Requirements and Intelligent Systems

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https://spectrum.ieee.org/in-2016-microsofts-racist-chatbot-revealed-the-dangers-of-online-conversation

"Tay was designed to learn more about language over time, enabling her to have conversations about any topic…. Eventually, her programmers hoped, Tay would sound just like the Internet. "

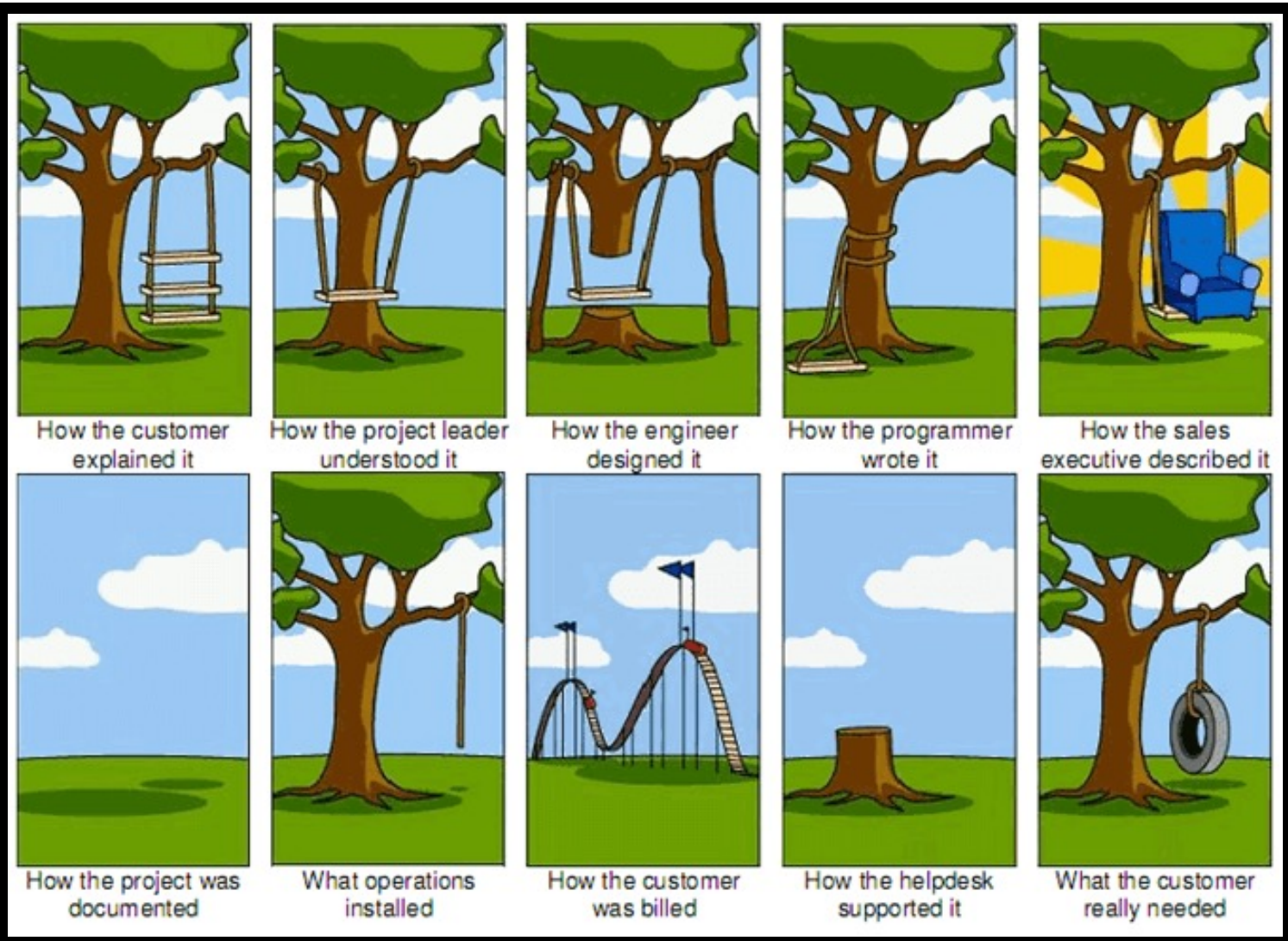


Image Source: http://tamingdata.com/wp-content/uploads/2010/07/tree-swing-project-management-large.png

So, what are requirements?

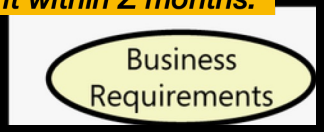
Requirements

- Requirements are a specification of what should be implemented.
- They are descriptions of how the system should behave, or of a system property or attribute.
- They may be a constraint on the development process of the system.

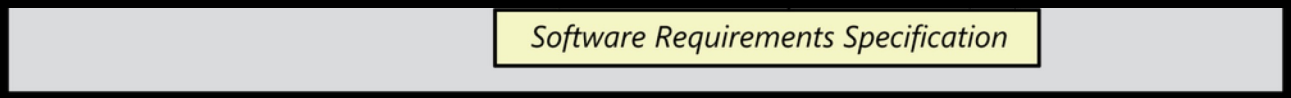
Sommerville, Ian, and Pete Sawyer. 1997. *Requirements Engineering: A Good Practice Guide.* Chichester, England: John Wiley & Sons Ltd.

