Rensselaer

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Capturing the problem: Use case development and requirement analysis

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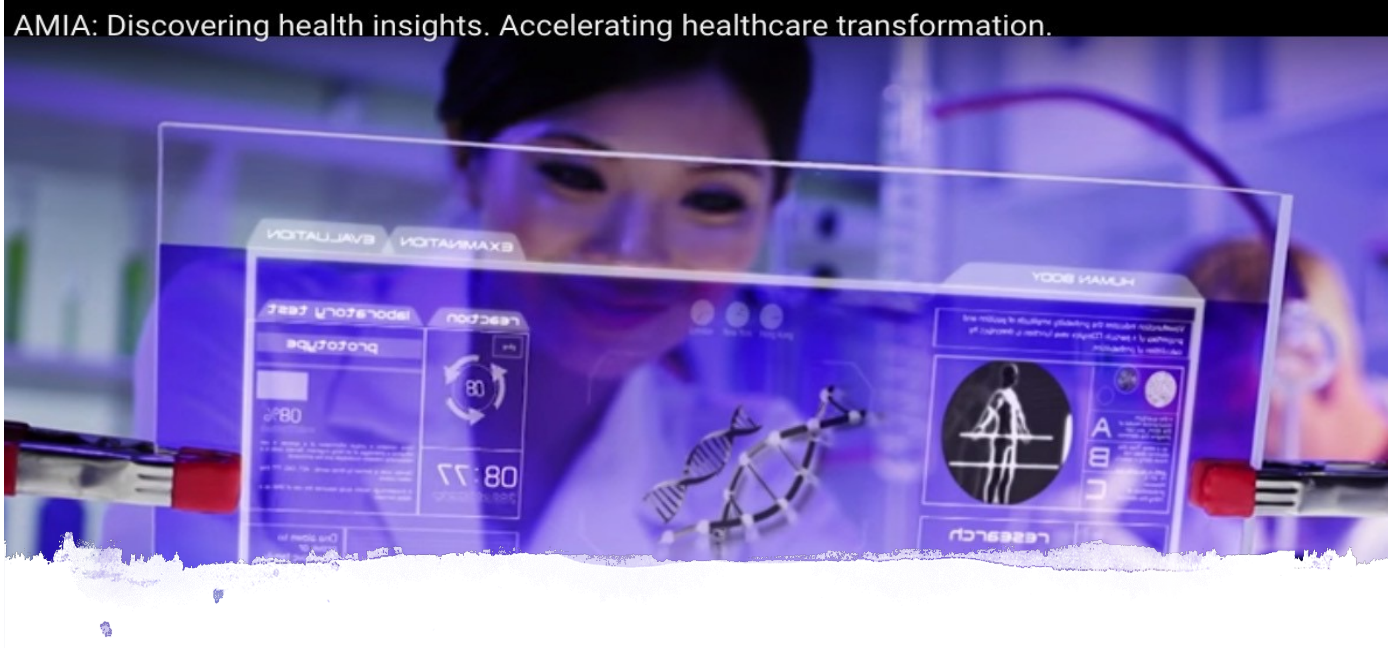
January 14th, 2025

ITWS, ERTH, CSCI 4400/6400

Contents

- Questions about the Syllabus
- Discussion of Reading
- Discussion of Informatics Current Events
- Background on use cases
- Developing use cases (**In class- Group Work)**
- Assignment 1: available on LMS under the Assignments Section – (Due: Jan 31, 2024)



Why Infomatics ?

- https://www.youtube.com/watch?time_continue=94&v=kvz0-OFv1Zo
- https://www.amia.org/why-informatics

Reading List…

- BioInformatics: http://www.wired.com/wiredscience/2008/07/researchers-tra/
- Biomedical informatics for proteomics http://www.nature.com/nature/journal/v422/n6928/full/nature01515.html?free=2
- Clinical Bioinformatics: https://jclinbioinformatics.biomedcentral.com/articles/10.1186/2043-9113-5-S1-A1

- **Urban Informatics (link updated, we will discuss this during next week)** https://journals.sagepub.com/doi/full/10.1177/0739456X18793716
- Geo-Informatics: https://en.wikipedia.org/wiki/Geoinformatics
- Astro-Informatics: https://asaip.psu.edu/Articles/astroinformatics-in-a-nutshell
- Use Case https://en.wikipedia.org/wiki/Use_case

Clinical Research Informatics

First Clinical Research Informatics (CRI) Solutions Day: advanced IT support from EU projects for clinical trials : https://jclinbioinformatics.biomedcentral.com/articles/10.1186/2043-9113-5-S1-A1

- Clinical trials are the foundation for the advancement of medical research, but they are also complex, time consuming and expensive.

- To ensure scientific validity, clinical trials must record large amounts of data on health and treatment of a carefully selected group of patients or trial participants.

