Characterizing Human Explanation Strategies to Inform the Design of Explainable AI for Building Damage Assessment

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NEURAL INFORMATION PROCESSING SYSTEMS
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Background

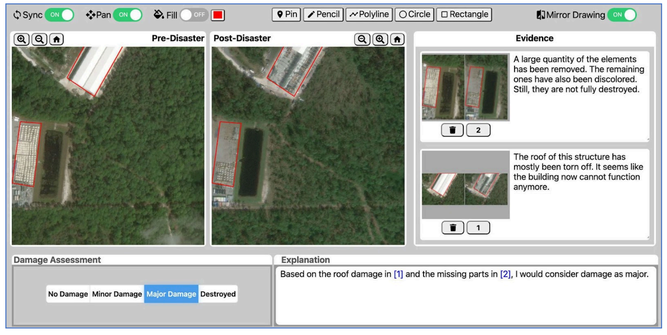
- Public satellite image datasets of natural disasters, such as xBD, have been used to develop AI tools for assessing building damage from satellite imagery
- Yet, fully-automated approaches are unlikely to be perfectly safe and reliable
- On such an account, explainable AI (XAI) is a promising means of supporting human-AI collaborations for high-stakes visual detection tasks
- However, most existing XAI techniques are not informed by the understandings of task-specific needs of humans for explanations

Research method

- As a first step toward understanding what humans require from XAI in building damage assessment tasks, we begin by characterizing **how humans generate explanations** for their own assessments in such tasks
- We conducted an online crowdsourcing study (N=60) to collect data on how people explain their own assessments in contexts of building damage detection

Annotation system

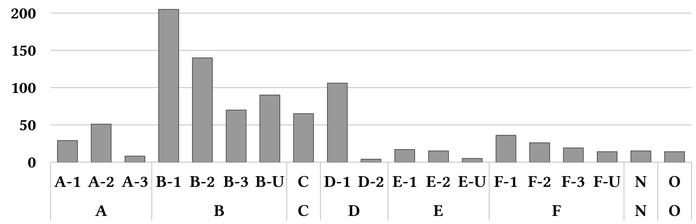
- We developed a web-based annotation system, where users can draw markups directly on pre- and post-disaster image using various drawing tools, along with explaining them as a text



Annotation system we designed and used during the study

Analysis & Results

- We used an iterative, open coding approach to identify categories among the explanations that participants generated
- From the study, we could surface 6 major strategies (A - F), along with several minor explanation methods (O) and “No damage” (N)
- A total of 929 codes were derived
- Summary of the codes and the descriptions of each code are as follows:



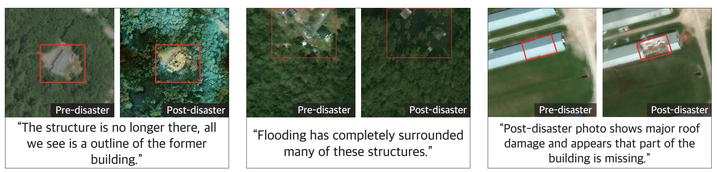
Summary of the codes

Code A: Constructing a causal argument to explain building damage

- **A-1**. Pointing to visual evidence of a natural disaster in a building’s surroundings to explain their assessment of building damage (e.g., *“From the evidence of flooding, I would say the building seems to have been affected”*)
- **A-2**. Inferring that a particular type of natural disaster had occurred based on evidence of damage to a building, then explaining their overall assessment of building damage with reference to the type of disaster (e.g., *“The building has roof damage. Probably a hurricane came and hit it”*)
- **A-3**. Constructing more complex, multi-step causal arguments (e.g., *“(Step 1) There was a fire and (Step 2) it was a wildfire that took everything from the building. (Step 3) You can only see the outline of the building”*)

Code B: Contrasting pre- and post-disaster imagery

- **B-1**. Referencing contrasts in the appearance of a specific building between the pre- and post-disaster images
- **B-2**. Comparing the pre- and post-disaster appearance of the area surrounding a building
- **B-3**. Highlighting contrasts in the appearance of specific sub-structures
- **B-U**. Ambiguous cases in which people generated contrast-based explanations, without clearly specify which elements they were comparing



(a) Example of B-1 **(b) Example of B-2** **(c) Example of B-3 and C**

Examples of code B-1, B-2, and B-3

Code C: Highlighting affected part of a building

- Rather than drawing markup around the whole building, some participants referenced specific affected parts of the building, but without necessarily comparing pre- and post-images in their explanations

Code D: Explanations based on the extent of damage to a specific building

- **D-1**. Explaining their assessment of the level of damage to a given building based on the proportion of the building that appears to be damaged (e.g., *“Approximately a half of the building was collapsed”*)
- **D-2**. Lowering assessments of damage by arguing that the damage appeared repairable (e.g., *“One part (of the building) was hit ... seems like it could be rebuilt”*)

Code E: Explaining reasons for lack of confidence in their own assessment

- **E-1**. Signaling their lack of confidence with reference to properties of a satellite image, such as low-resolution, visual distortion, or small buildings being obscured by shadows or taller buildings (e.g., *“The imagery has great distortion and is difficult to judge”*)
- **E-2**. Pointing out that they saw other changes between the pre- and post-disaster images, which made it challenging to precisely assess building damage (e.g., *“Oddly, it appears this building has been newly built up since the disaster”*)
- **E-U**. Noting that it was difficult to assess building damage, without necessarily providing a clear reason (e.g., *“This area is hard to judge”*)

Code F: Using the number of damaged structures in an image as the measure for severity of the disaster

- **F-1**. Explaining the building damage assessment with reference to the number of other buildings that appeared to be affected (e.g., *“It appears that one building has disappeared, leading me to believe it was destroyed. However, the remaining buildings seen are unharmed”*)
- **F-2, F-3**. Explaining their assessment with reference to the extent of damage visible in the surrounding area, by including (e.g., *“None of the large buildings appear to be damaged, but there is evidence of a large mud patch (in the surrounding area), indicating some minor flood damage”*) or excluding (e.g., *“All trees have been damaged or destroyed”*) building damage
- **F-U**. Ambiguous cases (e.g., *““Every area was totally destroyed”*)

Conclusion & Future work

- Participants often made use of contextual information (e.g., surrounding area and building) with direct evidences, weaving these into a coherent story
- Participants also frequently made reference to the visual contrast between pre- and post-disaster images, while arguing for its causal interpretations
- Finally, participants sometimes signaled their level of confidence in their own damage assessments within their explanations along with the reasons
- Future studies should explore how different types of explanations may impact HADR decision-makers in practice