And, where are requirements from?

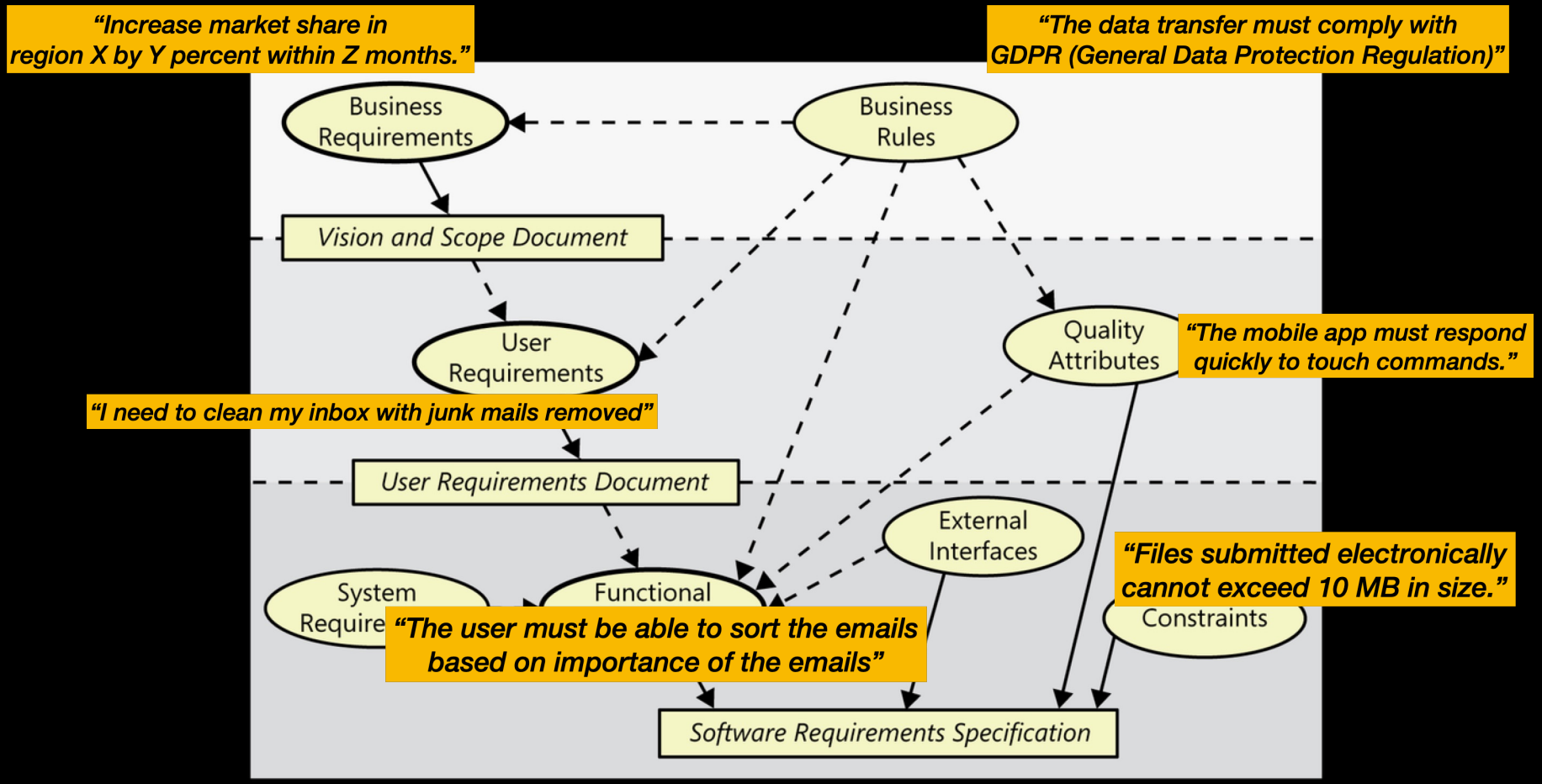
"Increase market share in region X by Y percent within Z months."



"The user must be able to sort the emails based on importance of the emails"



Software Requirements by Karl Eugene Wiegers, Joy Beatty, Microsoft Press, 2013



Software Requirements by Karl Eugene Wiegers, Joy Beatty, Microsoft Press, 2013

Elicitation

Identifying the product's expected user classes and other stakeholders. Understanding user tasks and goals and the business objectives with which those tasks align.

Validation

Reviewing the documented requirements to correct any problems before the development group accepts them. Developing acceptance tests and criteria to confirm that a product based on the requirements would meet customer needs and achieve the business objectives.

