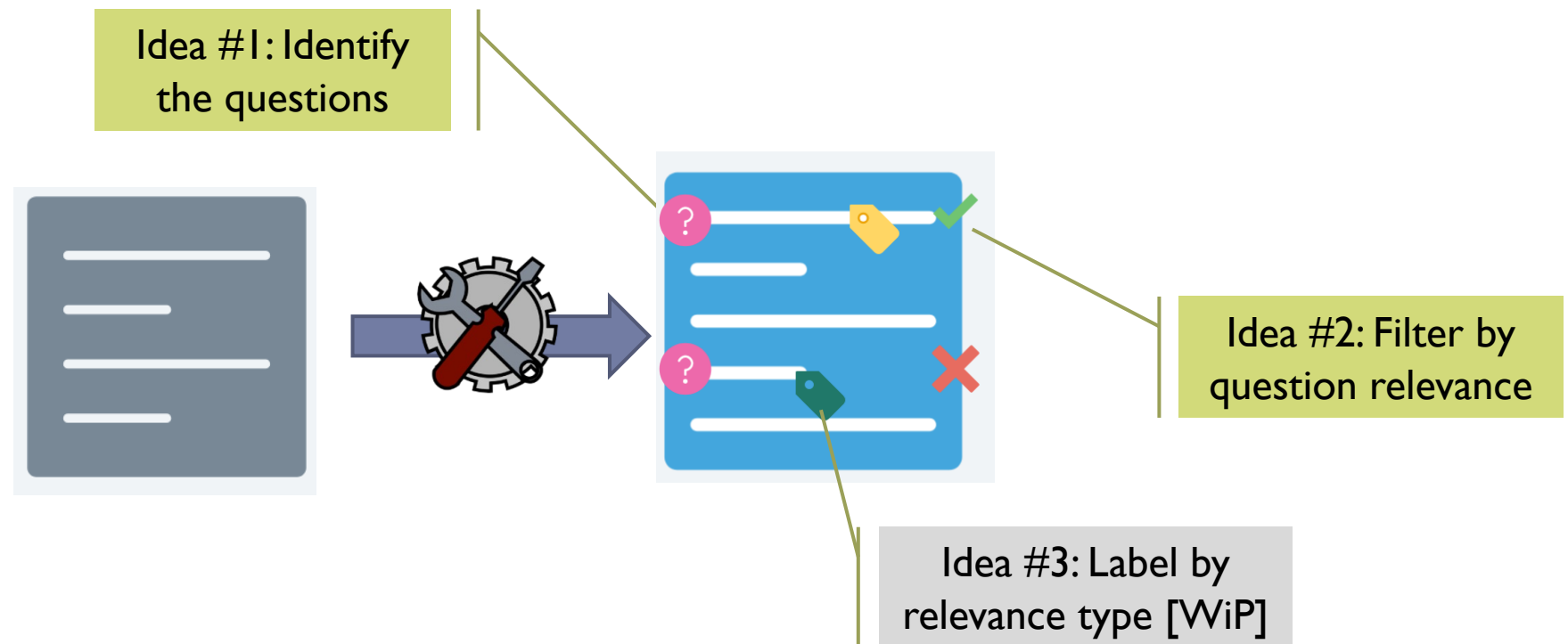
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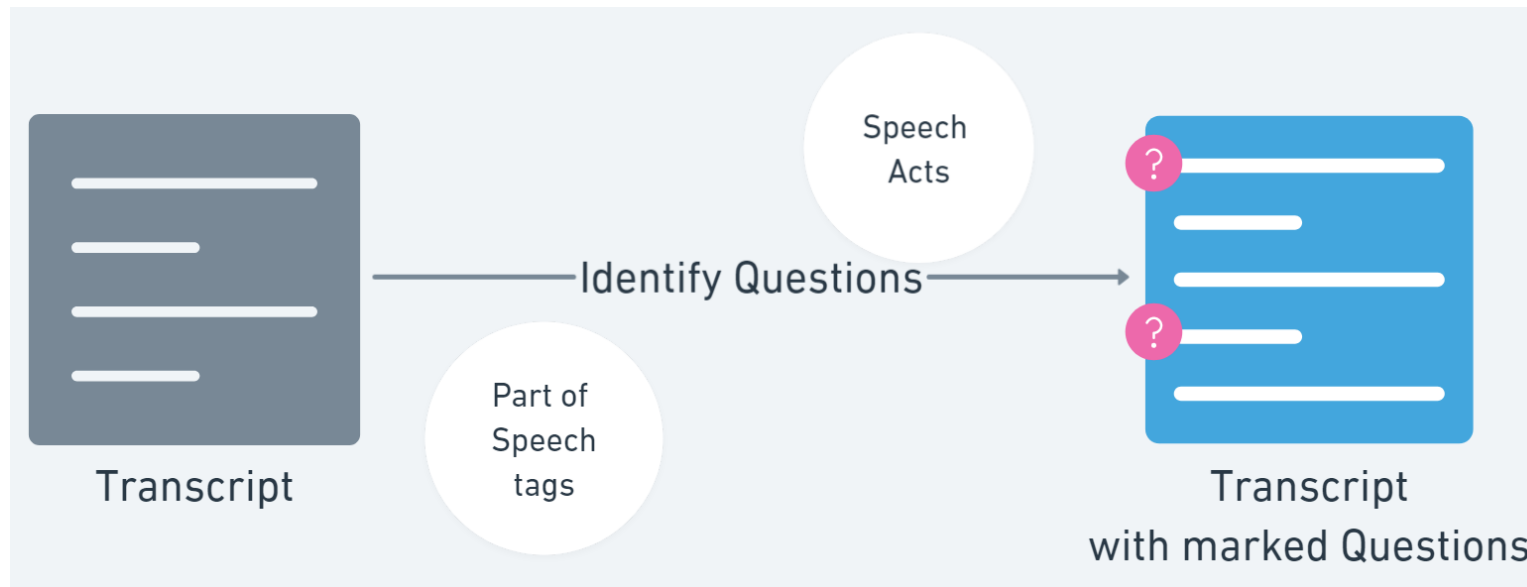