- **That is why a robust and highly flexible IT infrastructure that permits rapid reconfiguration to support different trials while maintaining consistent data models is needed to ensure that clinical data can be shared and used for analysis.**

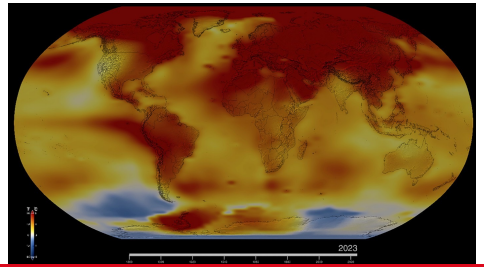
OLD news: “How 2016 Became Earth’s Hottest Year on Record”, New York Times Jan 18, 2017

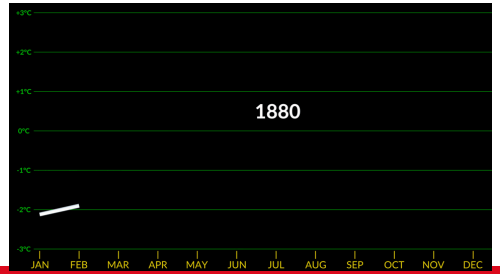
Global temperatures have continued to rise, making **2016 the hottest year on the historical record and the third consecutive record-breaking year**, scientists say. **Of the 17 hottest years ever recorded, 16 have now occurred since 2000**. Human-induced climate change has made it at least 160 times more likely that three consecutive years after 2000 would be record-setting, according to Michael E. Mann, a climate scientist at Pennsylvania State University.

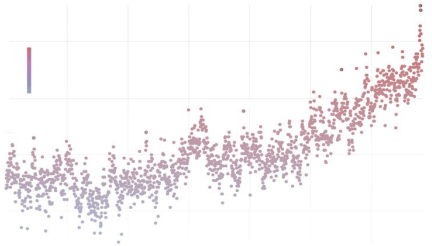
His findings show that if human-induced climate change was not part of the equation, the **amount of warming in 2016 would have less than one-in-a-million odds of occurring**.

https://www.nytimes.com/interactive/2017/01/18/science/earth/2016-hottest-year-on-record.html?rref=collection%2Fsectioncollection%2Fscience&action=click&contentCollection=science&region=rank&module=package&version=highlights&contentPlacement=8&pgtype=sectionfront

NEW: NASA Analysis Confirms 2023 as Warmest Year on Record







Xinformatics Events: “What Did Neanderthals Leave to Modern Humans? Some Surprises”

New York Times Jan 20, 2017

Geneticists tell us that somewhere between 1 and 5 percent of the genome of modern Europeans and Asians consists of DNA inherited from Neanderthals, our prehistoric cousins.
We hypothesize that roughly 50,000 years ago, when the ancestors of modern humans migrated out of Africa and into Eurasia, they encountered Neanderthals. Matings must have occurred then. And later.
One reason we deduce this is because the descendants of those who remained in Africa — present day Africans — don’t have Neanderthal DNA.

At my lab, we’ve been doing genetic testing on the blood samples of 28,000 patients at Vanderbilt and eight other medical centers across the country. Computers help us pinpoint where on the human genome this Neanderthal DNA is, and we run that against information from the patients’ anonymized medical records. We’re looking for associations.
What we’ve been finding is that Neanderthal DNA has a subtle influence on risk for disease. It affects our immune system and how we respond to different immune challenges. There’s an increased risk for blood clots and tobacco addiction.
To our surprise, it appears that some Neanderthal DNA can increase the risk for depression.

https://www.nytimes.com/2017/01/20/science/john-anthony-capra-neanderthals-dna-humans.html?rref=collection%2Fsectioncollection%2Fscience&action=click&contentCollection=science&region=rank&module=package&version=highlights&contentPlacement=2&pgtype=sectionfront

Xinformatics Current Events: “Trusted Transparency in Healthcare Informatics”

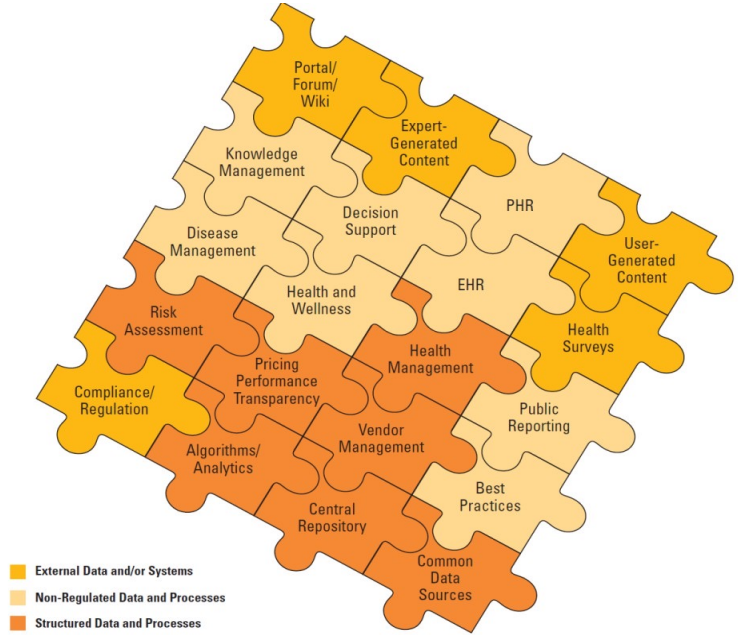
The healthcare providers, patients, employers, and other decisionmakers who rely on healthcare information face an overwhelming jigsaw puzzle of clinical data and processes.

What’s the right way to approach healthcare informatics so that each constituent can put the pieces together in the way that best suits their particular needs?

Greater access to information is generally a good thing, but too much information in the realm of healthcare can actually increase costs, create confusion, and lead to bad decisions.

To make matters even more challenging, the **volume of healthcare information is expanding exponentially across two dimensions: the depth of clinical data and the sophistication of data analytics**.

The effect of this massive growth varies considerably based on your perspective. For example, employers are leveraging data analytics to help model the effect of various plan profitability.



