

1. Introduction

Steam¹ is a videogame digital distribution service, which offers services such as a digital store, digital rights management, video streaming, social networking and APIs for supporting in-game achievements and microtransactions. In terms of market share, the Steam platform is currently the largest digital distribution platform for PC games, with nearly 30.000 games and over 100 million users.

Steam's digital store includes a dedicated page for each game in their catalog. The information included in this page mixes both factual information provided by the game developer and opinions and user reviews contributed by Steam users. For instance, the following information is provided about a particular game:

- The Pan European Game Information (PEGI)² classification, providing a recommended age label and a list of content descriptors.
- The list of language translations for in-game information, dialog and/or subtitles.
- The list of downloadable content (DLC) that provide extras to the game, such as additional maps, missions, characters, items or skins.
- The list of supported platforms as well as the minimum and recommended system requirements (CPU, RAM memory, graphics card, available storage) for each one.

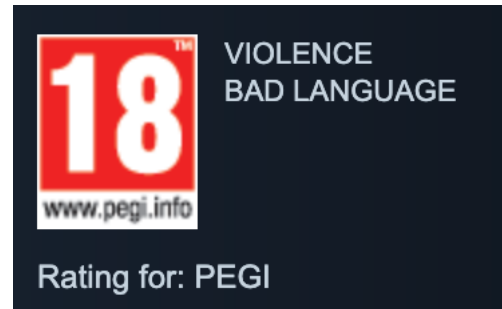
Regarding opinions, users can assign tags to games (such as ``single-player'' o ``role-playing game'') as well as write textual reviews. Furthermore, users can show their agreement with a particular review by endorsing it (``was this review helpful?").

¹ <https://store.steampowered.com/>

² <https://pegi.info>



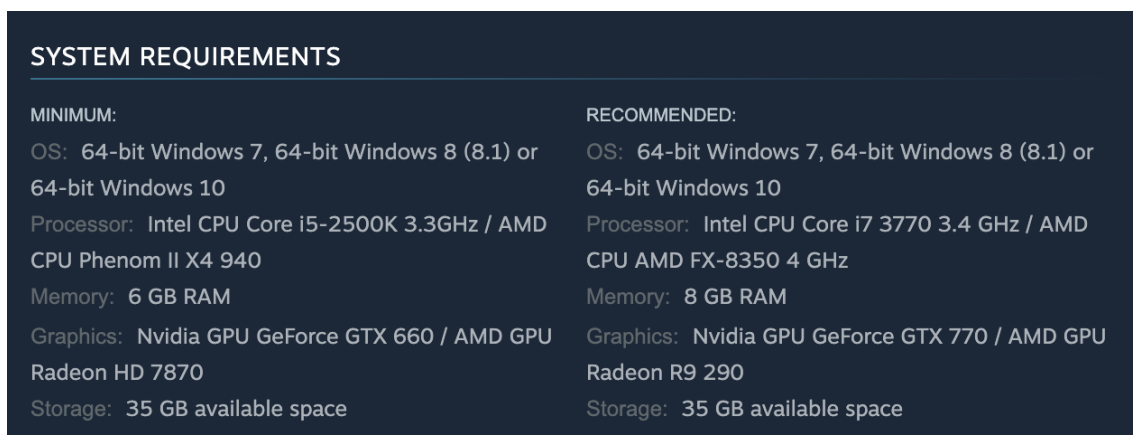
Steam digital store



PEGI label for a game



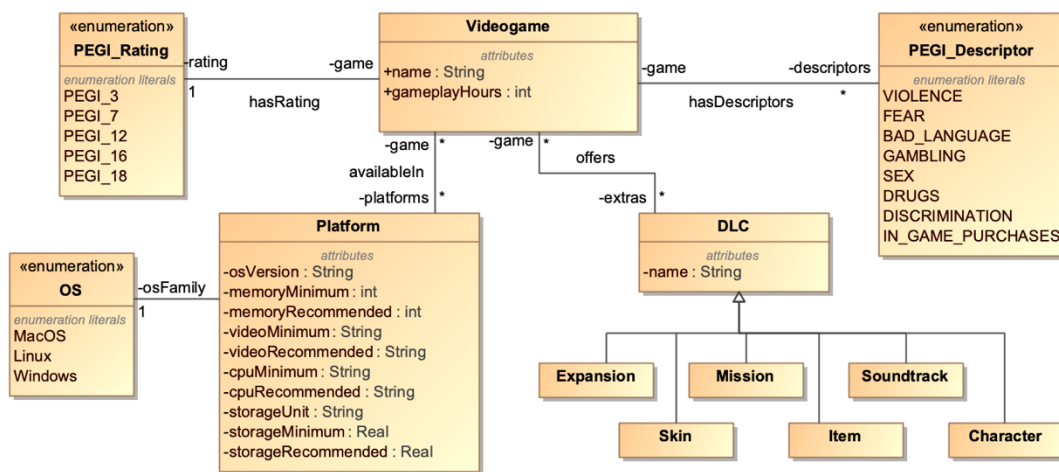
Sample user review + the GUI to vote in favor of this review



