

## Codebook:

### Labeling sentiment and topics of user generated reviews on electric vehicle charging experience for supervised machine learning

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#### 1. Research Objectives:

The objective of this research is to train a machine learning model to identify the sentiment and the discussed topic from user generated text. The purpose of this codebook is to train raters to follow established rules for consistent ratings to achieve high inter-rater reliability.

#### 2. Labeling Tasks

##### Sentiment Labeling Task

- Identify whether the review presents negative or positive sentiment.
- The focus of the sentiment analysis is detecting negative sentiment, therefore if a review is not negative, then it should be labeled as positive.
- Negative Sentiment:
  - Notification of unavailability for successful charging
  - Expressing concerns
  - Any negativity overrides positivity
  - Examples:
    - *“Out of order”*
    - *“A non ev car parking in the lot. can't get to fast charger.”*
    - *“OUT OF SERVICE AGAIN! This station is a waste of time”*
    - *“Never lucky enough to get a spot to charge, someone’s always there. Good luck!”*
- Positive Sentiment:
  - *Explicit positives*
  - Non-negative information sharing (confusing ones)
    - *“They have three charging stations right by the entrance.”*
    - *“The other station is free now”*
    - *“Charged! When I called Blink CS before I traveled they said a tech had been here to fix this station, and I am happy to report it is!”*
    - *“Huge solar panels power this amazing station!!”*
    - *“Surprisingly not ICed at 5:45pm on a Tuesday. Stall2B seemed slow, delivering only 28 KW at 45% SOC .moved to 3A.”*

## Main Category Labeling Task

There are 9 categories to label, which are:

Topic	Subtopic
Functionality	General Functionality, Charger, Screen, Power Level, Connector Type, Card, Reader, Connection, Time, Error Message, Station, Mobile Application, Customer Service
Availability	# of Stations Available, ICE, General Congestion
User Interactions	Charger Etiquette, Anticipated Time Available, User Tips
Location	General Location, Directions, Staff, Amenities, Points of Interest, User Activity, Signage, Operation Hours
Cost	Parking, Charging, Payment
Range Anxiety	Trip, Range
Service Time	Charging Rate
Dealership	Dealership Charging Experience, Competing Brand Quality, Relationship with Dealers
Other	General Experiences

The labels for all the categories except for Others, are NOT mutually exclusive. Please select all the categories you think the review is discussing. However, Others category is mutually exclusive with the rest of the categories. If any of the Functionality, Availability, User Interactions, Location, Cost, Range Anxiety, Service Time, and Dealership categories are selected, Others should never be selected. When none of the 8 categories were selected, Others must be selected.

### Functionality Category

Functionality refers to comments describing whether or not particular features or services are working properly. Comments regarding station functionality are typically negative, as locations often face issues in any one of the given sub-categories above. If the charging capabilities of these charging stations are impaired in any way, users cannot achieve the goal of successfully charging their vehicles.

- **Functionality:**
  - Discussion on the following topics:
    - *General Functionality, Charger, Screen, Power Level, Connector Type, Card, Reader, Connection, Time, Error Message, Station, Mobile, Application, Customer Service*
  - Can identify whether the charger is working for the customer (counter examples will show under “Not Functionality” section)
    - *“charging now”, “great charging”*
    - *“charged”*
    - *“broken”*
    - *“could not charge”,*
    - *“I needed extra charging! Thanks”*
    - *“Charging my Zero S while here for monthly meeting of our electric car club. Wwww.eevc.info”*
  - Mention of charger type (connector\_type)

- J1772, CHAdeMO, Wall Outlet, CCS (SAE Combo), Tesla Supercharger, NEMA plug, Tesla Model S, Level 1 (L1), Level 2 (L2), DC Charger, Fast Charger, Quick Charger (QC)
  - *“Great friendly staff. Staff parks their cars in the two Tesla HPWC and one J1772 spaces to reserve these spots for EVs.”*
- Mention of charging station brands (not Dealership)
  - *EVgo, EVlink, Chargepoint, Blink, SuperCharger, SemaCharge, AeroVironment, Sun Country, GE WhattStation, Greenlots, Volta, CarCharging, Circuit Electique, Destination*
  - *“Charging was NOT free. Standard Blink rates applied.”*
  - *“Chargepoint card required.”*
  - *“Requires EVgo”*
  - *“Didn’t realize needed ChargePoint Card”*
- **Not Functionality:**
  - Cannot confirm the charger is working for the customer of the review
    - *“a charged car was parked there”*
    - *“a charged Nissan”*
    - *“Got here at opening time for Country Cafe. Very easy charge and location. Great spot for top-ups.”*
    - *“Spot was ICE'd. Guess I'll be level 2 charging for the next 2 hours in 17 degree weather to get home.”*
  - Limited operation due to accessibility
    - *“Not operable because the electricity is cutoff after 8pm”*
    - *“Could not charge because the dealership was closed”*
  - Does not specify the functionality issue
    - *“I hate coming here to charge. It is one of the worst places to charge. There is always an issue trying to charge here.” - Location*