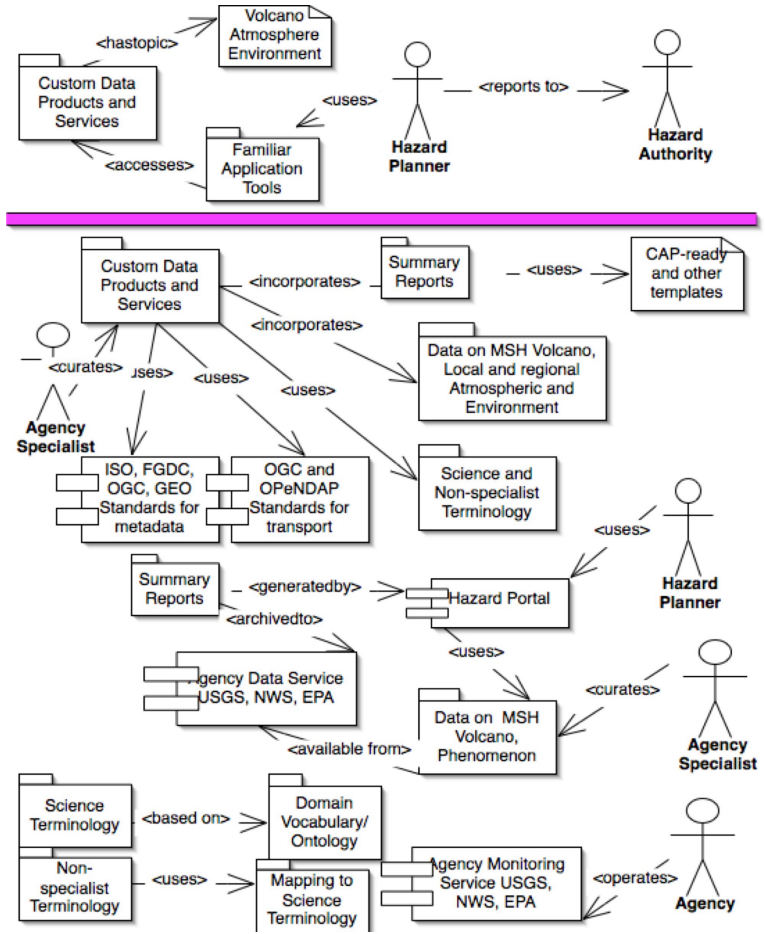
http://www.eiu.com/report_dl.asp?mode=fi&fi=353566020.PDF

Use Cases

- a **use case** is a list of actions or event steps typically defining the interactions between a role and a system to achieve a goal.
- The actors in a use case can be a human or other external system
- Use case diagrams helps us to understand which way the information flow.

volcanic activity from Mount St. Helens

https://en.wikipedia.org/wiki/Mount_St._Helens



Use Case

- Is a collection of possible sequences of interactions between the system under discussion and its Users (or Actors), relating to a particular goal.
- The collection of Use Cases should define all system behavior relevant to the actors to assure them that their goals will be carried out properly.
- Any system behavior that is irrelevant to the actors should not be included in the use cases.

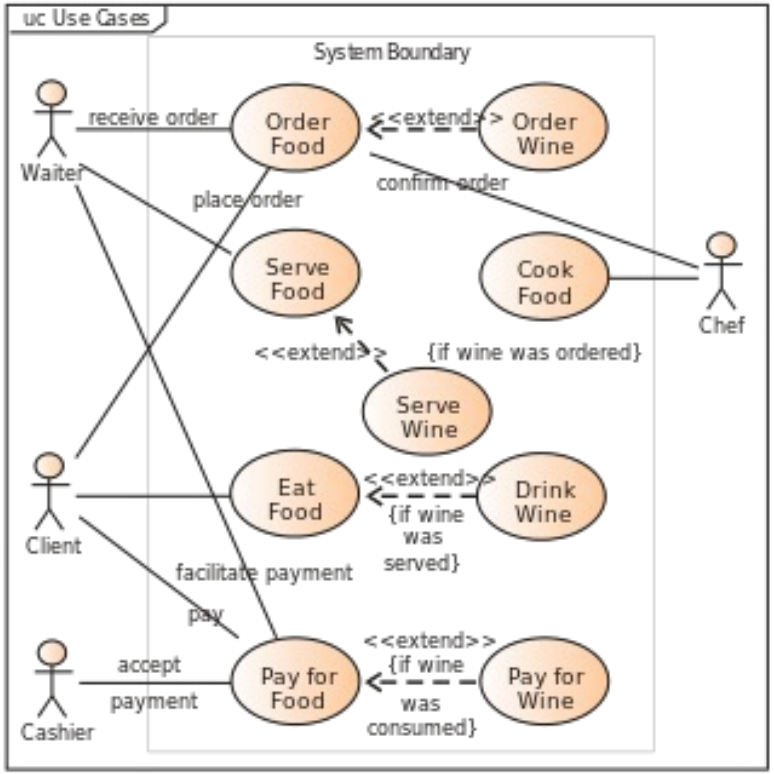
Use Case

- is a prose description of a system's behavior when interacting with the outside world.
- is a technique for capturing functional requirements of business systems and, potentially, of an IT system to support the business system.

