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Selective Content Delivery Based On Content Emotion

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Selective Content Delivery Based On Content Emotion

ABSTRACT

Content items and associated criteria for delivery are received by a server from content provider. The server provides online services such as social networking, media hosting and sharing websites, news, etc. The server extracts content features from the content items using text extraction, image processing and other techniques. The server determines a content emotion associated with the content by applying trained machine-learning models. The server selects content items based on the content emotion, detected user emotion of a requesting user, and the criteria associated with different content items. Selected content items are delivered to a requesting user in a ranked order. The server obtains user interaction data from interaction of the requesting user with the delivered content items and detects a user emotion based on the interaction data. The content emotion associated with the content item is adjusted based on an aggregate of the detected emotion of users that received the content item. The adjusted content emotion is used for evaluation of the content item to other users. The described techniques for selection and delivery of content items based on content emotion, and adjustment of the content emotion based on user interaction allow the server to deliver content items that have a high likelihood of providing a quality user experience. The described techniques improve engagement of the user with the online service provided by the server.

KEYWORDS

content item; emotion detection; content score; user emotion; user profile; user targeting; content delivery; content selection; machine learning; delivery criteria; social network; media hosting; interaction data

BACKGROUND

Users access content via various online providers, e.g., social networking providers, media hosting and sharing websites, news websites, etc. Providers benefit from providing a positive user experience, e.g., by delivering content to each user that the user is likely to be interested in. Content can include content items that other users such as social network friends had viewed or otherwise interacted with. Some content owners provide criteria to provide individual content items to particular groups of users, e.g., based on user attributes. Accurately determining what content that a user finds interesting is important for providers and content owners, because they benefit when a user views or interacts with the provided or sponsored content.
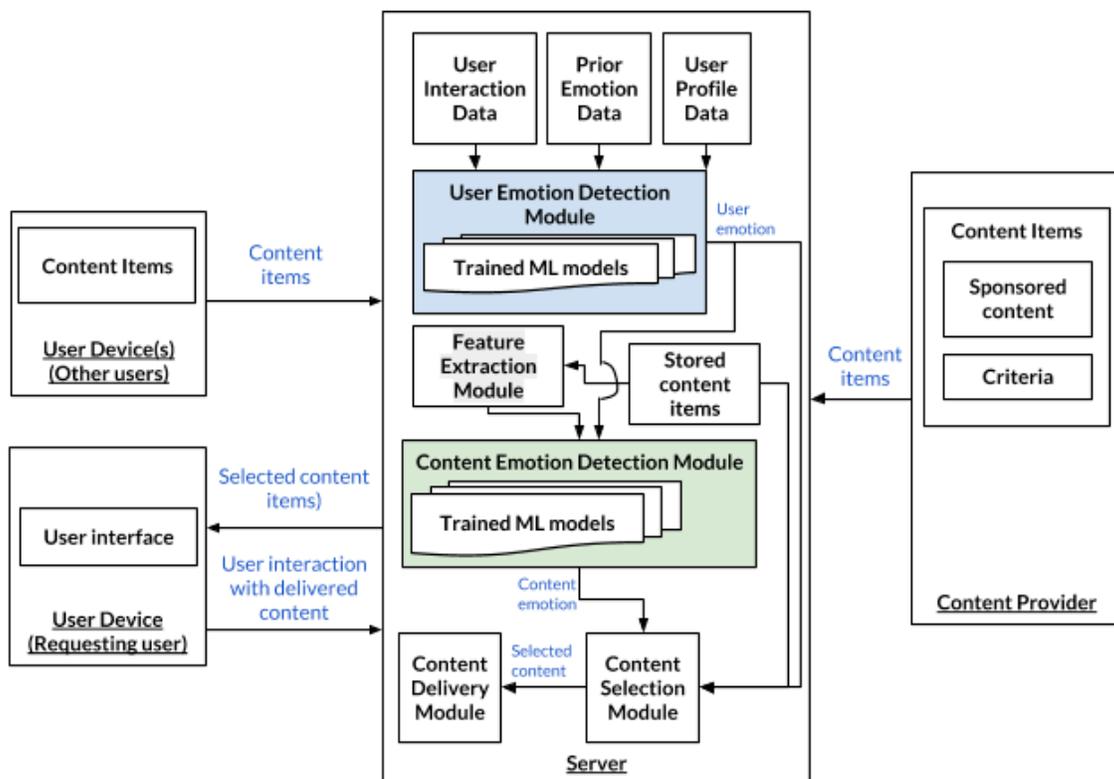
DESCRIPTION

Fig. 1: Delivering content based on user emotion and content-specific criteria

Fig. 1 is an illustration of an example environment for delivery of content items based on user emotion. Users access a server, e.g., a social networking provider, news website, media hosting website, etc., via a user device such as a computer, tablet, smartphone, wearable device, head mounted display, etc. In some instances, the access is two-way, users can receive content items from the server and also contribute content items such as images/videos, audio, text content such as documents, comments or online posts, etc. Users can also interact with the server by reacting to content items, e.g., as text comments or other feedback indicative of user emotions (e.g., via use of emojis, selections of icons that allows user to react to content, etc.)