# Summarizing a transcript: ideas

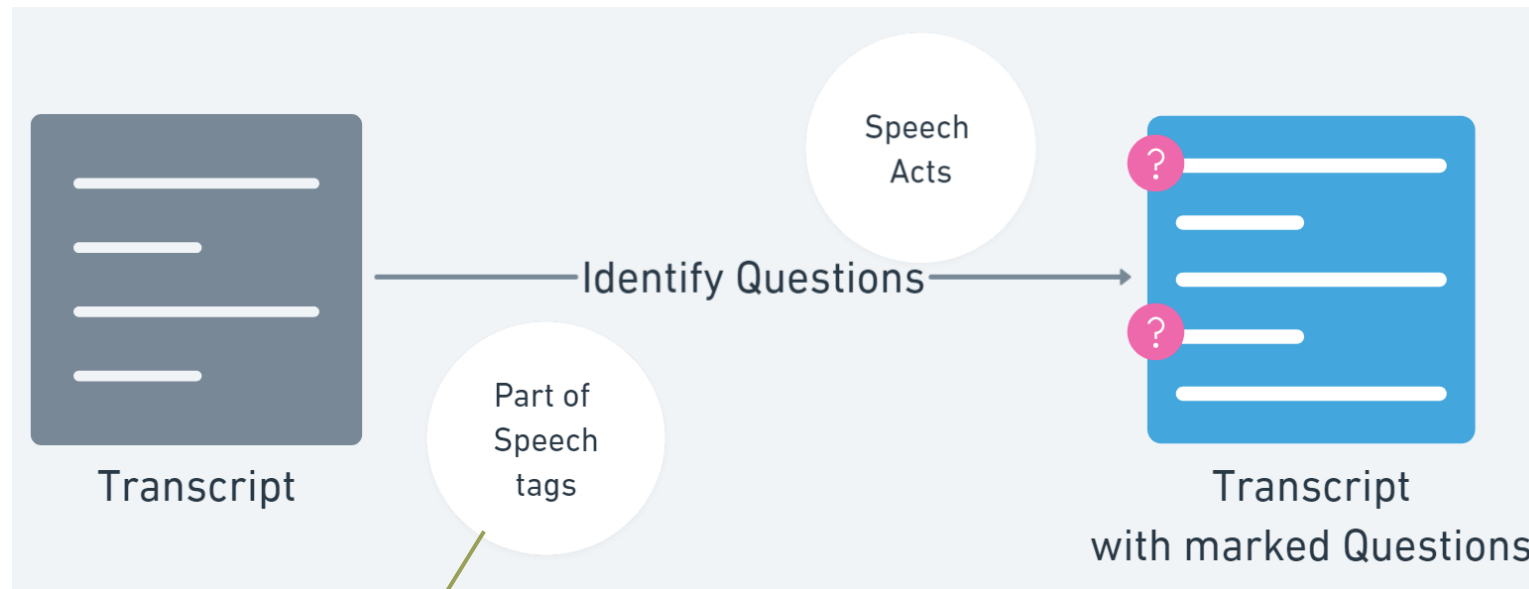
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# How to identify the questions? (Idea #1)

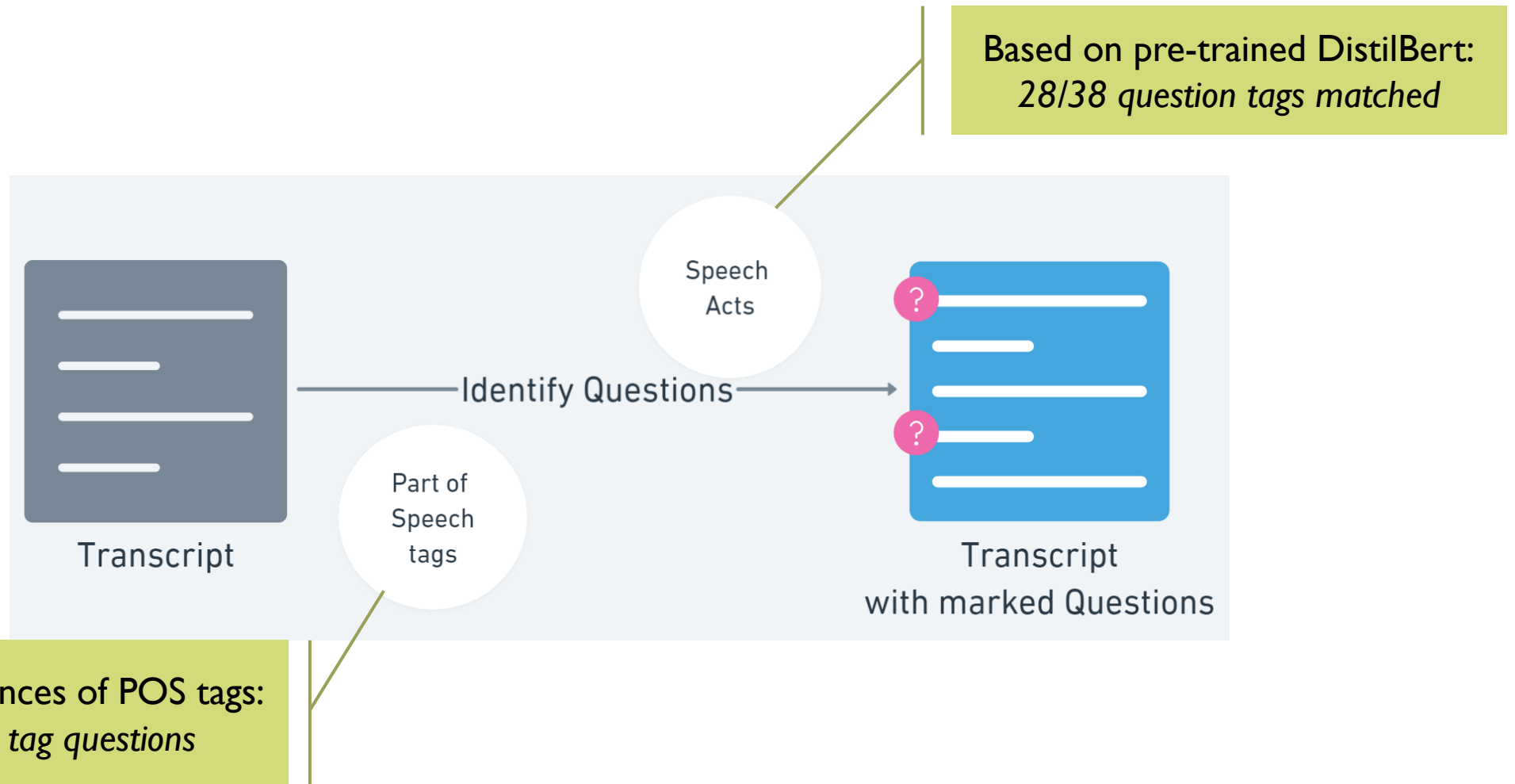


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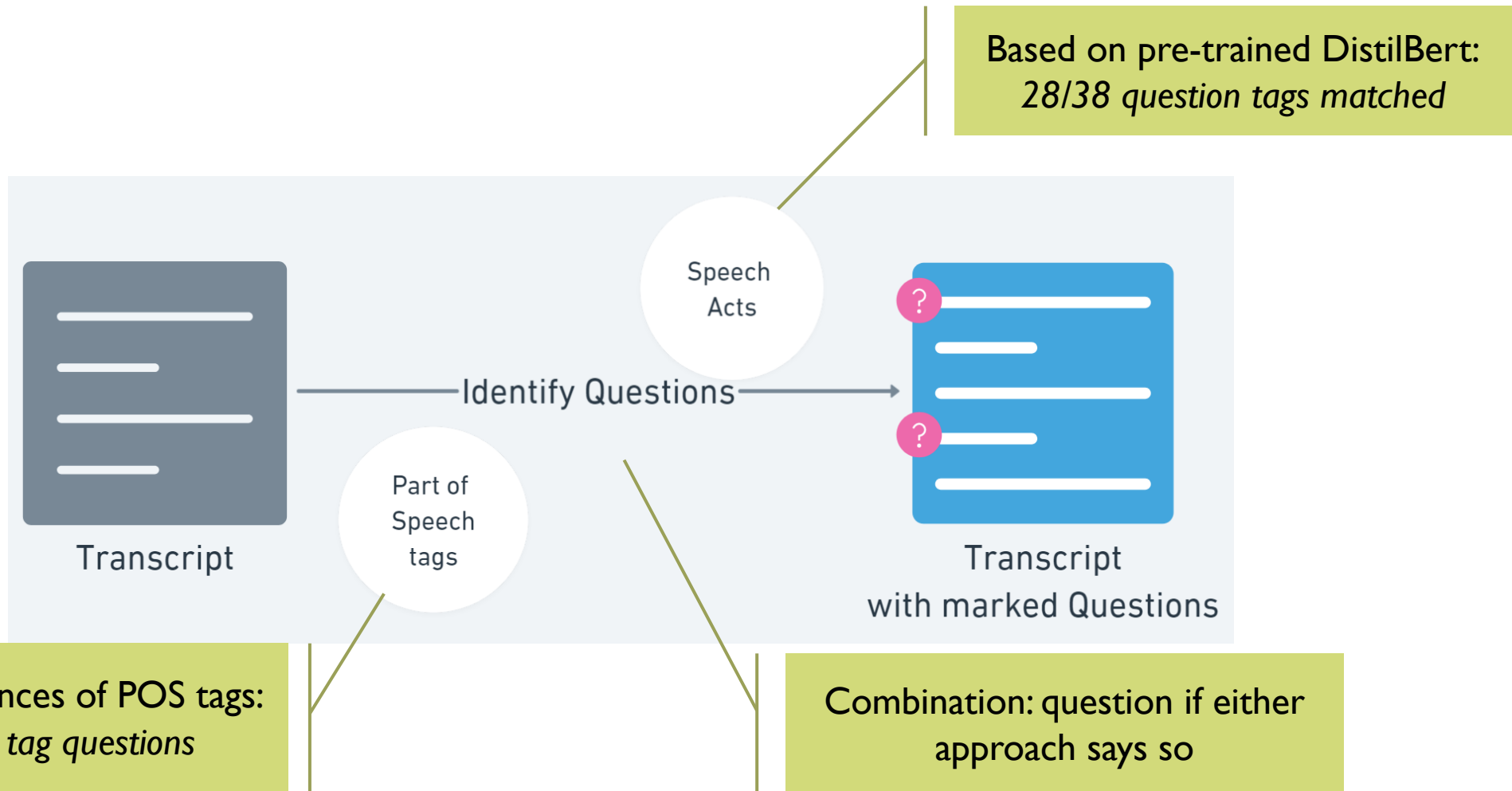