Use Case

- Must be documented (or it is useless)
- Should be implemented (or it is not well scoped)
- Is used to identify: objects ~ resources, processes, roles (aka actors), requirements, etc.
- Should iterate with experts on wording and details at least once

A business Use case diagram depicts a model of several *business use cases* (goals) which represents the interactions between a restaurant (the business system) and its primary stakeholders (*business actors* and *business workers*).



https://en.wikipedia.org/wiki/Use_case

Use Case Examples:

- I have a gazillion images of the night sky from a survey but there's no way I (or all of the known professional galactic astronomers) can classify all those galaxies – what can I do?
- Provide browse and quick look access to a broad variety of climate, weather and ocean data.
- Provide web portal access to a federation of library catalogs with drill-down search and access of published articles

What is this ?

Image Resource: https://arctickingdom.com/6-ways-see-northern-lights-canadian-arctic/

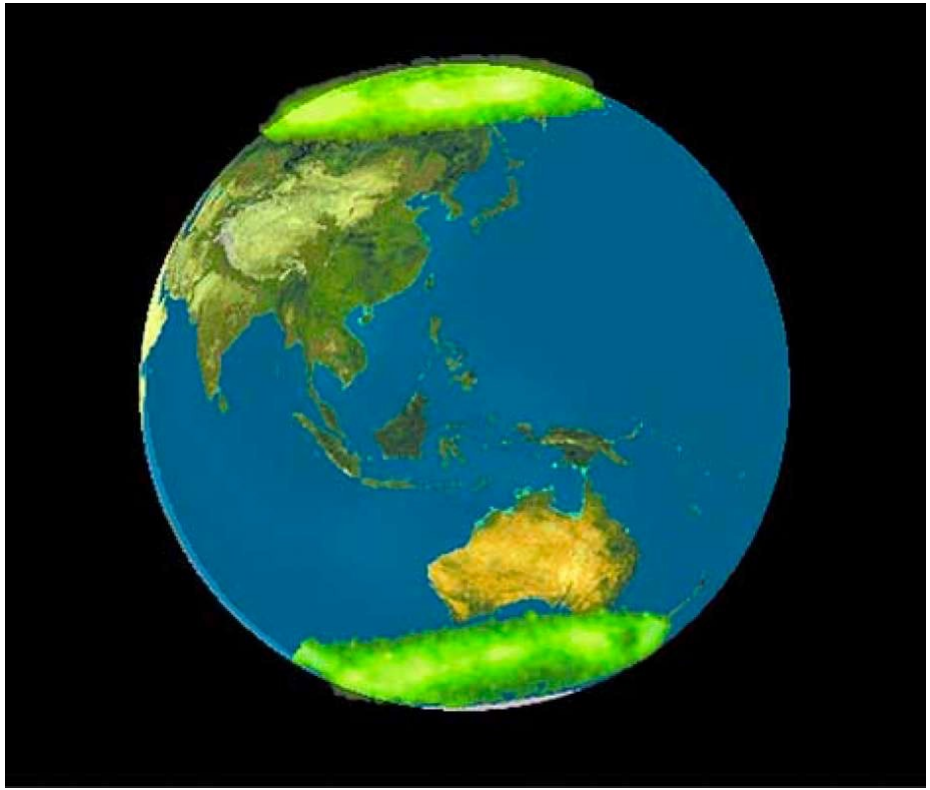


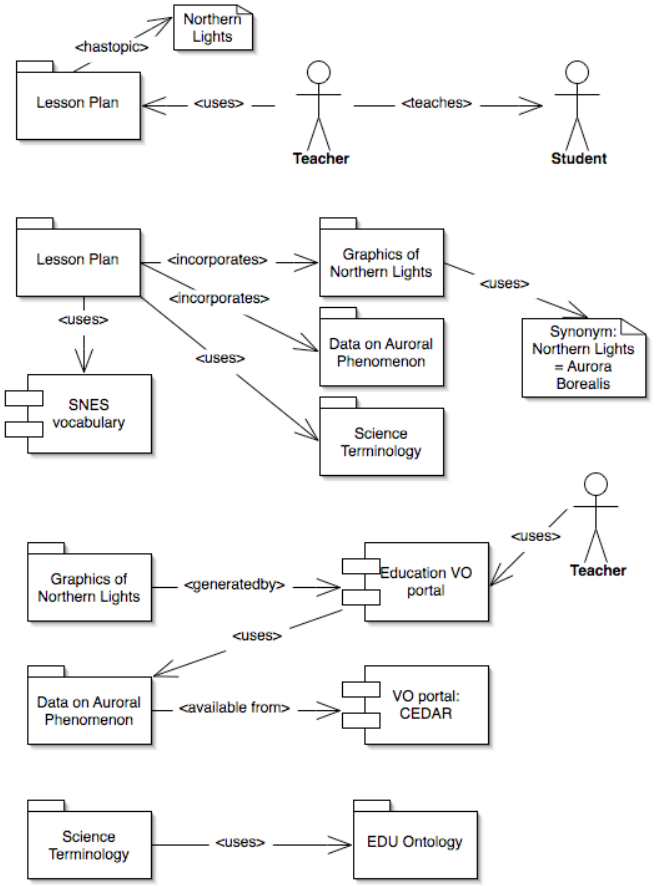
Image Resources: https://www.sfgate.com/news/article/Camera-captures-Northern-Lights-Southern-Lights-2863605.php

Use Case Examples:

A 9th grade teacher is US is preparing a lesson plan aimed at getting students to learn more about the ‘northern lights’, addressing NSES(National Science Education Standards) content standards in earth science. The teacher wants the students to learn the scientific terminology, where the phenomena occurs and retrieve some data or graphics for a recent occurrence. The goal of the lesson plan is the engage students, using authentic data from the aurora, as part of an inquiry-based program.