Fig. 1 illustrates a user device associated with a requesting user that is requesting content items from the server and displays them on a user interface, and other user devices associated with other users, e.g., that contribute content items to the server. User interactions of the user device that consumes content with the server are stored by the server as user interaction data. While different user devices are shown in Fig. 1 as submitting content to and interacting with the server, the same user device can submit content to the server and receive content from the server.

Content items are also provided by content providers such as commercial content providers, audio or video producers, news outlets, blogs, online advertisers etc. Some content items, e.g., advertisements, sponsored posts, etc. may be deemed sponsored content. Content providers can pay for delivery of such sponsored content by the server to various user devices. Content items from such providers can also be associated with criteria that specify the users to which the content items are to be delivered, e.g., based on user demographics, interests, etc., and other contextual factors for delivery of content.

The server receives and stores content items ("stored content items") from user devices and content providers. The server can also fetch content items from providers as needed. The

server also stores user interaction data, prior emotion data, and user profile data. The server includes an emotion detection module that includes machine-learning models that are trained to detect user emotion based on the user interaction data, prior emotion data, and user profile data. User profile data can include demographic information, user activity related to prior content items provided by the server, user interaction with other users and content providers via the server such as chat, sharing content items, making purchases, checking-in at various locations, etc.

The user emotion detection module provides a detected emotion to a content selection module that accesses stored content items or retrieves content items from content providers along with associated criteria. The criteria can be provided by the content providers or can be determined by the server.

The content emotion detection module detects a content emotion associated with individual content items and provides it to the content selection module. The content emotion is assigned a score, e.g., a numerical score or other score. The content items received (and stored by the server) are provided to a feature extraction module that extracts features based on analyzing the content. The extracted features are provided to the content emotion detection module. The content emotion detection module includes trained machine-learning models that determine the emotion associated with the content ("content emotion") based on the features and provides it to the content selection module.

The content selection module matches the detected user emotion with the content emotion and the criteria associated with the content to select content items to be delivered to the user device of the requesting user. The content delivery module delivers the selected content items to user devices.

The ML models of the user emotion detection module and content emotion detection module can be implemented using any suitable machine learning techniques and algorithms, e.g., neural networks, Bayes classifiers, support vector machines, logistic regression, memory-based learning, decision trees, etc. Dimensionality reduction is performed, e.g., using linear discriminant analysis, principal component analysis, etc. to obtain a representative set of content features from the features extracted from content items. ML models used for content emotion detection are trained to predict the content emotion using feature vectors of features extracted from content items for which the content emotion is known, e.g., based on expert input.

Training can include positive and negative training examples. The training can be trained using supervised training (e.g., where labels representing content emotion are known for content items used for training). Model quality is evaluated using a set of content items in a validation set. The quality can be measured in terms of accuracy (a proportion of content items that the model accurately predicted content emotion for) and coverage (a proportion of the content items having a particular content emotion that were identified by the model). Models are trained both to predict content emotion for new content items, and to adjust content emotion for previously evaluated content items, e.g., based on user interactions with the content items such as an aggregate measure of the detected emotion of users in response to interacting with the content item. The aggregate measure can be weighted on sample size, e.g., the number of users over which the aggregate measure is calculated. Adjustments can include changing likelihood values, or strength of emotion values for a content emotion associated with a content item.
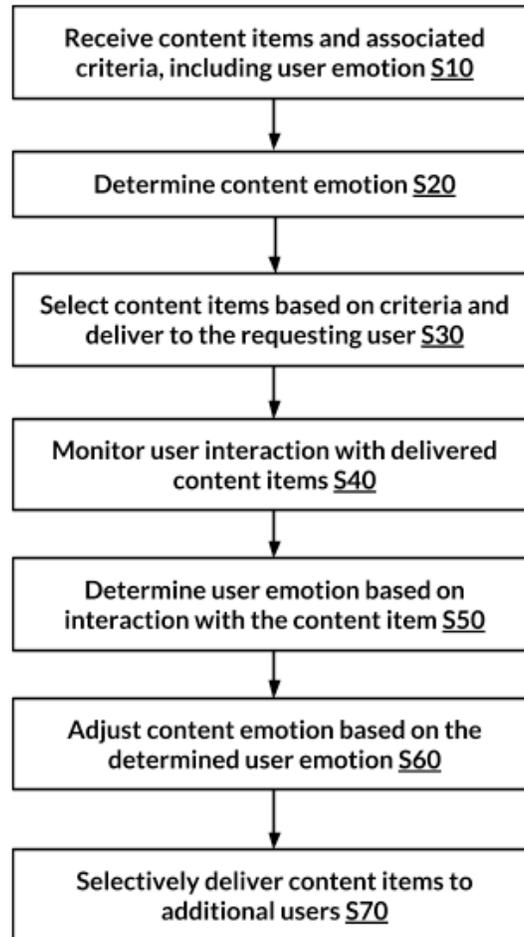
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┌─────────────────────────────────┐
│   Receive content items and associated │
│   criteria, including user emotion S10  │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Determine content emotion S20         │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Select content items based on criteria and │
│   deliver to the requesting user S30    │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Monitor user interaction with delivered │
│   content items S40                     │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Determine user emotion based on       │
│   interaction with the content item S50 │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Adjust content emotion based on the   │
│   determined user emotion S60           │
└─────────────────────────────────┘
              │
              ▼
┌─────────────────────────────────┐
│   Selectively deliver content items to  │
│   additional users S70                  │
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Fig. 2: Providing content to users and refining content emotion