Based on sequences of POS tags:  
*Wh-, yes/no, tag questions*

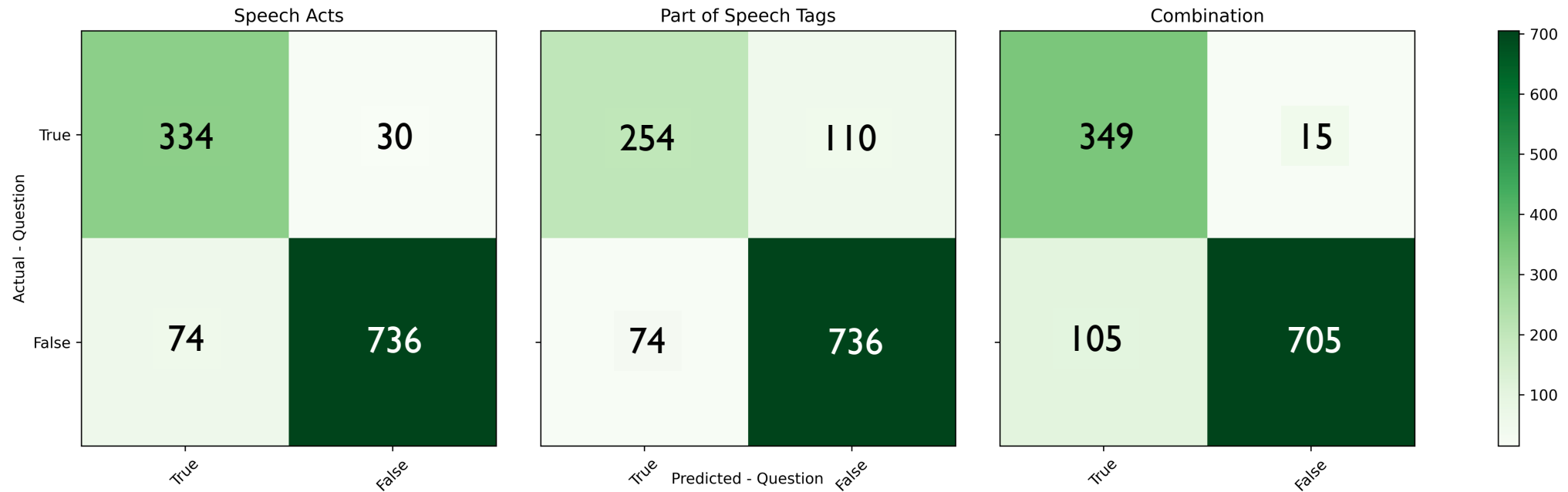
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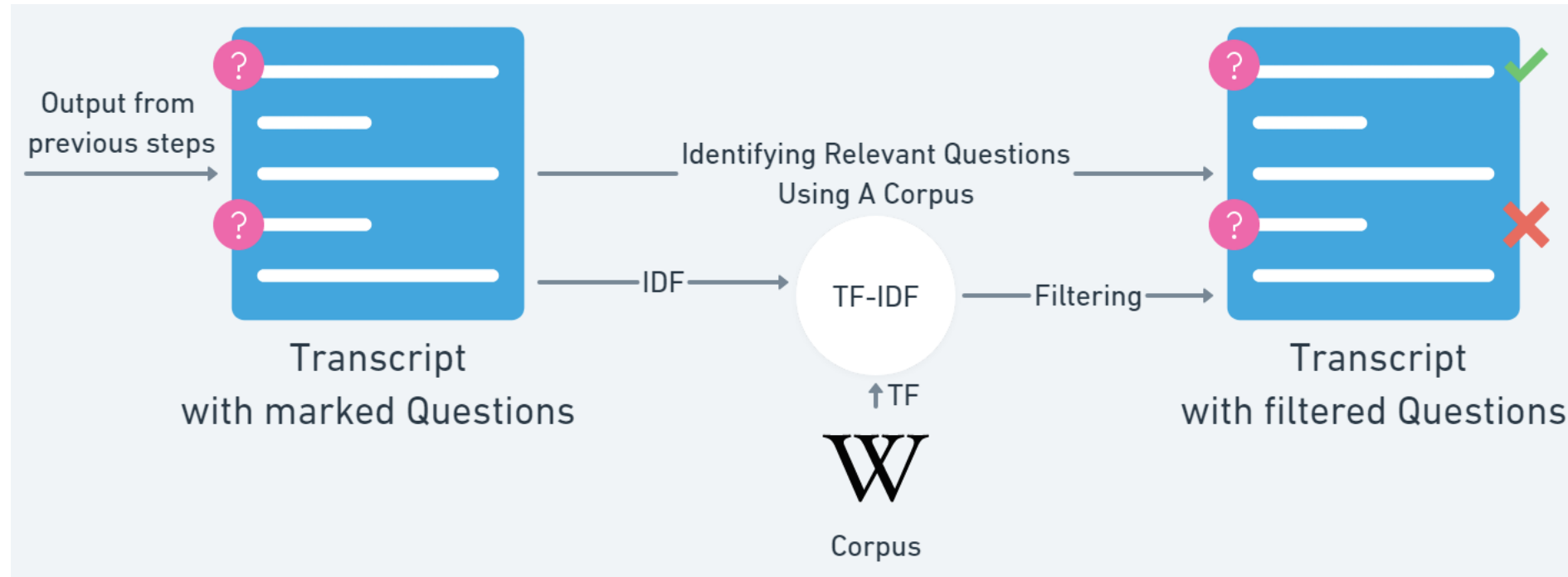