NSES : National Science Education Standards :
https://www.csun.edu/science/ref/curriculum/reforms/nses/

Schematic


Northern Lights
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EDU Ontology

Elements of a Use Case

- http://wiki.esipfed.org/index.php/SolutionsUseCase_Template
- Start with the Plain Language Description
  - Short Definition
  - Purpose
  - Describe a scenario of expected use
  - Definition of Success

Reading Assignment:
https://wiki.esipfed.org/SolutionsUseCase_Template

Goal

- A 1-2 sentence, concise statement of the intended outcome to the primary actor
- This is what will be tested as success (or failure)

“Summit that Mountain”

Scoping

- Focus initially on:
  - Core functionality
- What it takes to implement the use case, resist early generalizations – frame the “problem”
- May (will) have to iterate on use case and requirements

- Acknowledge other important issues such as:
  - Required vs. optional
  - Non-functional requirements
  - Available personnel (skills) and resources

*In general, functional requirements define **what** a system is supposed to do whereas non-functional requirements define **how** a system is supposed to be.*
non-functional requirements (such as platform, performance, timing, or safety-critical aspects).

Non- Functional Requirements: https://en.wikipedia.org/wiki/Non-functional_requirement

Functional and Nonfunctional Requirements

*In general, functional requirements define **what** a system is supposed to do whereas non-functional requirements define **how** a system is supposed to be.*

- non-functional requirements (such as platform, performance, timing, or safety-critical aspects).

Read: *Functional and Nonfunctional Requirements:* https://www.altexsoft.com/blog/business/functional-and-non-functional-requirements-specification-and-types/

Summary

- A plain language description of
  - **why this use case exists**,
  - **what problem is to be solved**, and
  - what **a successful outcome**, and
  - what the **impact** may be.
- Often termed the ‘business case’
- And a verbose (more detailed) description of one instance of a problem to be solved
  - **what resources are generally needed** (if known)
  - **who might be expected to do the work or provide the resources** and
  - **who might be expected to benefit from the work**.

Summary

- A narrative of how the use case via its flows and actors and resources results in achieving the result and a description of the artifacts
- **If there is a ‘failure’ component include a brief statement of how the use case via its flows and actors and resources did not result in achieving the result**
  - Describe role of actors in failure
  - Describe role of resources in failure
  - Describe what artifacts were and were not produced
  - Describe impacts of failure and any metric values

Summary

- List any performance or metric requirements for this use case and any other other considerations that a user would expect
- Definition of success
  - Quick test that would show whether or not the case is working as described.

- Wherever possible avoid specifying technical solutions or implementation choices
- Also note when the use case may be applicable to more than one application area

But for Xinformatics?

- Everything up to now can be considered '**informational**' and is **accessible to people**
- It is intended to keep people in the loop
- Let's discuss this use case:
  - I have a gazillion images of the night sky from a survey but there's no way I (or all of the known professional galactic astronomers) can classify all those galaxies – what can I do?
  - What would you do?
- **In-Class exercis**e (perhaps smaller groups?)

But for Xinformatics?

- Everything up to now can be considered ‘informational’ and is accessible to people
- It is intended to keep people in the loop
- Let’s discuss this use case: OR

– I want to “Summit that Mountain”
– What would you do?

- **In- Class exercise** (perhaps smaller groups?)

Gazillion Images of Night Sky: Use Case

Summit that Mountain: Use Case

So far … Summary

- By now, the reality of going into complete detail for the design should be apparent
- Keeping it simple is also very important as you begin to implement
- Being prepared to iterate is really essential
- Now is the time to validate your model with domain experts and your team
- The next stage would be to assess your technology components and design (but we cover that later)

Reference – READ THIS

- Slides 31-54 – yes, **you will need to read** and use them to complete Assignment 1!

Use Case Elaboration

- Actors
  - Primary Actors
  - Other Actors
- Preconditions
- Postconditions
- Normal Flow (Process Model)
- Alternative Flows
- Special Functional Requirements
- Extension Points

Actors

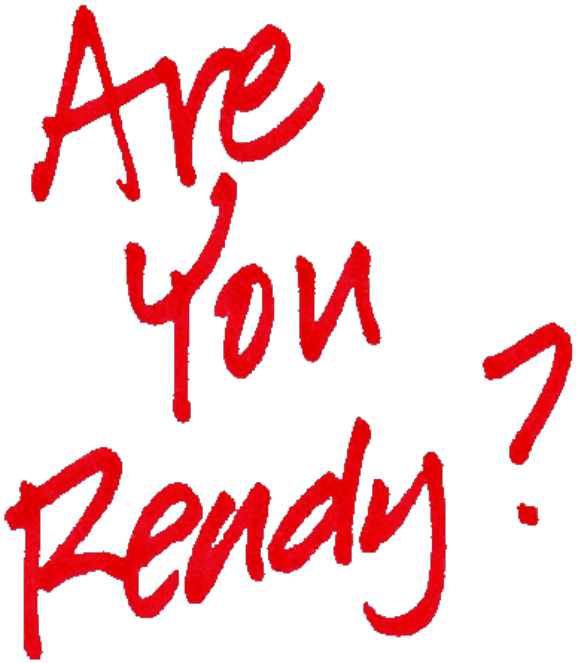
- The initial analysis will often have many human actors
- Begin to see where these can be replaced with machine actors – may require additional encoding
- If you are doing this in a team, take steps to ensure that actors know their role and what inputs, outputs and preconditions are expected of them
- Often, you may be able to ‘run’ the use case (really the model) before you build anything

Actors

- Real people (round heads – smart consumers of information) and computers (block heads – dump consumers)
- E.g. Data provider, end-user, data manager, alert service
- Primary – initiate (act on)
- Secondary – respond (acted upon)

Pre-condition?