## Availability Category

Availability refers to comments concerning whether chargers are available at a given station. Users often comment about how many other cars are charging and how many chargers are not in use. This is an important aspect of the electric vehicle owners’ experiences as they cannot successfully charge their vehicles without the availability of the chargers to do so. Users will also let the community know typical busy or slow times for certain chargers with phrases like “busy on Saturday night” or “all chargers available Sunday morning”.

- **Availability:**
  - Information on number of chargers and spots, on purpose to share the knowledge that helps estimate congestion
    - *“2 out of the 4 chargers were down”*
    - *“there are total of XX chargers”*
    - *“There are many spots”*
  - Information on occupation of charging spots
    - *“two spots are free now”*

- *“There is long line for the charger”*
  - *“busy on Saturday night”*
  - *“all chargers available Sunday morning”*
- Mention of on non-electric vehicle taking up EV charging parking spot
  - *“Ice” mentions – “ICED”, “Ice’d”, “Icing”, “ice”*
  - *“Charged here, very convenient for shopping at a Target, wish all of them had a station. The other spot was taken by a jack A\$\$ who owns an ICE Ford piece of junk, does not know how to read!!!”*
  - *“non-ev was blocking the spot”*
- Not Availability:
  - No specific information of number of spots or chargers
    - *“the left one worked, right one didn’t”*
    - *“one on far left and one on far right”*
  - Mention of specific location within charging space (See Location)
    - *“there is a spot at the right corner of the building”*
    - *“spot on the 2nd floor of the parking deck”*
  - Mention of the time when a space will be available (See User Interactions)
    - *“you can unplug me at 12pm”*
    - *“I will be leaving at 6pm”*

## **User Interaction Category**

User interaction refers to comments in which users are directly interacting with other vehicle owners in the community. This is a unique category in that users are conversing with or commenting to other users directly. Electric vehicle owners often refer to particular cars when asking to be plugged in or plugged out. This can also include questions being asked or user tips for a particular station or area.

- User Interaction:
  - Comments on charger use
    - *“1045 am charging for one hour with our jesla evse on way to quick charge in lancaster”*
    - *“Here for 1 hr 30 mins.”*
    - *“sorry gray volt and thanks for leaving a note allowing me to unplug you i’ll be sure to plug you in when i have enough charge to get home i was bone dry”*
    - *“topped up my (attended) volt for the trip home it’s so generous of mitsubishi to continue to open their chargers to the community however i noticed a silver volt owner leave their car and bike away not cool”*
    - *“all chargers on on both floors in use saturday aug 29 left notes for chargers on 5th floor to please plug me in when done thank you volt owner for doing that”*
    - *“charging”*
  - Seeking feedback or advise from others
    - *“i might take a risky drive this weekend from south burlington to rutland to try out this station if anyone can confirm anything about it being up and running that might save me a headache”*
    - *“thanks for the tips on using the blink app which i now have i also called blink to report the broken touch screen”*

- *"13 still down now 8 of 9 fast chargers on 101 corridor are down creating an easy valley ev charging crisis mechanic is scheduled now so i am waiting around to ask questions about why so many are down so long"*
- *"Can somebody post a photo of the new connector? I hope it's the new and improved V1.."*
- Giving feedback or advise to others
  - *"stephen you can use the greenlots app if you don't have a fob"*
  - *"we will be here for a couple of hours we used our blink incard & forgot to check the responsiveness of the touch screen no issues with the card though 😊"*
  - *"charged successfully but you need to wiggle and push in handle manually the lever is broken av is notified"*

## Location Category

Reviews that discuss general location information, directions, staff, description of amenities, point of interest, user activity while charging, signage, operating hours belong to this category. The location category refers to comments about various features or aspects specific to a particular charging station location. Users are interested in the amenities and features of the stations they visit before arriving there to charge. This community provides one another with helpful tips and tidbits about which locations have the best food, staff, or surrounding businesses. These reviews ensure users have the best knowledge about the stations at which they are charging their vehicles and ensure that users are most prepared for their charging experiences.