# Is Idea #1 effective?

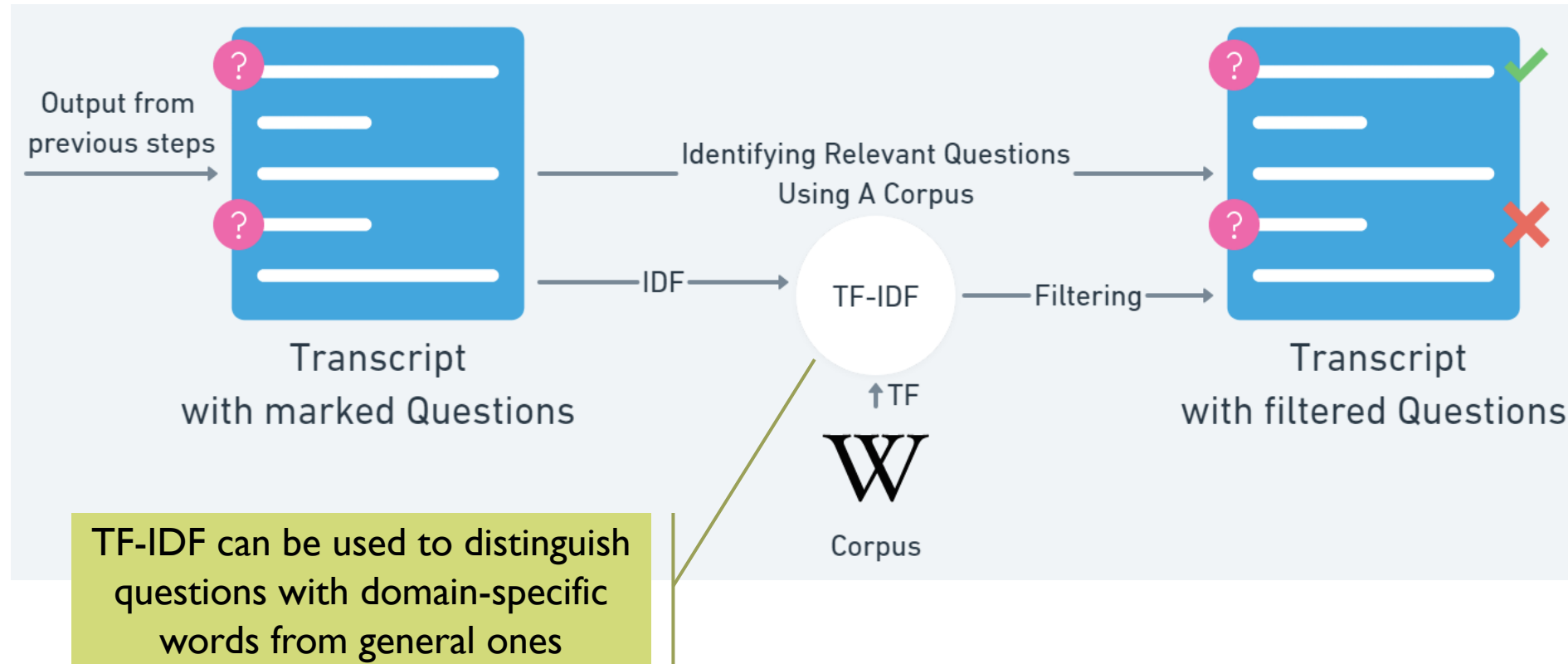


Approach	Precision	Recall	F1-score	Accuracy
Speech Acts	81.8%	91.7%	86.5%	91.1%
Part of Speech Tags	69.7%	77.4%	73.4%	84.3%
Combination	76.8%	95.8%	85.3%	89.7%