An example process to selectively provide content to users and refining the content emotion associated with the content is illustrated in Fig. 2. At block S10, the server receives content items, e.g., from content providers and user devices. The server also (optionally) receives associated criteria for delivery of the content, e.g., a user emotion criteria. Block S10 is followed by block S20.

At block S20, the server determines a content emotion associated with the content items. For example, the server determines the content emotion by using one or more trained ML

models, as illustrated in Fig. 1. The received content items are first provided to a feature extraction module that extracts content features from individual content items.

The extracted features include, e.g., words or phrases that describe the content item. For example, the feature extraction module can implement object recognition techniques on image or video content to determine words or phrases descriptive of the content (e.g., "happy" when images include content such as birthday or wedding parties, or objects that indicate happiness, such as balloons; "relaxed" when images include content such as beach; based on images having bright colors or other image properties; etc.), extract keywords/terms from text content (e.g., words such as "enjoying," "feeling fantastic," "happy," etc.). The features can also be extracted from other material from the content provider, e.g., a content provider identity, a content provider profile or website, etc. and based on the content emotion associated with other content items from the content provider. The ML model(s) of the content emotion detection module are applied to the extract features to determine the content emotion.

When the content provider is a user, as depicted in Fig. 1, the content emotion can be further based on information regarding the user that provides the content, and the user interaction activity related to the user that provided the content. For example, content items from users that are associated with a detected emotion of "happy" at the time of providing the content item to the server can be associated with a content emotion "happy." The content emotion is associated with a content emotion score that is a numerical or other value. A content item can have a single content emotion with an associated score that indicates a level of the content emotion (e.g., "Funny, 10"), multiple content emotions with associated scores (e.g., "funny, 7," "humorous, 9"), etc. Further, the score can also indicate a likelihood that the content emotion is determined accurately, e.g., "contemplative: 70%," "sad: 50%," etc. Block S20 is followed by block S30.

At block S30, the content item is delivered to one or more users based on the criteria. For example, the content item is delivered to individual user devices as one of a group of content items that is organized in a sequence. The sequence can be a user-specific sequence. The content delivery module (or the content selection module) ranks multiple content items based on respective content emotion associated with each of the content items. The ranks are utilized in determining the sequence. Ranking of the content items can also take into account a current emotion of the user (prior to delivery of the content items), as determined by the user emotion detection module.

Delivering content items is based on criteria associated with the content items. For example, the criteria associated with a content item can include a content emotion score range associated with the content emotion and a user emotion score range associated with a current emotion of the user to whom the content item is being evaluated for delivery. The criteria specify that the content is to be delivered (or to be prohibited from delivery) to the user if the content emotion score is in the content emotion score range and if the current user emotion has a score within the user emotion score range. The criteria can be represented, e.g., as data elements that include content emotion, user emotion of the requesting user, and action to be performed, e.g., select for immediate or later delivery, or withhold from delivery. The criteria can include time periods, e.g., for which content items with certain emotion scores are not delivered to users with particular detection emotion.

