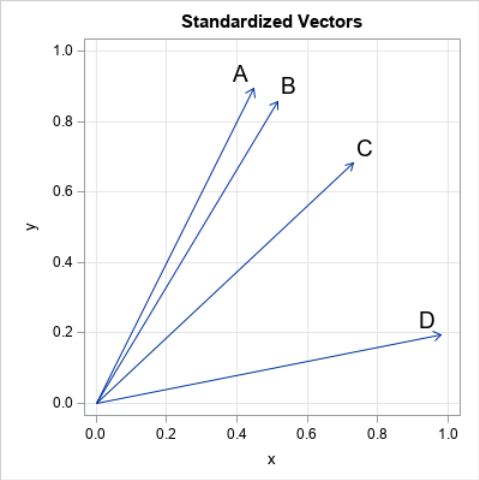
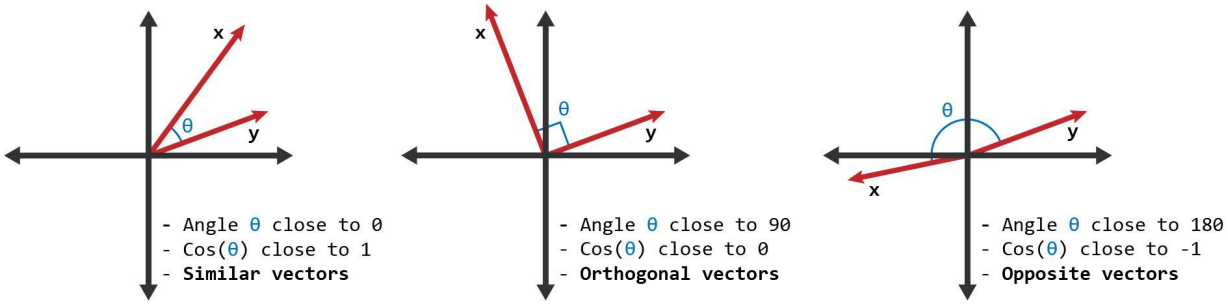
PetMatch Models' Explainability

Content-Based Filtering Model

The first core model in PetMatch is a Content-Based Filtering model using cosine similarity, which is straightforward enough that an add-on explainability tool/model was not required. To better understand why we need to see what cosine similarity does. Cosine similarity measures the similarity between two data points in a plane, measured by the cosine of the angle between two vectors. The more similar the two data points are the larger the distance is between those two vectors. In the example below, we can see that items A and B would have a higher similarity score than A and D. This makes explainability straightforward. A higher similarity score means that if a user likes A they will most likely enjoy B. Therefore, Petmatch can rely on the cosine similarity scores of each animal and simply return the highest scores for recommendations. This could be considered a global approach to explainability given that we provide the whole known animal list, score each animal against all the rest, and collectively understand the global top-scoring animals based on similarity to a set animal the user already liked. Put concretely, if the user liked animal A, we would recommend B because the score would the highest. Additionally, cosine similarity is easy to interpret. For example, say we have two animals x and y and we want to see how similar they are compared to each other. As we see below, if the score is closer to 1 (left), then the two animals are very similar to each other. If the score is closer to 0 (middle), they are unrelated. If the score is close to -1 (right), then they are completely opposite.





As an example of actual output from our Content-Based Filtering Model, we assume that a user liked animal #58671675. The animal attributes were then compared to our global knowledge of other like animals (e.g cats with cats, dogs with dogs). Then the top 5 were returned with the highest scores on the top. If an animal had a score lower than the top 5, it was not recommended.

['Recommending 5 cats similar to [58671675]...

['Recommended: [58672378] (score:0.9333333333333331)
['Recommended: [58672041] (score:0.9333333333333331)
['Recommended: [58672198] (score:0.8666666666666665)
['Recommended: [58671875] (score:0.8666666666666665)
['Recommended: [58671744] (score:0.8666666666666665)

If we visualize these animals we can see the similarities. The why these animals were recommended simply comes down to the top cosine similarity scores.