# How to filter relevant questions? (Idea #2, version A)

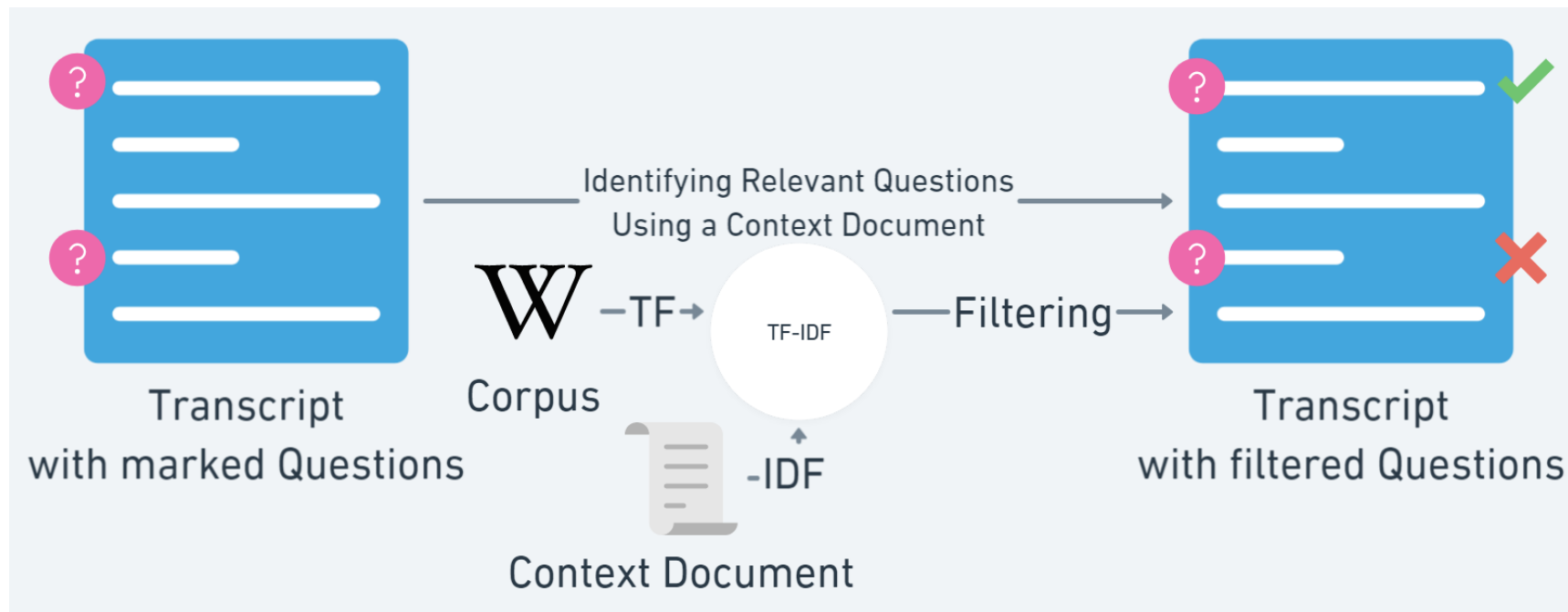


# How to filter relevant questions? (Idea #2, version A)

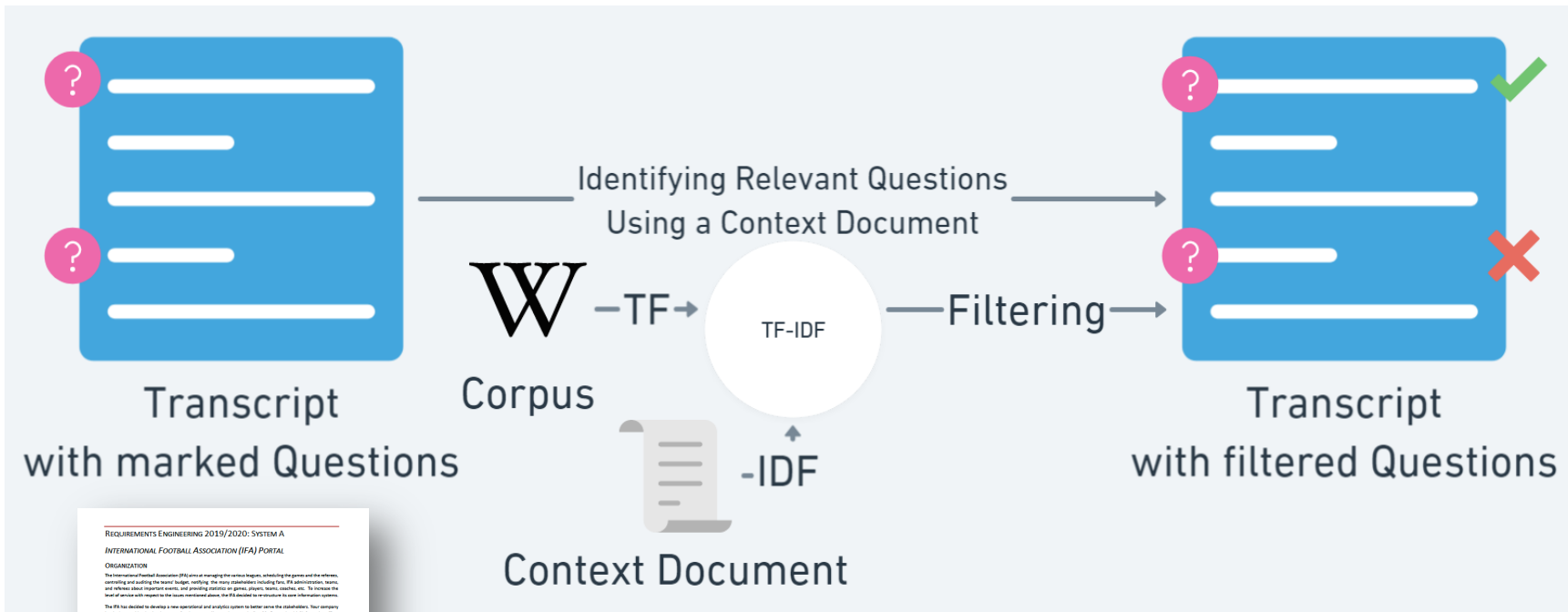




# How to filter relevant questions? (Idea #2, version B)



# How to filter relevant questions? (Idea #2, version B)



REQUIREMENTS ENGINEERING 2019/2020: SYSTEM A  
INTERNATIONAL FOOTBALL ASSOCIATION (IFA) PORTAL

ORGANIZATION

The International Football Association (IFA) aims at managing the various leagues, scheduling the games and the referees, controlling and auditing the financial budget, writing the rules and regulations, leading the IFA administration, teams and referees about important events, and providing statistics on games, players, teams, coaches, etc. To increase the level of service with respect to the users involved above, the IFA decided to implement a new information system.

The IFA has decided to develop a new operational and analysis system to better serve the stakeholders. Your company is asked to consider the development of such a system. You need to go and talk to Mr. Stone, the chief information officer of the IFA who is in charge of leading the entire system.

AS-IS SITUATION

The current operational system is well supported every day of the week. The IFA would like to improve the performance. There is a lack of the following: (1) transparency, mainly when referring to budget auditing; (2) automation in scheduling, mainly to avoid human errors; (3) better support for the fact that you already have several data files; (4) calculation about calculation of the events occur in the games; and (5) communication with the various stakeholders is inefficient as it is done using various means (e.g., mostly e-mails) about the organization of the game with a general call and notify the team for the fact over a long time period.

Indeed, the IFA manages its operations by various means, including several systems that are isolated and thus cannot communicate and exchange data, which leads to problems in analyzing the IFA goals. For example, the team manager that the system and other external systems needs to be able to find the existing capabilities of the IFA. Currently, the IFA does not support that time verification and updates that are required for the fact. In addition, referees are notified about their calendar without considering their activities and their scheduling requirements. Moreover, the entire operation is done by the IFA administration and consumes much of their time, leading the IFA expansion.

VISION

In order to be able to manage and control the IFA that there is a need for a complete change in the operational system and infrastructure of the IFA, so as to make it more operationally efficient. The goal of this infrastructure is to better support the stakeholders and the IFA activities. For that purpose, the system manager using the system has to be able to manage the information about responsibility to be managed. It is expected that 50000 people could access the system at any time and the response time should be fast. Furthermore, the infrastructure should support several users around the globe. Furthermore, the infrastructure should allow the support for scalability in many aspects, such as: costs, for budget management and control for expenses, the system's performance across the league. The IFA fully aware of its own ability to maintain and operate the infrastructure, as it is not a software company, and thus requires the infrastructure to be able to support the system.

The system should delegate responsibilities for each of the stakeholders. For example, there will need to manage their own financial budgets, players, referees, league information, etc. The set of all actions, controlled by the IFA administration. Referees will write the game report using the system, preferably in real-time, using the appropriate technology. There are usually information consumers, and will be able to add comments, photos, and articles about the reports, players, etc. The league status should be available at any time.

Mr. Stone is willing to provide you with additional information through a video or telephone interview. He has some ideas about how to proceed that he is open to be changed that he likes to help you shape the system to be built.

A context document can be, e.g., a system/project definition document

# What is our gold standard for relevance?

---

## **Previous speakerturn:**

**Interviewee:** *Yes, absolutely.*

## **Current speakerturn:**

**Interviewer 1:** *Good. Um, yeah, we got an email from your company and it said that there is some serious problems with traffic congestion that leads to a bad traffic during peak hours and also from the activists that are arguing of the effect on the environment. **Do you think there are more problems or just these two?***

## **Next speakerturn:**

**Interviewee:** *Well, this is the reason why we contacted you and actually we believe a lot in ah environmental concerns and I'm an activist myself. So that's I cycle here, right? Not only for the body, it's for the environment. Ah, so yes, there is traffic and there is environmental problems to be solved and yeah, to the extent we can we want to improve on that. And I hope you have a solution for me.*

# What is our gold standard for relevance?

**Previous speakerturn:**

**Interviewee:** *Yes, absolutely.*

**Current speakerturn:**

**Interviewer 1:** *Good. Um, yeah, and it said that there is some stuff that leads to a bad traffic during those times that are arguing of the effect of those things, are more problems or just the*

**Next speakerturn:**

**Interviewee:** *Well, this is the reason we believe a lot in an environment. So that's I cycle here, right? Not in the environment. Ah, so yes, there are more problems to be solved and yeah, we can improve on that. And I hope you*

**Q6/52: What type of requirements-relevant information can be found here?**

*(Disregarding the previous speakerturn, only looking at the current and the next speakerturn)*

- A functional requirement (functionalities that the system should exhibit, e.g. registering users, scheduling events, calculating something, ...)
- A non-functional requirement (a quality that should be there given certain functionality, e.g. speed, security, capacity, compatability, usability, ...)
- System users (directly discusses the users of the system, or stakeholders)
- Current process understanding (talks about the system as-is, problems that are faced or things that have to improve)
- Within or outside of the scope (directly talking about certain things that are inside the scope of the system to-be or not, boundaries discussed)
- There is no requirements-relevant information

Previous

Next

# What is our gold standard for relevance?

**Previous speakerturn:**

**Interviewee:** *Yes, absolutely.*

**Current speakerturn:**

**Interviewer 1:** *Good. Um, yeah, and it said that there is some... that leads to a bad traffic during... that are arguing of the effect of... are more problems or just th*