Analysis

Decomposing high-level requirements into an appropriate level of detail; Deriving functional requirements from other requirements information; Understanding the relative importance of quality attributes; Allocating requirements to software components defined in the system architecture Negotiating implementation priorities

Specification

Translating the collected user needs into written requirements and diagrams suitable for comprehension, review, and use by their intended audiences.

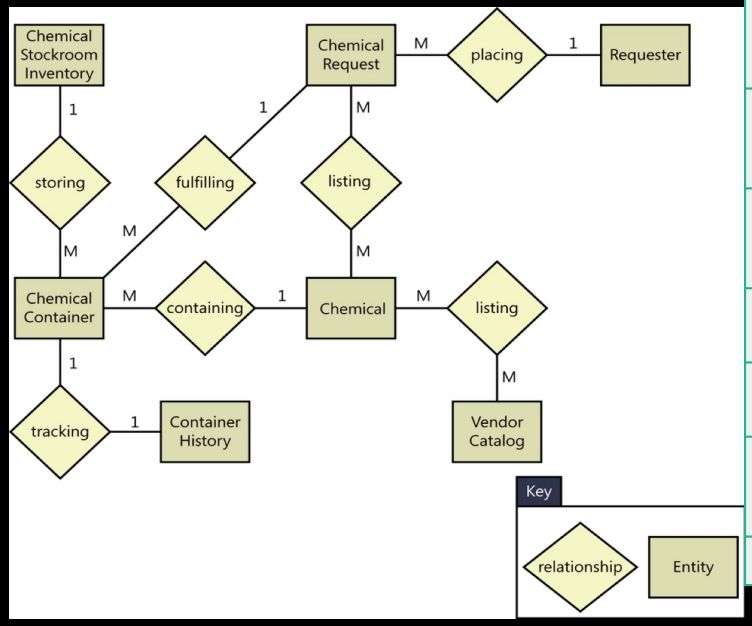
Example Requirement Specification

"Global Personal Marketplace SRS"

- What sections are included in this document?
- How are the Functional Requirements (FRs) organized in this example?
- What kind of information is included in the FRs?

Data Requirements

"An order consists of the customer's identity, shipping information, and one or more products, each of which [illegible] number of units, unit price, and tota



Data Element	Description	Composition or Data Type	Length	Value
Chemical Request	request for a new chemical from either the Chemical Stockroom or a vendor	+ Request ID + Requester + Request Date + Charge Number + 1:10{Requested Chemical}		
Delivery Location	the place to which requested chemicals are to be delivered	+ Building + Lab Number + Lab Partition		
Number of Containers	number of containers of a given chemical and size being requested	Positive integer	3	
Quantity	amount of chemical in the requested container	numeric	6	
Quantity Units	units associated with the quantity of chemical requested	alphabetic characters	10	grams, kilograms, milligrams, each
Request ID	unique identifier for a request	integer	8	system-generated sequential integer, beginning with 1
…	…	…	…	…