- **Location:**
  - Mention of specific location within charging place, on purpose to help other users find the charging spot
    - *"There is a spot at the right corner of the building"*
    - *"spot on the 2nd floor of the parking deck"*
  - Information about where the charging station is located: staff, amenities, user activities while charging, signage, operating hours
    - *"Not operational after 8pm. The electricity powers off."*
    - *"staff is friendly"*
    - *"the people are so nice here need a urgent charge they are just great people here"*
    - *Along with two others. Still 3 spots open! Two are labeled 45 min only.*
    - *the fast charger is not powered up, spent 9 hours with the dealership today L2 charging on both sides of a trip to N cal. staff is nice. got to talk a lot of the leaf. lots of miss information other in the sticks.*
    - *"Great spot"*
    - *"A very handy location! It's just In range of Fischer in Titusville. There are two chargers here BTW..."*
    - *"Charge station worked fine. Glad is at foot of mountain. My range anxiety went down a notch :)"*
    - *"Two hour limit stated on sign."*

- *We rented an Airstream trailer overnight here and they let us charge our Tesla Model S overnight for free. Great amenities, see their website. Easy walking distance to the Circus Circus Resort Casino.*
- *“Perfectly located. Came 70 miles from Rochdale. GOM still showed 37 miles when I got here. Brattleboro next.”*
- Discussing location and address of the charging station
  - *“address?”*
  - *“The GPS took me to a wrong place”*
  - *“This QuickCharger does seem like it's a Level 2.5. :) It may terminate charging prematurely, in which case you'll have to contact Greenlots to give you a free follow-up session. Also, the highway exits to and from this charger location are confusing with the one way streets and especially now with the construction. Go slow and follow signs, not necessarily your GPS.”*

## Cost Category

Reviews that discuss parking, charging fees and payment belong to Cost category. Pricing is another big concern in the electric vehicle community. The pricing category refers to comments about the amount of money required to park and/or charge at particular locations. The electric vehicle community is excited by free charging locations and readily shares praise surrounding the free locations.

- Cost:
  - Cost for charging
    - *“Charged for free”*
    - *“expensive”*
    - *“it is free”*
    - *“charging is complementary”*
    - *“valet park for parking charge”*
  - Cost for parking
    - *“charging is free, but you need to pay for parking”*
    - *\$12 to park and \$2.40/ hour to charge at my max 3.3kWh draw, def not cheaper to drive an EV. Wide adoption is a long way off if this keeps up.*
  - Overall cost that are required to charge
- Not Cost:
  - When “free” used as “available” in the context
    - *“there is a free spot”* - Availability

## Range Anxiety Category

Range anxiety refers to comments regarding EV users fear of running out of fuel mid-trip. Range confidence, therefore, refers to comments concerning routes and tactics of EV users confident in their vehicles ability to reach destinations of interest. Because EV charging stations are usually less common to find than traditional gas stations, this concern is one of the biggest barriers for wider EV adoptions. This category

entails user experiences related to their level of confidence in having sufficient amount of power before arrival at a destination.

- Range Anxiety:

- Mention of travel/trip
  - *"excellent stop on the way to atlanta charging at 28/hr"*
  - *"looked good hooked up and got the red alarm light evgo couldn't reset both chargers not working - again this station needs to be replaced it is a lemon and it is the first station coming up coast hwl"*
  - *"greenlots app reports "offline" need to use l3 sae for "ev" trip otherwise skipping columbus"*
  - *"rad on our way to leavenworth"*
  - *"return trip from manzanita via av dcqc at cannon beach 8 miles on gom @ lbw 33 & snowing over the pass charger worked great"*
- Mention of battery life
  - *"got 145mph of range with my tesla and the chdemo adapter they also have a j1772 level 2 charger and some 11v outlets ( but no nema 14-5 outlets)"*
  - *"went to a redwood symphony event at the theater this evening parked in upper lot and was delighted to see 4 schneider / chargepoint spots only 2 of the 4 were operational the left hand sides were both faulted cables plenty long to reach either side charge reached 100% about 20 minutes before i drove home thanks canada college and chargepoint"*
  - *"20% to 80% in 25 min on my leaf however unlike the other quick chargers that raise my battery temperature another bar up this one did not that's great for my long trip"*
  - *"thank you curtis consulting i am down to 1 bar 7 miles on the gom 10 miles and a big hill to home and hungry you saved us"*
- Mention of charge need
  - *"needed a boost in charge and found this place thank you fork lift central"*
  - *"working great what a lifesaver i thought i'd be trapped out here far away from home"*
  - *"scanned card and screen blipped out stranded in seattle"*