**Next speakerturn:**

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Previous

Next

**Q6/52: Where is this requirements-relevant information located?**

- The question in the current speakerturn can be answered with requirements-relevant information
- The next speakerturn (after the question) contains requirements-relevant information

Previous

Next



# Is Idea #2 effective?

Idea 1	Idea 2	Precision	Recall	F1-score	Accuracy
SA	Context Doc.	64.4%	70.3%	67.2%	86.7%
SA	Conversation	64.4%	66.4%	65.4%	86.4%
POS	Context Doc.	53.8%	62.4%	57.8%	82.5%
POS	Conversation	53.9%	63.3%	58.2%	82.4%
COMB	Context Doc.	55.0%	81.7%	65.7%	83.5%
COMB	Conversation	55.7%	81.2%	66.1%	83.9%

No large differences between the approaches – Ideas #2A and #2B are practically equivalent

# Summarization: outlook

- ▶ What does relevance mean?
  - ▶ Large disagreement, especially on questions

Set	Amount	Percentage
2	44	46.31%
4	44	50.58%
5	23	41.07%
6	5	12.20%
7	27	25.71%
9	28	43.75%
10	44	48.35%
12	15	15.31%
16	8	14.55%
Total	238	34.40%

Set	Question	Answer
2	77.27%	27.27%
4	72.73%	29.55%
5	69.57%	30.43%
6	60.00%	40.00%
7	62.96%	37.04%
9	53.57%	46.43%
10	81.82%	18.18%
12	66.67%	33.33%
16	50.00%	50.00%
Total	70.17%	31.09%

# Summarization: outlook

- ▶ What does relevance mean?
  - ▶ Large disagreement, especially on questions

- ▶ How much can we summarize?
  - ▶ End goal of the tool

Set	Amount	Percentage
2	44	46.31%
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10	81.82%	18.18%
12	66.67%	33.33%
16	50.00%	50.00%
Total	70.17%	31.09%

Set	Shown	Taggable	Questions	Relevant
2	70.060%	56.886%	31.138%	17.365%
4	72.973%	58.784%	32.432%	22.297%
5	70.408%	57.143%	30.612%	20.408%
6	72.464%	59.420%	30.435%	21.739%
7	73.743%	58.659%	31.285%	10.615%
9	67.241%	55.172%	26.724%	13.793%
10	67.901%	56.173%	30.247%	25.309%
12	74.194%	63.226%	36.129%	28.871%
16	77.500%	68.750%	38.750%	23.750%
Total	71.635%	58.944%	31.857%	19.506%



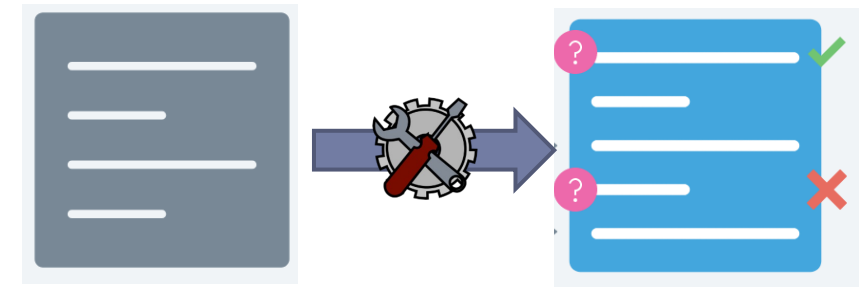
# 5. Outlook



# Tools for Conversational RE: Two Examples

The screenshot shows the Trace2Conv interface. At the top, there's a navigation bar with 'Login', 'Manual', 'Validation Requirements', and 'Transcripts'. Below that, a system message states: 'The system automatically sends an e-mail to the contact person of every vendor that is imported through the connection with JD Edwards so that he receives a link where he can create his password'. The main area displays a grid of entity occurrences with columns for 'system', 'sends', 'e-mail', 'contact', and 'person'. Each cell contains a 'VIEW SPEAKER TURNS' button. Below the grid, there are two tabs: 'MULTIPLE (SINGLE) TOKEN OCCURRENCES' and 'SCORING MECHANISM MULTIPLE TOKENS'. The 'MULTIPLE (SINGLE) TOKEN OCCURRENCES' tab is active, showing a detailed view of a speaker turn with the text: 'i would say that it's so that **vendor**s can easily access information, we get a lot of phone calls right now within either accounts payable or the departments and **vendor**s want to know whether or not we received the invoice, is it being processed, hasn't been paid. so we're hoping that this will eliminate a lot of those conversations and make it much easier for them to get information as well as um like you said that the address book thing, the history, um and hopefully maybe choose, like being able to upload their invoices through that process, yeah, leslie said, so moving toward electronic, i think is gonna be a big objective, um kind of a big undertaking for us, we've got about 6000 **vendor**s in je, a couple 1000 of them are active, so first off, we're gonna clean up, but that's really the target, ideally we would have as many of those **vendor**s as possible, sending us either emailing electronic invoices are uploading them through the portal. so that's a that's a big part of our success'.

Trace2Conv:  
pre-RS traceability



Requirements Conversation  
Summarizer

# Direction #3: distilling requirements?

---

- ▶ Can we automatically generate requirements from conversations?
- ▶ Long-term direction
  - ▶ High value
  - ▶ Extremely challenging
  - ▶ Rarely mentioned in an explicit way (Spijkman, CAiSE'21)

Category	Text tagged	Tags
1. Current process	31.2%	35.2%
2. Future process	16.8%	18.1%
3. Explicit requirements	12.0%	8.6%
4. Questions	4.5%	19.1%
5. Product functionality	7.2%	12.5%
6. Organizational problem	2.1%	4.0%
7. Organizational details	0.9%	2.0%
8. Product motivation	0.1%	0.7%

# Direction #3: distilling requirements?

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## Concept Extraction in Requirements Elicitation Sessions: Prototype and Experimentation

Tjerk Spijkman<sup>b,a</sup>, Boris Winter<sup>a</sup>, Sid Bansidhar<sup>a</sup> and Sjaak Brinkkemper<sup>a</sup>

<sup>a</sup>Dept. of Information and Computing Sciences, Utrecht University, Utrecht, the Netherlands  
<sup>b</sup>fizor, Utrecht, the Netherlands,

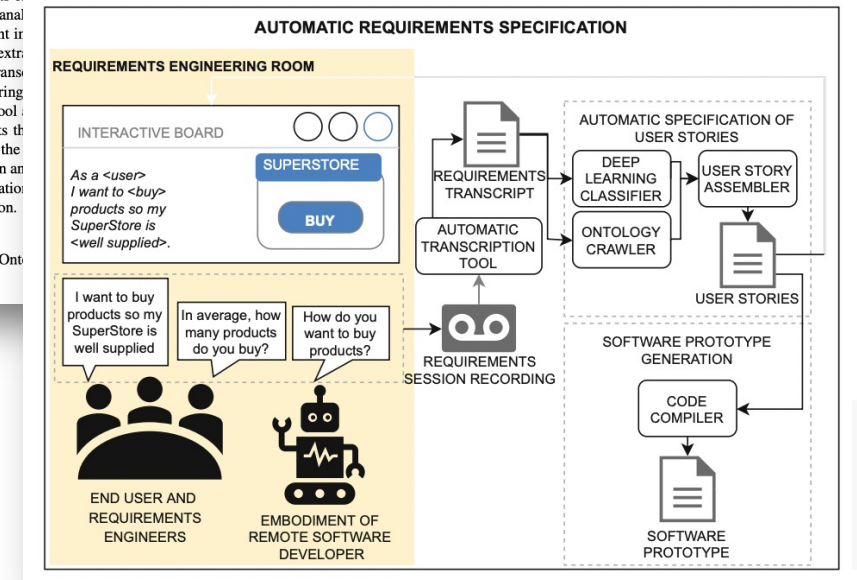
### Abstract

**[Introduction]** Requirements elicitation is an important, yet complex step in the software development life cycle. It is vital for business analysts to capture the requirements of a system, but they require a vastly different interaction with the system than the user. The introduction of a key abstraction extraction tool, such as a requirements engineering room, can help structure requirements according to Wiering's model. We then validated the results through expert validation, showing that the introduction of discussed knowledge and the use of a promising foundation for additional context information.