Software Requirements by Karl Eugene Wiegers, Joy Beatty, Microsoft Press, 2013

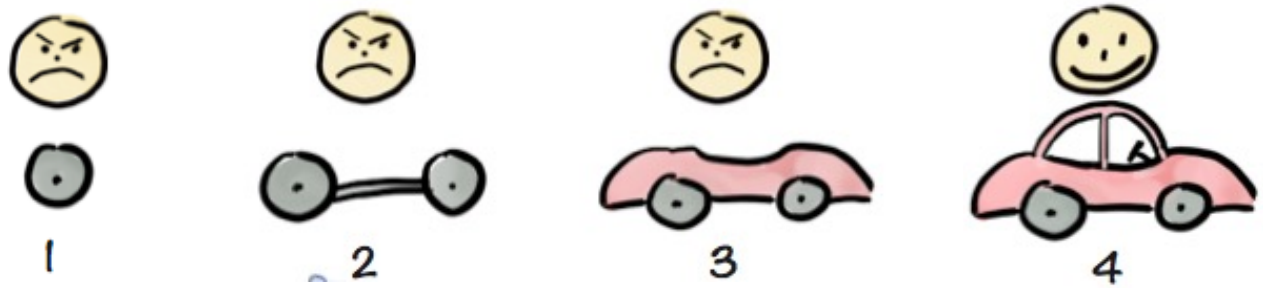
Data Requirements

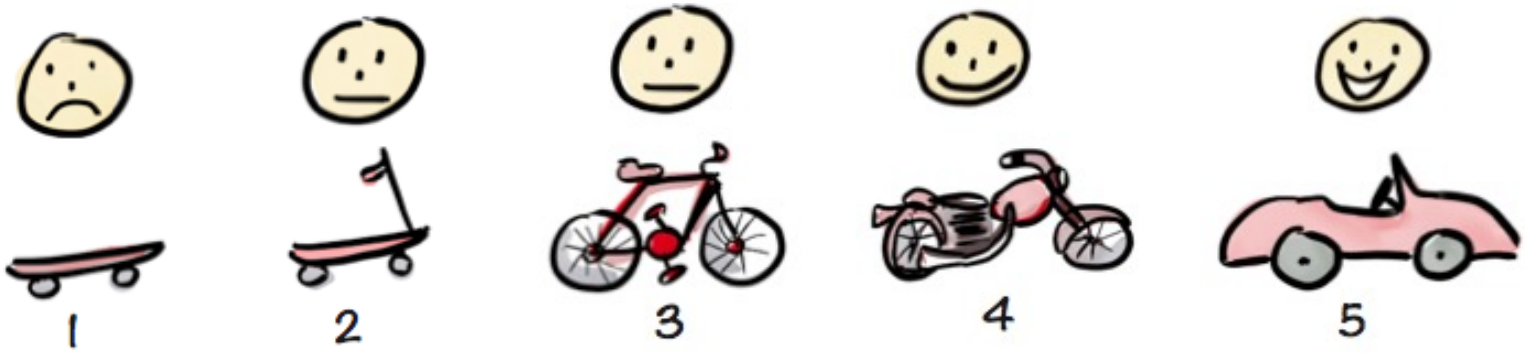
Use Case \ Entity	Order	Chemical	Requester	Vendor Catalog
Place Order	C	R	R	R
Change Order	U, D		R	R
Manage Chemical Inventory		C, U, D		
Report on Orders	R	R	R	
Edit Requesters			C, U	

FIGURE 13-5 Sample CRUD matrix for the Chemical Tracking System.

CRUD: Create, Read, Update, and *Delete*

Software Requirements by Karl Eugene Wiegers, Joy Beatty, Microsoft Press, 2013


1
2
3
4


1
2
3
4
5

User Stories

As a <type of user>, I want <some goal> so that <some reason>.

Use cases

- Update Customer Profile
- Search for an Item
- Buy an Item
- Track a Shipped Package
- Cancel an Unshipped Order

As a customer, I want to update my customer profile so that future purchases are billed to a new credit card number.

Identify Users

- Users vs Stakeholders
  - Examples? What are the differences?
- Classifying users
  - Access privilege or security level
  - The tasks they perform
  - The features they user
  - Domain expertise
  - …

Are different classes of users equally important for the system you are building?

Classifying Users

- Favored user classes

Receive preferential treatment when resolving conflicts between requirements from different user classes or making priority decisions

- Disfavored user classes

Might deliberately make it hard for the disfavoured users to do things they aren't supposed to do

- Indirect user classes

Access its data or services through other applications or through reports

Activity

- Who are the user classes for the GitHub pull request (PR) management system?
  - Example PR1, PR2
  - How do you classify them and why?
  - How is such classification going to impact the requirements for this system?

Indirect Stakeholders

"Janice is in her office, writing a report. She's trying to conceptualize the report's higher-level structure, but her ideas won't quite take form. Then she looks up from her desk and rests her eyes on the fountain and plaza area outside her building. She notices the water bursting upward, and that a small group of people are gathering by the water's edge. She rests her eyes on the surrounding pool of calm water. Her eyes then lift toward the clouds and the streaking sunshine. Twenty seconds later she returns to her writing task at hand, slightly refreshed, and with an idea taking shape."

Friedman, Batya, Peter H. Kahn, and Alan Borning. "Value sensitive design and information systems." *The handbook of information and computer ethics* (2008): 69-101.

Indirect Stakeholders



Friedman, Batya, Peter H. Kahn, and Alan Borning. "Value sensitive design and information systems." *The handbook of information and computer ethics* (2008): 69-101.

Requirement Elicitation

- A collaborative and analytical process

  Interviews

  Workshops

  Focus Groups

  Observations

  Questionnaires

Workshop

- Facilitated and formal
- Different stakeholders
- Deliverables

Focus Group

- Less formal
- Representative users
- Exploration

Requirement Elicitation

- A collaborative and analytical process

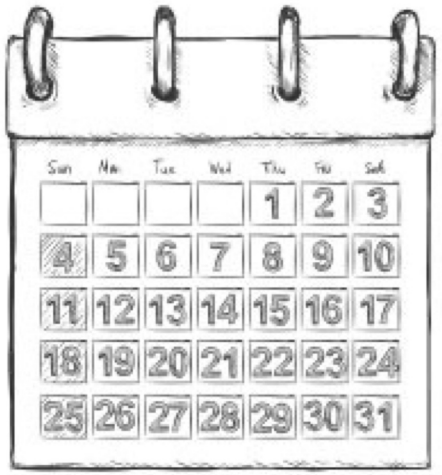
Interviews
Workshops
Focus Groups
Observations
Questionnaires

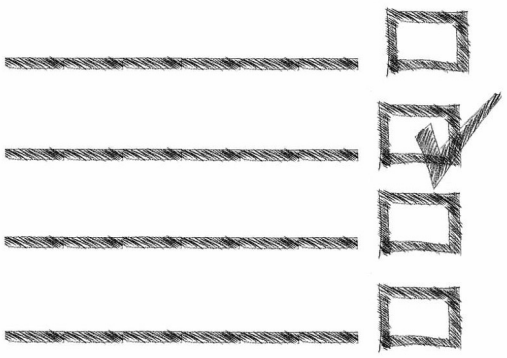
System Interface Analysis
User Interface Analysis
Document Analysis

Activity

Design a schedule management experience for

The person next to you





Step1: Interview

8 mins (4 mins each)

"Who are involved with the scheduling task? Why was it important? How actually managed the scheduling tasks"
"What was difficult about performing that task?"