- defines all the conditions that must be true (i.e., describes the state of the system) for the trigger to meaningfully cause the initiation of the use case.



Preconditions - data/model

Data Resource	Type	Characteristics	Description	Owner	Source System
(dataset name)	Remote, In situ, Etc.	e.g. – no cloud cover	Short description of the dataset, possibly including rationale of the usage characteristics	USGS, ESA, etc.	Name of the participating system which supports discovery and access

Model	Owner	Description	Consumes	Frequency	Source System
(model name)	Organization that offers the model	Short description of the model	List of data consumed	How often the model runs	Name of the participating system which offers access to the model

Preconditions - event/application

Event	Owner	Description	Relevant subscriptio n	Source System
(Event name)	Organization that offers the event	Short description of the event	List of subscriptions (and owners)	Name of the participating system which offers this event

Application/ DSS	Owner	Description	Sour ce Syst em
(Applicatio n name)	Organization that offers the Applicatio n	Short description of the application	Name of the participatin g system which offers this event

Post-condition?

- Describes what the *change in state* of the system will be after the use case completes.
- Post-conditions are guaranteed to be *true* when the use case ends.

Success scenarios

- A re-statement of how the use case via its flows and actors and resources results in achieving the result
- Describe impacts and metric values

Failure scenarios

- A statement of how the use case via its flows and actors and resources did not result in achieving the result
- Describe role of actors in failure
- Describe role of resources in failure
- Describe what artifacts were and were not produced
- Describe impacts of failure and any metric values
- And when you are doing science this is 80% of the outcome!

Normal (process) flows

- A basis step of (usually) distinct steps that result when the use case is triggers (commences)
- Steps are often separated by actor intervention or represent modular parts of the flow (can encapsulate activities)
- Should end with the final goal achieved

Process flow

- Each element in the process flow usually denotes a distinct stage in what will need to be implemented
- Often, actors mediate the process flow
- Consider the activity diagram (and often a state diagram) as a means to turn the written process flow into a visual one that your experts can review
- Make sure the artifacts and services have an entry in the resources section

Alternate (process) flows

- Variations from the main flow, often invoked by valid but non-usual (or rules)
- Activity diagrams are useful in representing this part of the document
- Do not usually represent exceptions/ error flows
- Can often help to identify general patterns in the use case via similarities with the normal flow
- While many are possible, usually only include one - illustrative

Non-Functional requirements

- (from Wikipedia): Non-functional requirements which specify criteria that can be used to judge the operation of a system, rather than specific behaviors.
- This should be contrasted with functional requirements that specify specific behavior or functions.

*In general, functional requirements define **what** a system is supposed to do whereas non-functional requirements define **how** a system is supposed to be.* Functional and Nonfunctional Requirements:

https://www.altexsoft.com/blog/business/functional-and-non-functional-requirements-specification-and-types/

Non-functional requirements

- Performance
- Reliability
- Scalability
- Usability
- Security
- Other Non-functional Requirements
  - Repeatability?

Functional and Nonfunctional Requirements:

https://www.altexsoft.com/blog/business/functional-and-non-functional-requirements-specification-and-types/

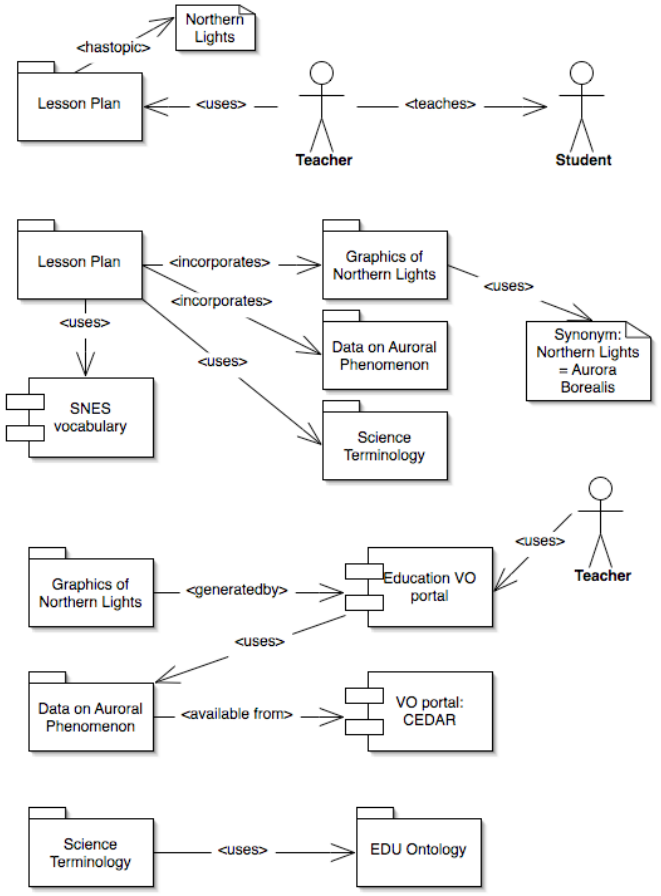
Artifacts – things left behind

- Add artifacts that the use case generates to the resources list in the table
- It is often useful to record which artifacts are critical and which are of secondary importance
- Be thinking of provenance and the way these were produced, i.e. what went into them and produce suitable metadata or annotations
- Engage the actors to determine the names of these artifacts and who should have responsibility for them (usually you want the actors to have responsibility for evolution)