### Keywords

Requirements Engineering, Ontology

Spijkman & al.,  
NLP4RE'21



Ruiz & Hasselman,  
EMMSAD'20

# The future of evaluation metrics

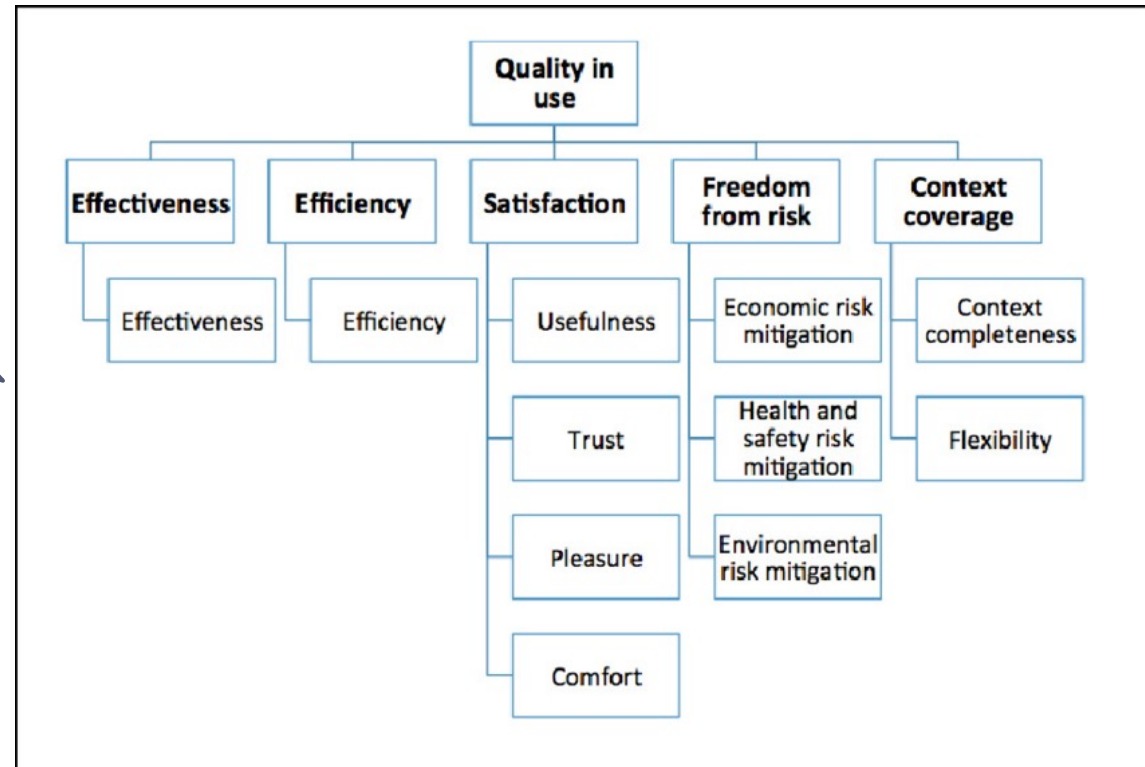
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- ▶ Most of the literature employs information retrieval metrics
  - ▶ Precision, recall, F1, ...
- ▶ Progressive shift toward **quality-in-use** with conversational RE tools?

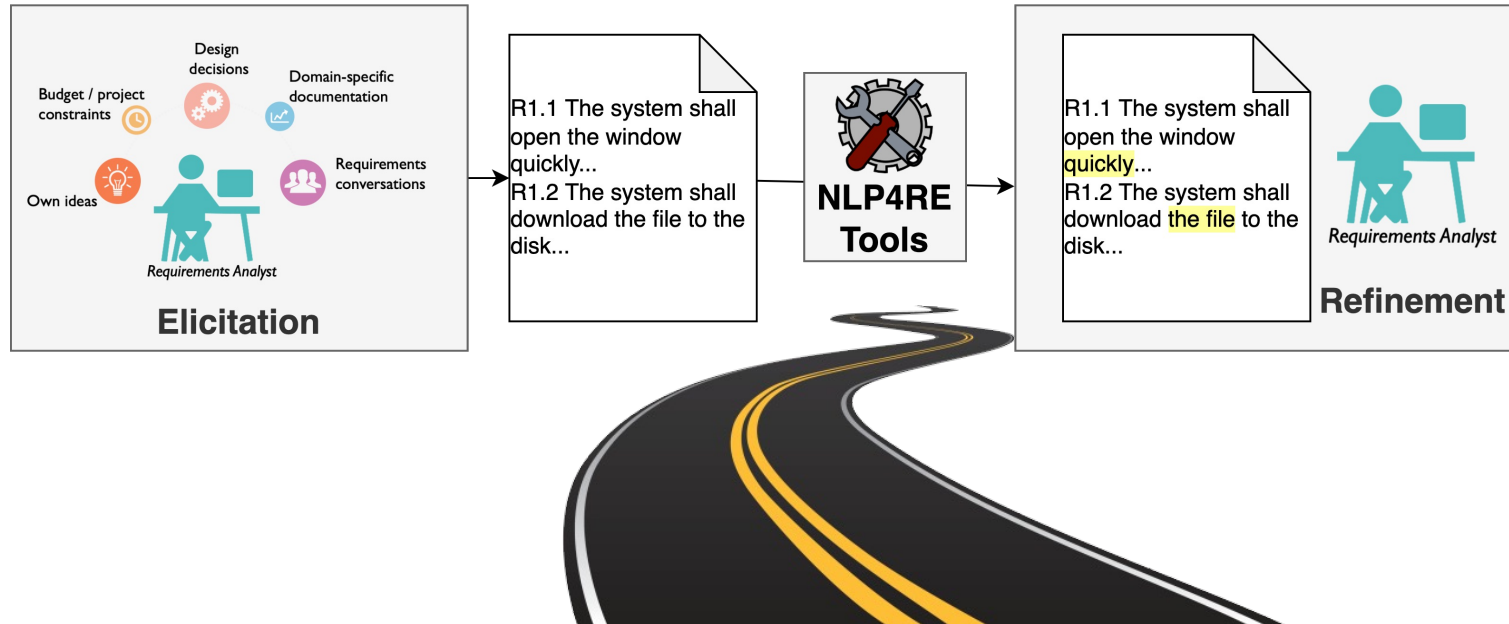
# The future of evaluation metrics

- ▶ Most of the literature employs information retrieval metrics
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ISO 25022  
(quality in use)