Notes from the first interview

Step2: Dig Deeper

6 mins (3 mins each)

follow up on things that intrigued you during the first interview. Try to dig for **stories, feelings, and emotion.** Ask 'WHY?' often

Notes from the second interview

Step3: Capture Findings

3 mins

Goals and Wishes

What is your partner trying to achieve through interaction with scheduling tool?

User verbs

Insights

New learnings about your partner's feelings and motivations. what's something you see about your partner's experience that maybe s/he doesn't see?*

Make inferences from what you heard

Step4: Taking a stand with a point-of-view

3 mins

_____
partner's name

needs a way to _____
user's need

because / but / surprisingly [circle one]

_____

_____
insights

Step5: Make a case for or against AI feature

3 mins

I think AI can / cannot [circle one] **help solve**

_____

user's need

because _____

_____

Step6: Designing the reward function for the new feature

5 mins

Our AI model will be optimized for

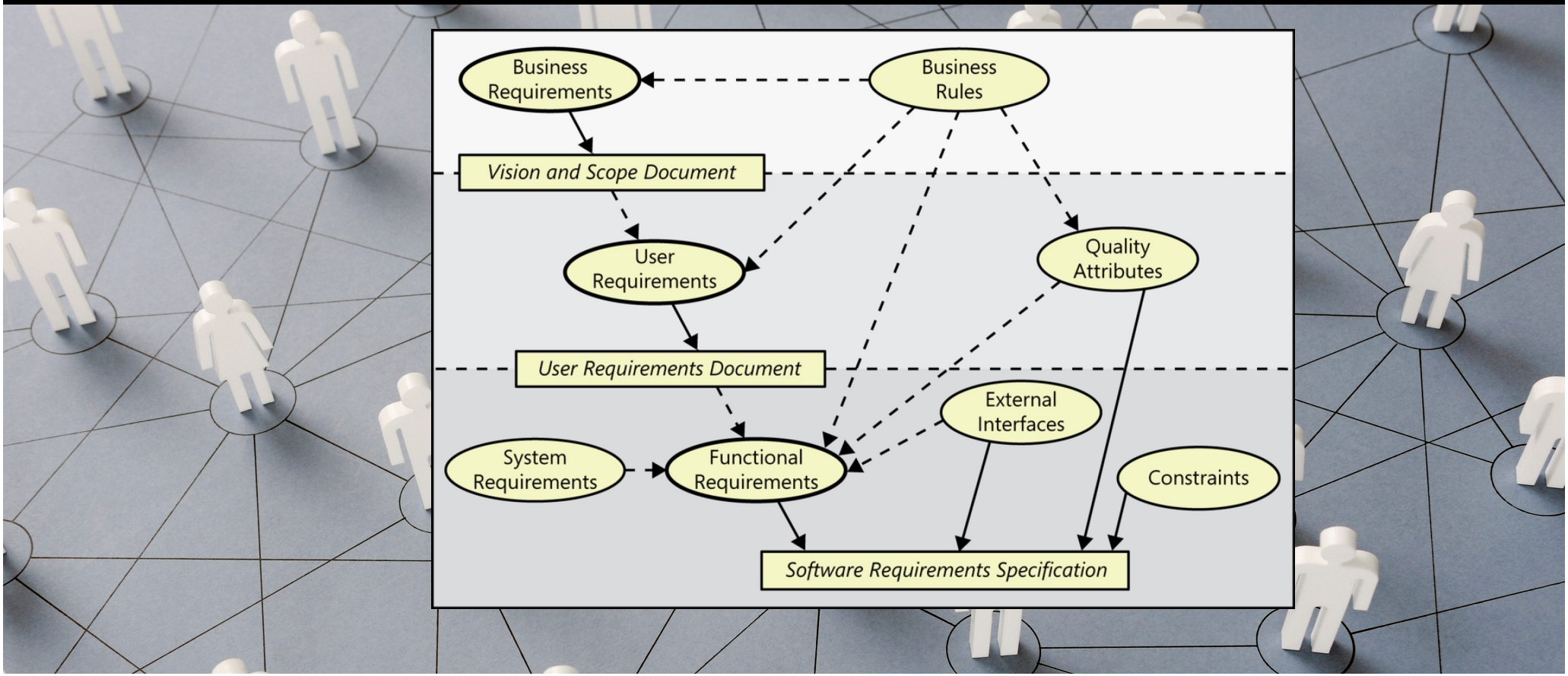
_____

related to user's need

because _____

_____

What is Requirement again?



Requirements Traps

- Not requirements
- Assumed, Implied Requirements
- Missing requirements

Acceptance Test

As a consumer, I am always aware of my current energy costs.