System requirements information (minimum & recommended)

Steam reviews offer an interesting dataset from the point of view of *opinion mining* and *sentiment analysis*, which has been analyzed in the software engineering literature (e.g., [Lin 2019]). User reviews may show conflicting opinions regarding a particular game. Some examples of controversial topics are software bugs, the minimum system requirements (with users explaining their first-hand experiences with incompatibilities, crashes or bad performance) and the amount of hours of content provided by the game. Some of these controversial topics are also analysed by specialized social gaming services, such as HowLongToBeat³.

In the following, we discuss how our uncertainty modeling approach can be used to study the opinions of several users about a particular videogame. First, the following figure shows the domain model for a videogame in the Steam store.

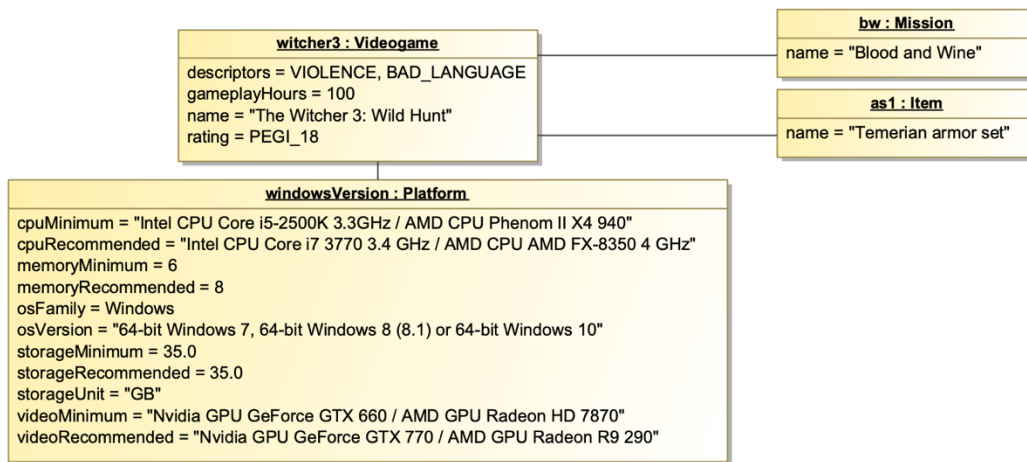


It is then possible to populate this domain model with the information for a particular game. For instance, we have selected a popular role-playing game (“The Witcher 3: Wild Hunt”⁴) and built the object model shown in the following figure⁵.

³ <https://howlongtobeat.com>

⁴ https://store.steampowered.com/app/292030/The_Witcher_3_Wild_Hunt/

⁵ For the sake of brevity, we have not included the complete information about this game: at the time of writing, 22 different DLCs were available in the Steam store.



As a popular game, it has attracted a very large number of reviews (more than 400k), some of them showing conflicting opinions about system requirements. Some users consider them to be sufficient while others disagree.

Let us illustrate our proposal in the case of one particular requirement, namely the CPU required to run the game (value of attribute “cpuMinimum” in class “Platform”). The value of this attribute constitute the “fact” about which users express their subjective opinions.

To study these subjective opinions, we consider the reviews of four Steam users, which we call Adam, Beth, Charles and Diana for convenience. The following table describes sample fragments from their reviews discussing system requirements and the number of votes given by other community members that considered each review helpful. The number of endorsements can be used as a measure of the popularity of that opinion among the player base, but can also be interpreted as the endorsers' own opinions, and therefore consider endorsers as agents who have expressed their opinions, too.