General Diagrams

- Schematic of the Use case
- Drawing diagrams:
  - Stick figures for actors (person or computer)
  - Boxes to denote resources
  - Arrows to denote process flow
  - Concept maps are a useful tool

Schematic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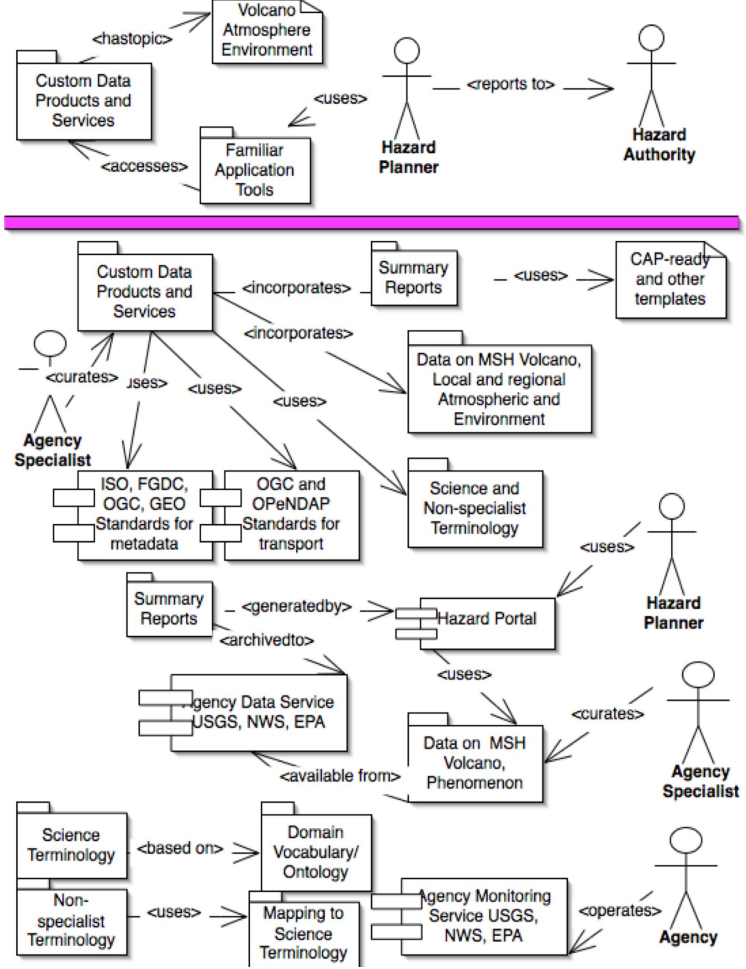
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OGC and OPeNDAP Standards for transport
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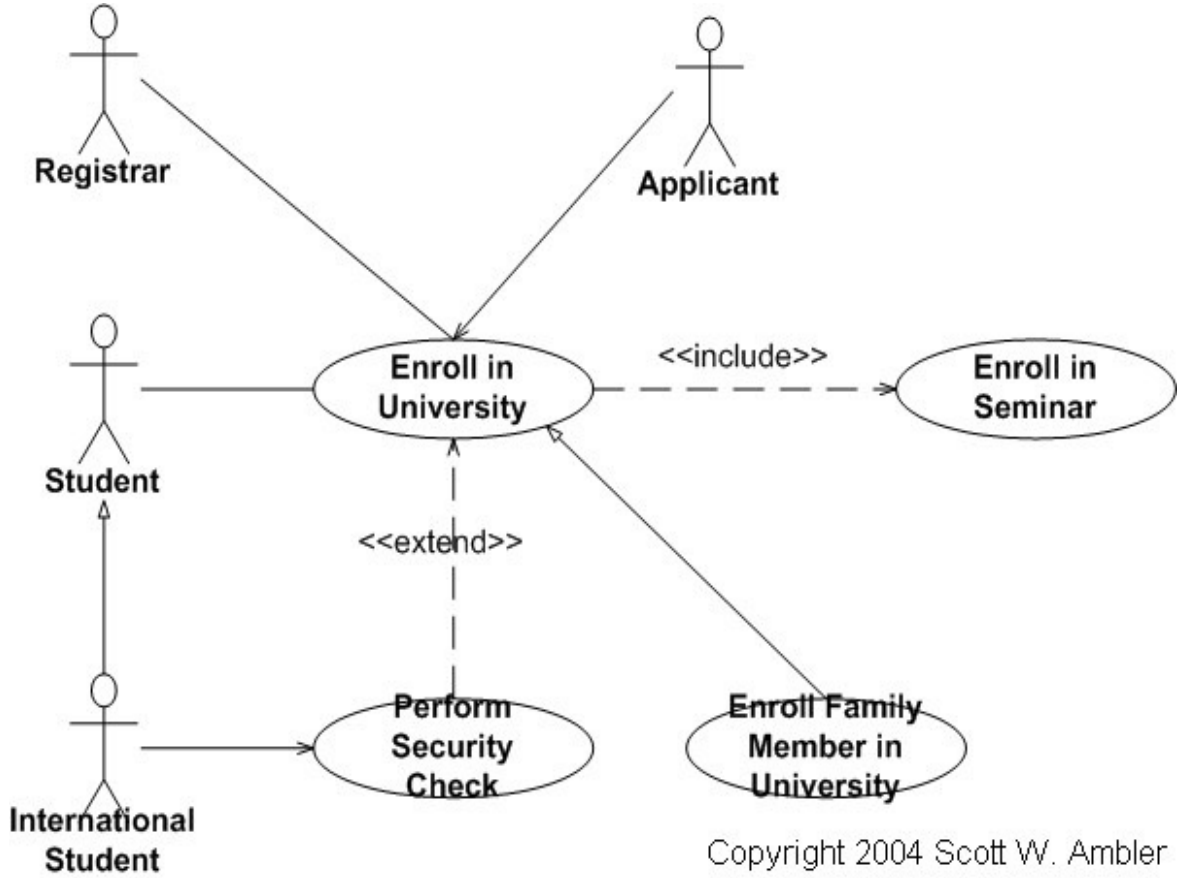
Registrar
Applicant
Student
Enroll in University
<<include>>
Enroll in Seminar
<<extend>>
International Student
Perform Security Check
Enroll Family Member in University
Copyright 2004 Scott W. Ambler