## **Service Time Category**

The service time category refers to comments reporting charging rates experienced in a session. These comments typically consist of only the statistics given in unites of mileage or kilowatts per hours. Other units would include mentioning voltage or charging speed achieved (e.g. fast charge).

- Service Time:

- Mention of charging speed
  - *"slow charge" / "charged very fast"*
  - *"Reached 50miles in 10 minutes"*
  - *"Charging at 30mi/hr"*
- Mention of voltage
  - *"198V at 30A"*

- Mention of electrical power, current
  - *“90KW on far left”*
  - *“Peak charging power: 30amps”*
  - *“No ICE issues. One other model S at the 50A station, other two were open”*
- **Not Service Time:**
  - No specific mention of the charging speed
    - *“I charged here for 10 mins and left”* - Functionality
  - Mention of service hours of the charging station
    - *“plugs only on during business hours they are free although they salespeople will try to 'trade u outta' your car lol”* - Location
  - Mention of limited use time
    - *“along with two others still 3 spots open two are labeled 45 min only”* - Availability, Location

## Dealership Category

The dealerships category refers to comments concerning specific dealerships and user’s associated charging experiences. These comments serve an important source of information regarding a major stakeholder relationship influential to electric vehicle policy making. Electric vehicle owners’ feelings in this subcategory are largely determined by the different dealerships’ accessibility regarding public charging.

- **Dealership:**
  - Mention of car names and brands
    - Leaf (Nissan), I3 (BMW), Tesla Model S, Volt (Chevrolet), 500e (Fiat), Spark (Chevrolet), C-max Energi (Ford), Fusion Energi (Ford), Prius (Toyota), RAV4 EV (Toyota), Soul (Kia)
    - *“quick charge working great salesman came out and turned it on for us as we aren't in the network thanks magic Nissan”*
    - *“first time i have seen a full house at the palm street parking garage three chevy volts and one nissan leaf”*
    - *“saw the silver volt in the right side spot i think he/she just wants that spot not really needed to charge sad”*
    - *“great to see a tesla s visiting the car show at the hotel”*
  - Dealership charging experience
    - *“on left side of building friendly Nissan dealer”*
  - Competing brand quality
    - *“These Nissan chargers really suck balls. Temp error and the guard is in control of the breaker. making me wait 20 minutes before he'll turn the power back on. Really wishing I had a Tesla right about now”*
  - Relationship with the dealers
    - *“thank you very nice dealership”*
  - Mention of dealers
    - *“Car dealers please note: new drivers should get a lesson on how to use these chargers as they are not intuitive and new drivers have broken the connectors”*



*previously at some of the stations because nobody has shown them how to use these connectors.”*

- *“very easy to find charging stations are by the front doors of the dealership”*
- *“chademo is still free but requires a chargepoint card if you don't have one the dealer will use theirs for your charging session”*

- **Not Dealership**

- No specific mention of the car name or brands, or the word “dealer”
  - *“awesome little store and chris is super nice and friendly”* - more like Location (staff)

### **Multi-label Examples**

*“This QuickCharger does seem like it's a Level 2.5. :) It may terminate charging prematurely, in which case you'll have to contact Greenlots to give you a free follow-up session. Also, the highway exits to and from this charger location are confusing with the one way streets and especially now with the construction. Go slow and follow signs, not necessarily your GPS.”*

- Functionality – mention of charger type (QuickCharger) and network (Greenlots)
- Service Time – mention of charging speed (*QuickCharger does seem like it's a Level 2.5, terminate charging prematurely*)
- Location – mention of location (*highway exits to and from this charger location are confusing*)
- User Interaction – giving advice to other users (*Go slow and follow signs, not necessarily your GPS*)