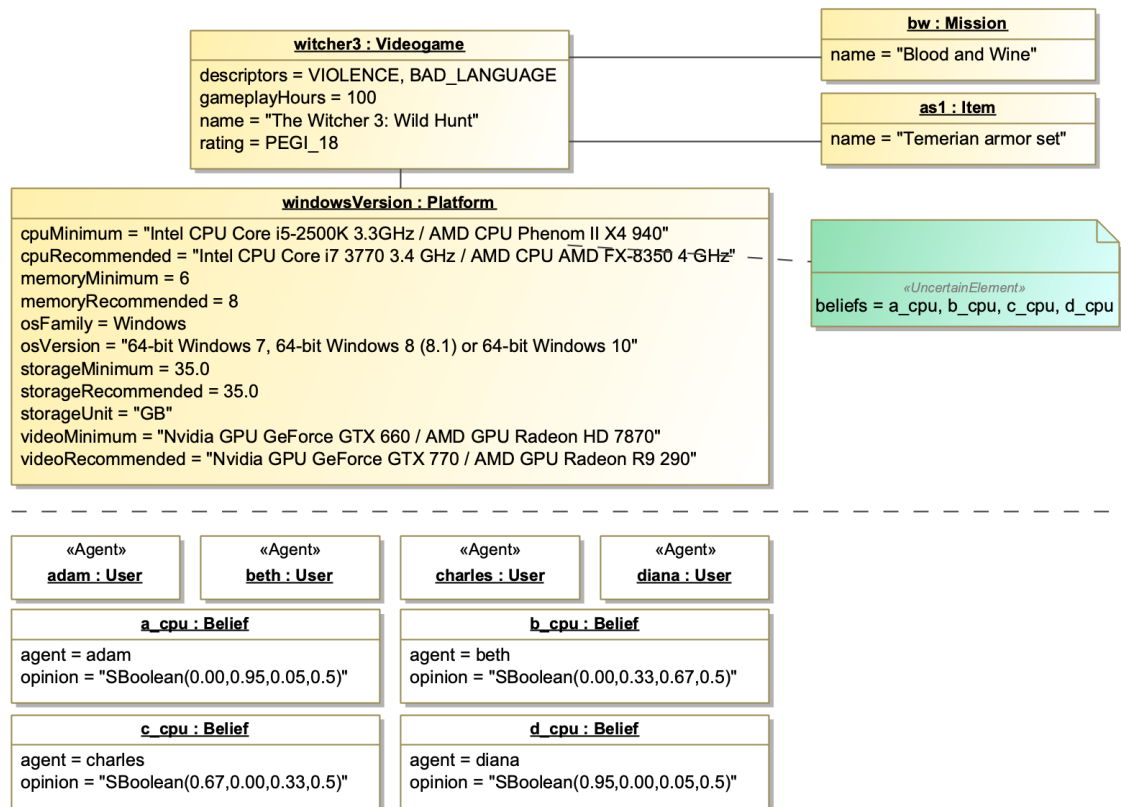
Review	Votes	Certainty	Subjective opinion
Adam: “My computer has twice the requirements and still it does not run at 100%, there are always some glitches or bugs”	18	Impossible	SBoolean(0.0,0.95, 0.05,0.5)
Beth: “It needs better hardware compatibility. Users with AMD hardware (I’m not included) are having a rough time, from what I hear”	114	Improbable	SBoolean(0.00,0.33,0.67,0.5)
Charles: “I have a modest PC and I can run it at 1080p/high with decent and stable FPS, so if you meet the requirements you should not have any trouble running it”	33	Probable	SBoolean(0.67,0.00,0.33,0.5)

<i>Diana: "Using a full AMD PC, the game runs perfectly in ULTRA quality with no glitches even though the game uses proprietary technology from NVIDIA"</i>	34	Certain	SBoolean(0.95,0.00,0.05,0.5)
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Notice that the textual opinions sometimes exhibit a degree of uncertainty, *e.g.*, second-hand opinions ("from what I hear") or statements of possibility ("you should not have trouble"). To capture this uncertainty, we have assigned a degree of certainty to each statement. For example, a degree of certainty "impossible" states that the agent does not agree with the proposed minimum processor requirements. Using this convention, we can define the subjective opinion that each user assigns to the attribute `cpuMinimum` that is stereotyped as `<<UncertainElementFusion>>` in the object diagram.

To compute the aggregated opinion that merges the opinions of all users we employ the `AverageBeliefFusion()` operator, because the opinions are dependent but we want to assign less weight to those opinions with high uncertainty.

The result of merging all 199 opinions (18 * Adam, 114 * Beth, 33 * Charles, and 34 * Diana) using this operator is `SBoolean(0.544, 0.304, 0.152, 0.5)`. Therefore, we can be 54.4% certain that the requirement is true, 30.4% that it is false, with an uncertainty of 15.2%. The projection of the result is 0.62, so we can initially trust (with some reservations) the vendor's claim.



References

- [Lin 2019] Dayi Lin, Cor-Paul Bezemer, Ying Zou, and Ahmed E Hassan. 2019. An empirical study of game reviews on the Steam platform. *Empirical Software Engineering*, 24, 1 (2019), 170–207