As a consumer, I always see current energy pricing reflected on my portal and on-premise devices so that I know that my energy usage costs are accurate and reflect any utility pricing

- **Verify the current pricing is always used and the calculated numbers are displayed correctly on the portal and each on-premise device (see attachment for formats).**
- **Verify the pricing and the calculated numbers are updated correctly when the price changes.**
- **Verify the "current price" field itself is updated according to the scheduled time.**
- **Verify the info/error messages when there is a fault in the pricing (see approved error messages attached).**

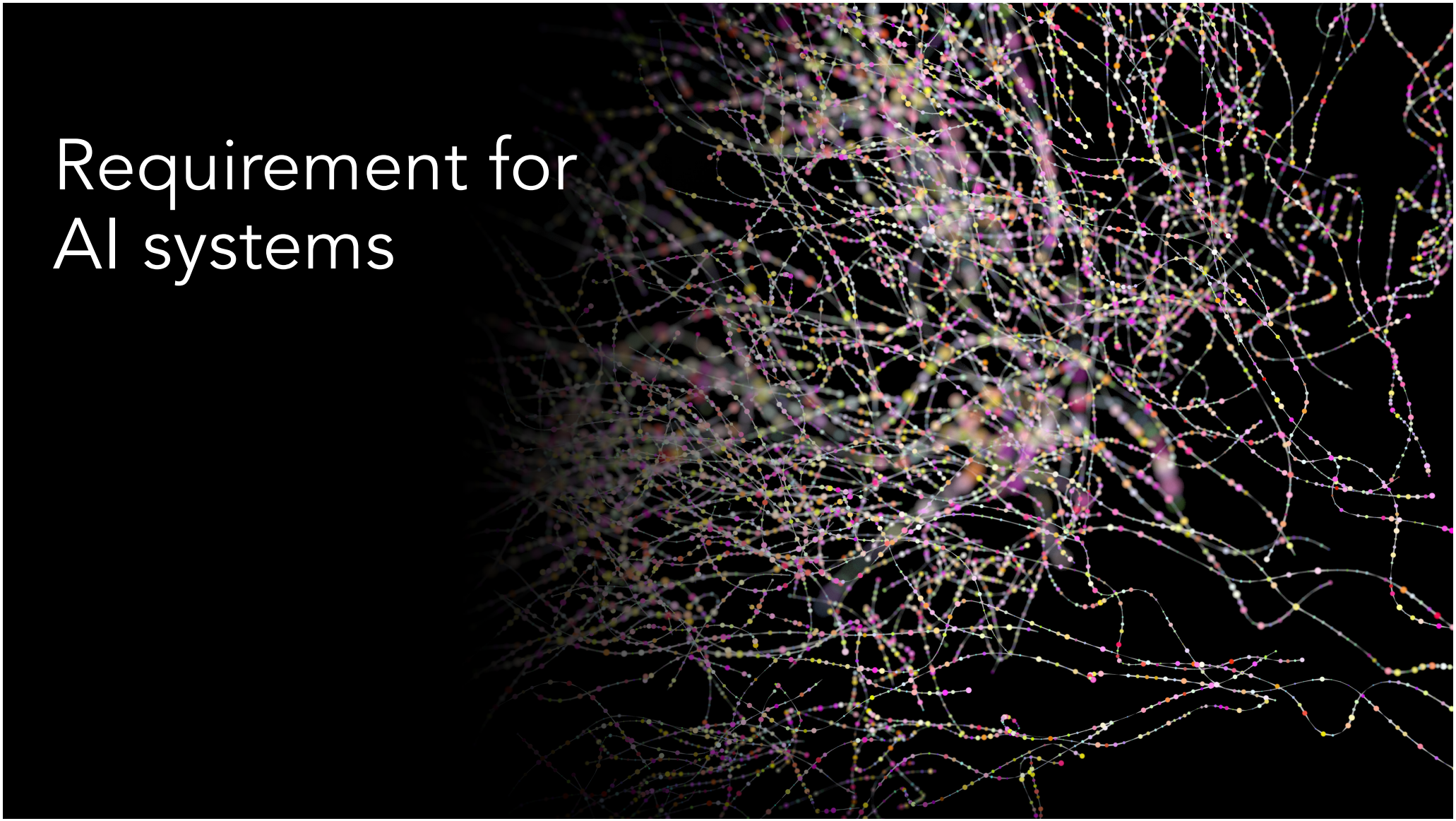
What is Requirement again?

Is what enough?

Ask the why and who question

Keynote talk by Amy Ko at RE 2021

Requirement for AI systems



Intersection of User needs and AI strength

As a <type of user>, I want <some goal> so that <some reason>.

I think AI can / cannot [circle one] help solve

_____

user's need

because _____

_____

Our AI model will be optimized for

_____

related to user's need

because _____

_____

Intersection of User needs and AI strength

As a <type of user>, I want <some goal> so that <some reason>.

Recommending different content to different users?

Prediction of future events?

Recognize patterns in images?

Understand natural language?

……

Maintaining predictability?

Provide static information?

Complete transparency?

……

Elicitation

- Elicit additional data sources
- Important stakeholders: Data scientists and legal experts
- “Protected” characteristics?