Other Diagrams

- State Diagram
- Activity Diagram
- Sequence Diagram

State Diagram: https://en.wikipedia.org/wiki/State_diagram#:~:text=A%20state%20diagram%20is%20a,this%20is%20a%20reasonable%20abstraction.

Activity Diagram: https://en.wikipedia.org/wiki/Activity_diagram

Sequence Diagram: https://en.wikipedia.org/wiki/Sequence_diagram

Typical procedure

- Fill out the use case – narrative
- Create a Use Case diagram
- Review the narrative: goal, summary, actors, normal flow
- Make sure it is all in sync
- Extract functional (and non-) requirements
- Proceed to information modeling (but we are not going to cover that here) …

So far … Summary

- By now, the reality of going into complete detail for the design should be apparent
- Keeping it simple is also very important as you begin to implement
- Being prepared to iterate is really essential
- Now is the time to validate your model with domain experts and your team
- The next stage would be to assess your technology components and design (but we cover that later)

Back to what's next…

Informatics Requirements

- Functional requirements specify specific behavior or functions.
  - In general, functional requirements define **what** a system is supposed to do whereas non-functional requirements define **how** a system is supposed to be.
- Requirements which specify criteria to judge the operation of a system, rather than specific behaviors aka "constraints", "quality attributes", "quality goals" and "quality of service requirements".
  - Execution qualities, such as security and usability, are observable at run time.
  - Evolution qualities, such as testability, maintainability, extensibility and scalability, are embodied in the static structure of the software system.

Developed for NASA TIWG

Requirements

- Start with the actors and capture their required actions, outcomes, etc.
- At each stage of the general (and alternate) process flow, ask them what is required at the stage (and what is optional)
- Also ask about non-functional requirements (preferably without calling them that)
- This is required for human *and* computer actors! [Yes, both human and non-human (computers)]

Example

Example of a functional and non-functional requirements:

- After the completion of required fields in a Web form, a confirmation email is sent to the email address(es) entered containing a confirmation of all entered inputs – **functional**
- This email must be sent within 2 hours of form submission – **non-functional**

Metrics

- Things you can measure (numerical)
- Things that are categorical and numerical
- Measure or estimate the baseline before you start – use case!

Evaluation?

- Can be structured or less-structured
- **A good way to start is to get members of your team (or someone else) to do a peer evaluation**
- **Treat this as a professional exercise at all times**
- Other possible techniques for moving forward on evolving the design, what to focus upon, priorities, etc.: SWOT Analysis (**S**trength, **W**eakness, **O**pportunities, **T**hreats)

Evaluation References

- Twidale, Randall and Bentley (1994) and references therein
- Scriven (1991, 1996)
- Weston, Mc Alpine, and Bordonaro, (1995)
- Worthen, Sanders, and Fitzpatrick, (1997)

Result/ outcome

- Refer to the use case document

- Outcome (and value of it) is a combination of data gathering processes, including surveys, interviews, focus groups, document analysis and observations that will yield both qualitative and quantitative results.
- Did you meet the goal?

Keep in mind

- You need an evaluation plan that can lead to improvements in what you have built
- You need an evaluation to value what you have built
- You need an evaluation as part of your preservation documentation – um, so that you might actually use the approach again, or um, reproduce it ;-)

Summarizing…

When someone asks: “What is your use case”?

- Treat it like your ‘elevator pitch’
- Know them, especially the ones you have implemented
- Tell them how you used it to develop a solution for use

If you have not developed one

- Try reverse engineering
- Start with a personal example
  - E.g. moving to Troy, cleaning out your room or house, …

Resources

- http://www.dsc.ufcg.edu.br/~garcia/cursos/ger_processos/seminarios/Crystal/Use%20Cases,%20Ten%20Years%20Later.htm
- http://www.foruse.com/publications/bibliographies/usecases.htm
- http://en.wikipedia.org/wiki/Use_case
- http://www.ddj.com/dept/architect/184414701
- Omnigraffle (Mac) or
- Cmap
- ESIP wiki template http://wiki.esipfed.org/index.php/SolutionsUseCase_Template
- Functional and Nonfunctional Requirements: https://www.altexsoft.com/blog/business/functional-and-non-functional-requirements-specification-and-types/

Discussion (In-class group work)

- About use cases?
- Diagrams?
- Requirements?

Assignment 1 available on LMS

- Use case development
- Assignment 1 available on LMS

- **Due: January 31st , 2024 by 9:00am ET** on LMS.