Still further, criteria can also specify that content item with certain content emotion (e.g., "funny") not be delivered to users if the other content items delivered to users are associated with content emotion such as "funny" or "sad." Such criteria are based on, e.g., determining from user interaction data that users that were delivered multiple content items with the content emotion

"funny" or a combination of "funny" and "sad," experienced an unsatisfactory interaction with the server.

Further, the time at which content items are delivered to the user and the rate at which the content items are delivered to users (e.g., users with a certain detected emotion) is determined by the content delivery module. For example, the content delivery module restricts the delivery of content items to a certain number of users per time period based on the content emotion score. Different rates and/or times of delivery are chosen for the content items based on the type of content emotion attached with the content item, e.g., "happy," "excited," "celebratory," "humorous," "contemplative," "sad," etc. Thresholds of the number of users can be utilized for evaluating popularity of content items.

Still further, a level of popularity of the content item among users can be utilized by the content delivery module, e.g., to promote or restrict certain content items. Such level of popularity is determined based on user interaction data of prior users that received the content item, including a detected emotion of such users upon viewing the content item.

Content items that are identified for delivery are delivered to the user, e.g., via a browser or other application on the user device. The content items are delivered in the sorted order and can include additional information such as reactions of other users, e.g., associated with the requesting user via the server, e.g., social network friends, work colleagues, etc. and metadata associated with the content it, e.g., popularity of the content item. The sorted order presents multiple content items such that content items likely of interest to the requesting user are presented prominently, e.g., are associated with higher ranks and presented prior to earlier content items.

Presentation can be in the form of a web page, with the higher-ranking items placed near a top portion of the page; a sequential set of pages, or video/slideshow with the higher-ranking content items placed earlier in the sequence. Lower ranking items can also be presented in different portions of a user interface on the user device, e.g., in a sidebar, in a small widget, etc. Block S30 is followed by block S40.

At block S40, user interaction with the delivered content items is monitored. A user can interact with the delivered content items, e.g., view the delivered content items such as images, videos, text, etc. completely or partially, with an associated viewing time. A user can provide a user reaction to the content item, e.g., by providing a text comment, by providing an emoji, by selecting a user interface element that enables the user to provide the reaction, etc. Such user interactions are sent to the server, as illustrated in Fig. 1. The server stores the user interaction data. Block S40 is followed by block S50.

At block S50, the server determines user emotion in response to individual content items of the delivered content items. User emotion is determined based on the user interaction data from the monitored user interaction. The server utilizes the user emotion detection module to determine the user emotion. Different models of the trained ML models of the user emotion detection module correspond to different user groups. To detect the user emotion, the user emotion detection module selects a particular ML model based on user profile data, e.g., based on a user demographic group. The ML models are trained on training data, e.g., that is obtained based on expert input. Block S50 is followed by block S60.

At block S60, the server adjusts content emotion associated with the content. Such adjustments are based on user emotions of different users in response to the delivered content

items, as determined in block S50. For example, the server determines an aggregate based on the detected user emotion of the users (or a subset of the users) that received individual content items and uses the aggregate to adjust the content emotion associated with the content. The aggregate can be weighted by the number of users. For example, the content emotion can be adjusted to "humorous" from "funny." Or the score for "humorous" can be increased, if the detected emotion for the users corresponds in aggregate to "humorous" more than "funny." Such adjustment can provide a more accurate content emotion score based on the detected emotions of users that viewed a content item. Block S60 is followed by block S70.

At block S70, the content items are selectively delivered to other requesting users. Selection of the content items to deliver is performed by the content selection module as described above, using the adjusted content emotion. The method is repeated for different content items and requesting users. In each iteration, the content emotion associated with the content items is refined based on the user emotion in response to the content. Iterative refinement of the content emotion in this manner improves the user experience, since selection of content items for delivery is based on content emotion and also on how prior users reacted to the content.

CONCLUSION

Content items and associated criteria for delivery are received by a server from content provider. The server provides online services such as social networking, media hosting and sharing websites, news, etc. The server extracts content features from the content items using text extraction, image processing and other techniques. The server determines a content emotion associated with the content by applying trained machine-learning models. The server selects content items based on the content emotion, detected user emotion of a requesting user, and the criteria associated with different content items. Selected content items are delivered to a

requesting user in a ranked order. The server obtains user interaction data from interaction of the requesting user with the delivered content items and detects a user emotion based on the interaction data. The content emotion associated with the content item is adjusted based on an aggregate of the detected emotion of users that received the content item. The adjusted content emotion is used for evaluation of the content item to other users. The described techniques for selection and delivery of content items based on content emotion, and adjustment of the content emotion based on user interaction allow the server to deliver content items that have a high likelihood of providing a quality user experience. The described techniques improve engagement of the user with the online service provided by the server.