Validation

- Analyze operational data
- Look for bias in data
- Retrain ML models
- Detect data anomalies

Analysis

- Discuss performance measures
- Discuss conditions for data preparation, definitions of outliers, and derived data

Specification

- Quantitative targets
- Data requirements
- Explainability
- Freedom from discrimination
- Legal and regulatory constraints

Specification for ML Components

- Formal methods perspectives
  - System level specification - standard specification languages
  - Input-output robustness - Local and Global resilient
  - Input-output relations - pre-condition, post condition
  - Semantic Invariance - Domain-specific, e.g., scale invariant
  - Distribution Assumptions - statistical modelling, e.g., Probabilistic Programming
  - Fairness - e.g., individual fairness, demographic parity, etc. still evolving area
  - ……

Seshia, Sanjit A., et al. "Formal specification for deep neural networks." International Symposium on Automated Technology for Verification and Analysis. Springer, Cham, 2018.

Dataset Specification and Documentation

- Why is the dataset created? (e.g., is there a specific intended task gap that needed to be filled? Who fund the creation of the dataset?)
- What preprocessing/cleaning is done? (e.g., discretization or bucketing, tokenization, part-of-speech tagging, SIFT feature extraction, removal of instances)
- If it relates to people, are they told what the dataset would be used for and did they consent? If so, how? Were they provided with any mechanism to revoke their consent in the future or for certain uses?
- Will the dataset be updated? How often, by whom?

Datasheet

Motivation for Dataset Cr

Why was the dataset created? (e.g., we
tasks in mind, or a specific gap that needed

What (other) tasks could the dataset be
there obvious tasks for which it should *not*

Has the dataset been used for any tasks
where are the results so others can compa
published papers)?

Who funded the creation of the dataset
associated grant, provide the grant numbe

Any other comments?

Data Collection Process

How was the data collected? (e.g., hardware apparatus/sensor, manual human curation, software program, software interface/API; how were these constructs/measures/methods validated?)

Who was involved in the data collection process? (e.g., students, crowdworkers) How were they compensated? (e.g., how much were crowdworkers paid?)

Over what time-frame was the data collected? Does the collection time-frame match the creation time-frame?

How was the data associated with each instance acquired? Was the data directly observable (e.g., raw text, movie ratings), reported by subjects (e.g., survey responses), or indirectly inferred/derived from other data (e.g., part of speech tags; model-based guesses for age or language)? If the latter two, were they validated/verified and if so how?

Does the dataset contain all possible instances? Or is it, for instance, a sample (not necessarily random) from a larger set of instances?

If the dataset is a sample, then what is the population? What was the sampling strategy (e.g., deterministic, probabilistic with specific sampling probabilities)? Is the sample representative of the larger set (e.g., geographic coverage)? If not, why not (e.g., to cover a more diverse range of instances)? How does this affect possible uses?

Is there information missing from the dataset and why? (this does not include intentionally dropped instances; it might include, e.g., redacted text, withheld documents) Is this data missing because it was unavailable?

Are there any known errors, sources of noise, or redundancies in the data?

Any other comments?

Dataset Composition

What are the instances? (that is, examples; e.g., documents, images, people, countries) Are there multiple types of instances? (e.g., movies, users, ratings; people, interactions between them; nodes, edges)

Are relationships between instances made explicit in the data (e.g., social network links, user/movie ratings, etc.)?

How many instances of each type are there?

What data does each instance consist of? "Raw" data (e.g., unprocessed text or images)? Features/attributes? Is there a label/target associated with instances? If the instances are related to people, are subpopulations identified (e.g., by age, gender, etc.) and what is their distribution?

Is everything included or does the data rely on external resources? (e.g., websites, tweets, datasets) If external resources, a) are there guarantees that they will exist, and remain constant, over time; b) is there an official archival version. Are there licenses, fees or rights associated with *any* of the data?

Are there recommended data splits or evaluation measures? (e.g., training, development, testing; accuracy/AUC)

What experiments were initially run on this dataset? Have a summary of those results and, if available, provide the link to a paper with more information here.

Any other comments?

Gebru, Timnit, Jamie Morger
Hanna Wallach, Hal Daumé II
for Datasets.

Data Preprocessing

What preprocessing/cleaning was done? (e.g., discretization or bucketing, tokenization, part-of-speech tagging, SIFT feature extraction, removal of instances, processing of missing values, etc.)

Was the "raw" data saved in addition to the preprocessed/cleaned data? (e.g., to support unanticipated future uses)

Is the preprocessing software available?

Does this dataset collection/processing procedure achieve the motivation for creating the dataset stated in the first section of this datasheet?

Any other comments?

Dataset Distribution

How is the dataset distributed? (e.g., website, API, etc.; does the data have a DOI; is it archived redundantly?)

When will the dataset be released/first distributed? (Is there a canonical paper/reference for this dataset?)

What license (if any) is it distributed under? Are there any copyrights on the data?

Are there any fees or access/export restrictions?

Any other comments?