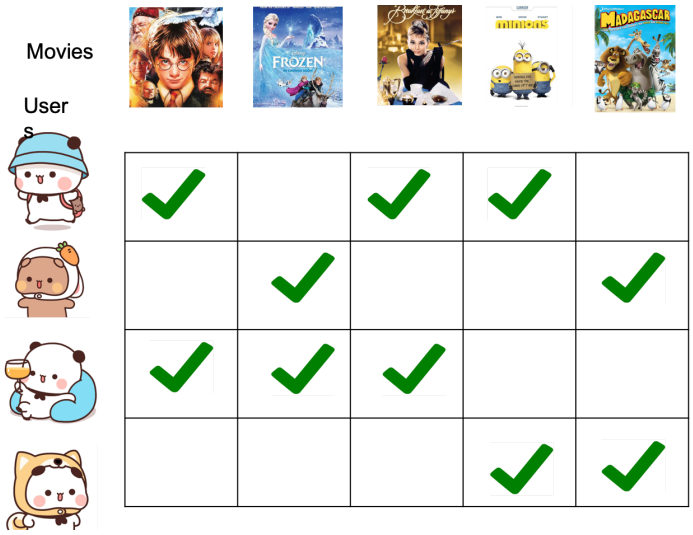
Collaborative Filtering Model

The second core model in PetMatch is a User-based Collaborative Filtering model called SVD++. SVD++ is an extension of the classic SVD model (Singular Value Decomposition). It takes into account implicit user ratings (viewing a cat a lot) in addition to explicit user ratings (clicking yes on a pet). Since this is Collaborative-Based Filtering using matrix factorization, the explainability of the model is more difficult than the Content-Based Filtering model but it can be intuitively understood nonetheless without resorting to an explainability tool/model.

Simply put, Collaborative Filtering finds the relationships between items and users. For user-based systems like Petmatch, once it knows these relationships it can provide recommendations for a user by finding similar users and sharing some of the animals they liked. It accomplishes this using something called ‘latent features’, which are associations between users and animals, to determine similarities between users. From an explainability perspective, this would provide at best a quasi-global explanation of the model. It is a big-picture view of all the relationships between users but it only knows about the animals that have already been rated by at least one user. Essentially put, the more the users use the system, the more the space of adoptable animals is explored and more effective recommendations are possible. This is famously known as the ‘cold-start’ problem. Thankfully this does not undermine our ability to explain why the model chose what animals to recommend.

A simple non-Petmatch example is below. We see that user 1 (panda with a blue hat) and user 3 (panda sipping a drink) are very similar. User 1 asks for a recommendation. Collaborative filtering sees that user 1 is very similar to user 3 and also knows that user 3 has seen the movie

‘Frozen’. Since user 1 has yet to see it, the model will recommend that they see ‘Frozen’ since a similar user with similar tastes watched it and liked it.



Since Petmatch is ‘user-based’ we determine similarities between users based on their rated animals so far (rather than movies). Concretely, say we have the below table and ‘user 1’ is looking for a recommendation. In this example, Y is ‘yes’ and N is ‘no. Based on the yes and no ratings for the cats, user 1 is most similar to user 3. User 3 rated ‘Cat 1’ positively but User 1 has yet to see it. Since these users are so similar, it is highly likely that User 1 will also enjoy ‘Cat 1’ and ‘Cat 1’ will receive a higher score and be recommended (the big red X).

	Cat 1	Cat 2	Cat 3	Cat 4	Cat 5	Cat 6
User 1	X		Y	Y		N
User 2		Y			Y	Y
User 3	Y		Y	Y		N
User 4	N	Y		Y	Y	Y

As an example of actual output from our User-based Collaborative Filtering Model, we recommended the top 5 cats for a user. The scores were essentially predicted ratings ranging from 0 (no) to 1(yes). The top scores closest to 1 were recommended to the user. Remember that this is ultimately based on recommending animals to a user based on what similar user(s) to them also liked. As you can see below, each returned recommendation has an estimated score along with it and only the best scores are returned. The model returned cats to the user that had the best chance of being a match based on what other users like them also liked!

Cat Id	Estimated Score
58803464	0.721076
58856166	0.719397
58945658	0.712392
58903660	0.703037
58934915	0.701032

If we visualize these animals we can see a bit more diversity than in our Content-Based Filtering model but there are still common themes to them. For example, most of the results are younger cats that have a patterned coat rather than one solid color. The why these animals were recommended comes down to sharing cats between similar users with similar tastes in cats.