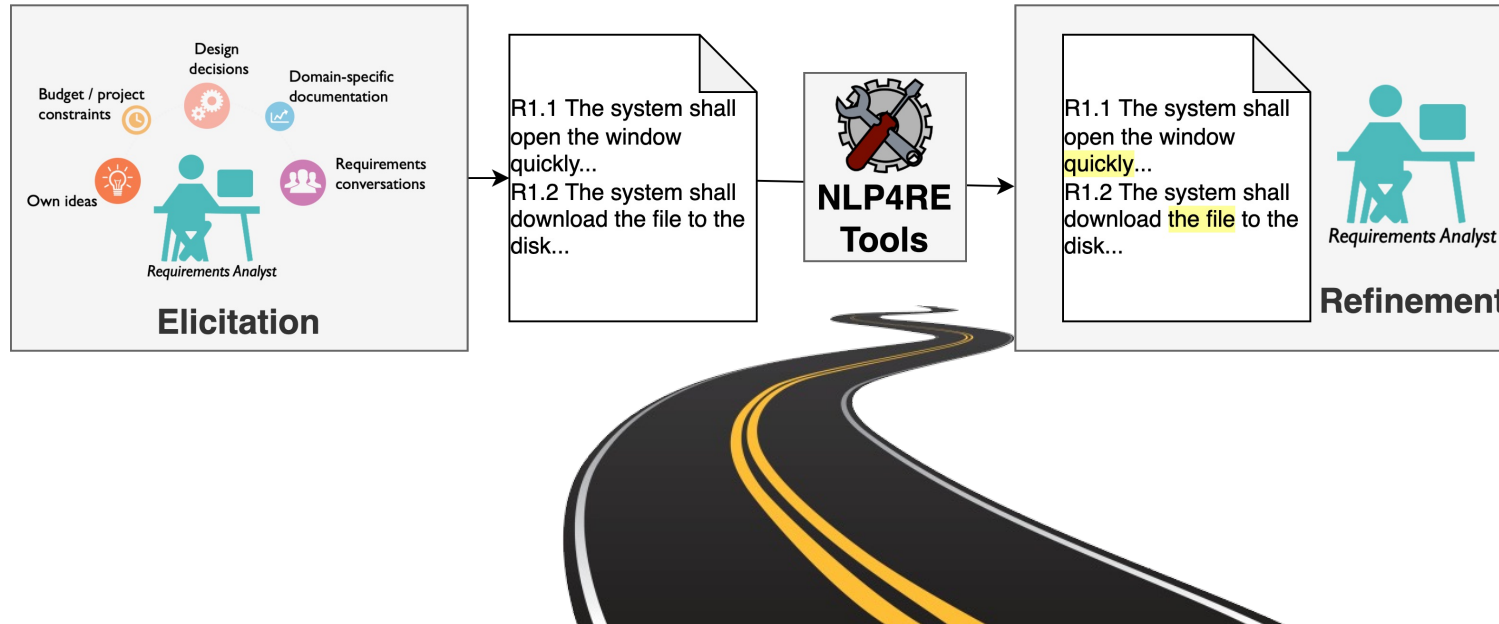


# The way ahead...

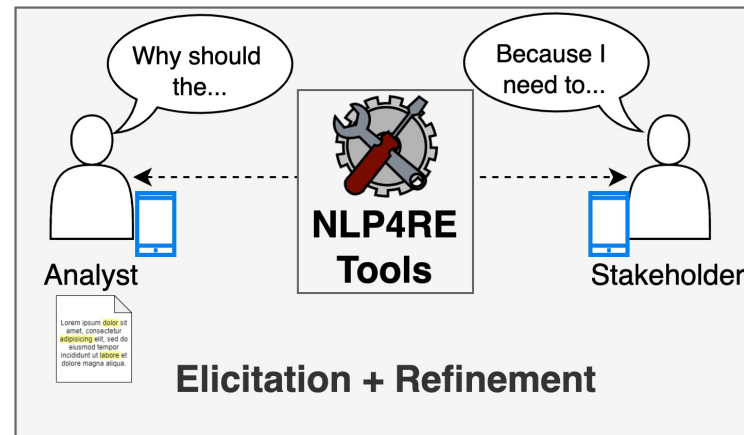


## Today's NLP4RE Tools

# The way ahead...



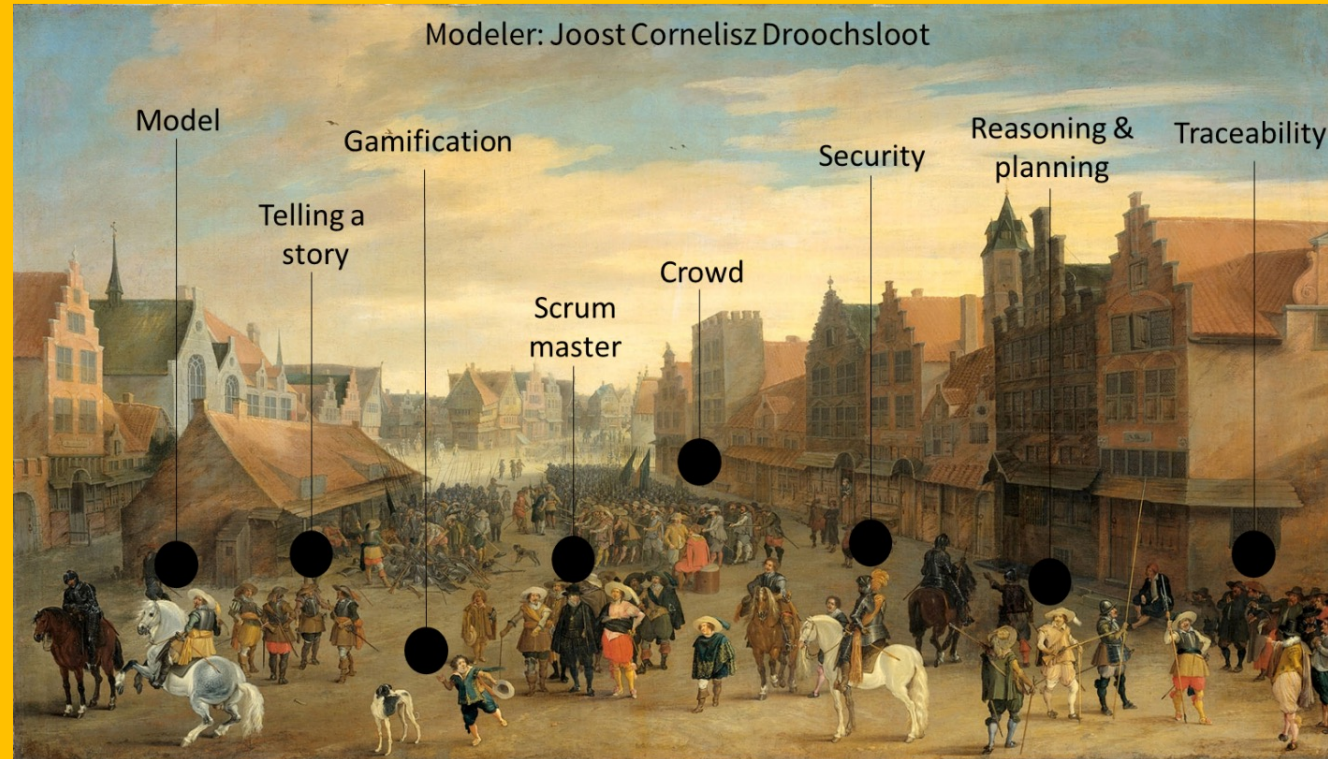
## Today's NLP4RE Tools



## Conversational RE Tools



# Thank you for listening! Questions?



*RE-Lab's research illustrated, 2018*

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