Dataset Maintenance

Who is supporting/hosting/maintaining the dataset? How does one contact the owner/curator/manager of the dataset (e.g. email address, or other contact info)?

Will the dataset be updated? How often and by whom? How will updates/revisions be documented and communicated (e.g., mailing list, GitHub)? Is there an erratum?

If the dataset becomes obsolete how will this be communicated?

Is there a repository to link to any/all papers/systems that use this dataset?

If others want to extend/augment/build on this dataset, is there a mechanism for them to do so? If so, is there a process for tracking/assessing the quality of those contributions. What is the process for communicating/distributing these contributions to users?

Any other comments?

Legal & Ethical Considerations

If the dataset relates to people (e.g., their attributes) or was generated by people, were they informed about the data collection? (e.g., datasets that collect writing, photos, interactions, transactions, etc.)

If it relates to other ethically protected subjects, have appropriate obligations been met? (e.g., medical data might include information collected from animals)

If it relates to people, were there any ethical review applications/reviews/approvals? (e.g. Institutional Review Board applications)

If it relates to people, were they told what the dataset would be used for and did they consent? What community norms exist for data collected from human communications? If consent was obtained, how? Were the people provided with any mechanism to revoke their consent in the future or for certain uses?

If it relates to people, could this dataset expose people to harm or legal action? (e.g., financial social or otherwise) What was done to mitigate or reduce the potential for harm?

If it relates to people, does it unfairly advantage or disadvantage a particular social group? In what ways? How was this mitigated?

If it relates to people, were they provided with privacy guarantees? If so, what guarantees and how are these ensured?

Does the dataset comply with the EU General Data Protection Regulation (GDPR)? Does it comply with any other standards, such as the US Equal Employment Opportunity Act?

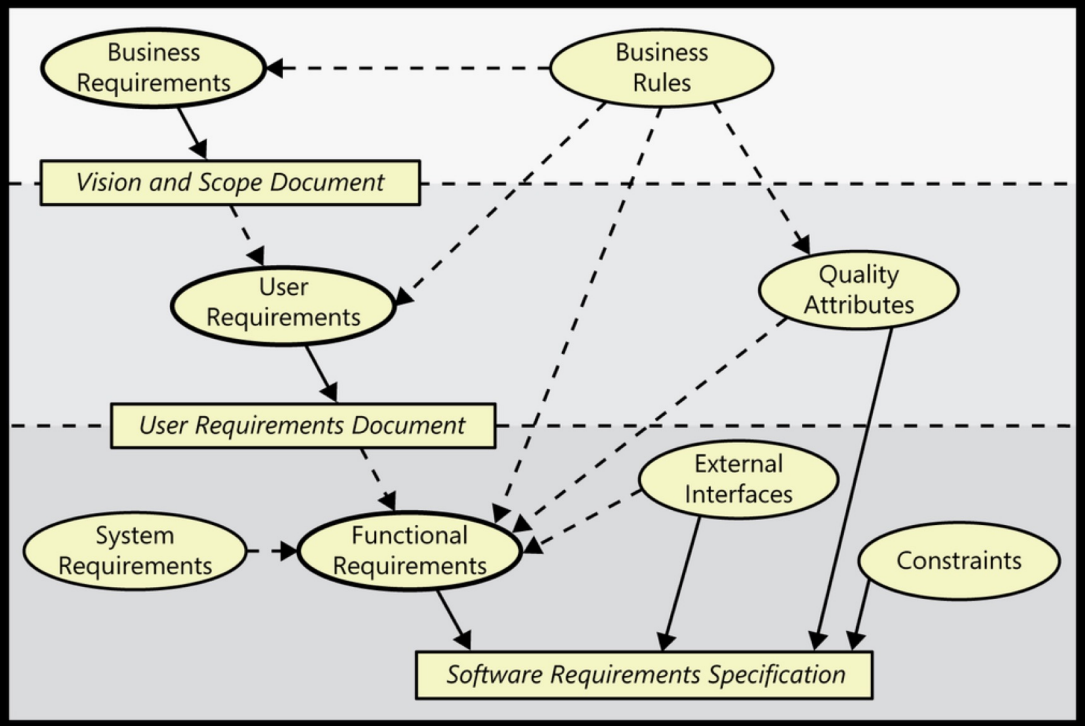
Does the dataset contain information that might be considered sensitive or confidential? (e.g., personally identifying information)

Does the dataset contain information that might be considered inappropriate or offensive?

Any other comments?

Challenges

- Understand and define non-functional requirements
- Reasoning the relations between different level of requirements



Rahimi, Mona, Jin LC Guo, Sahar Kokaly, and Marsha Chechik.
"Toward Requirements Specification for Machine-Learned Components."
In 2019 IEEE 27th International Requirements Engineering Conference Workshops (REW), pp. 241-244. IEEE, 2019.

Dreossi, Tommaso, Alexandre Donzé, and Sanjit A. Seshia.
"Compositional falsification of cyber-physical systems with machine learning components."
Journal of Automated Reasoning 63.4 (2019): 1031-1053.

On next Wednesday:

Team and Collaboration