COP5725 - Database Management Systems

Project Deliverable 2: Weather Recording System

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Contents

1 Quality of the overview and description of the application

Weather and climate are important factors that determine the normal operation of all sectors of society. Weather usually describes the atmospheric conditions at a certain point or period of time, such as temperature, precipitation, humidity, wind, and ultraviolet index. Weather data is very important in our daily lives. People change their clothes and daily travel plans according to changes in weather and climate. The collected precipitation and temperature data can be used to prevent natural disasters or disasters such as floods and droughts. In addition, weather and climate play a decisive role in agriculture and aviation. For example, weather conditions determine whether an aircraft can take off on time and which route is the safest and safest to choose. At the same time, the construction industry also needs weather data to arrange construction plans and programs. The long-term collection of weather data is of great significance for summarizing the meteorological conditions of the region and predicting the climate change trend in the region.

Nowadays, there are many ways to collect weather data, from large weather radars to small weather stations, which are recording weather data all the time. In view of the importance of weather data, how to properly process and utilize these data has become an important topic. However, using paper data to record and analyze weather data is very cumbersome, inefficient, and unreliable. In addition, the paper-based data recording method is not convenient for storage and quick query. Therefore, we use the Oracle database to design a Weather Recording System.

With the help of a web-based user interface, the system can store these large amounts of weather data in a structured manner and display these data publicly. For different users, you can use this system to operate on weather data according to different needs. In addition, the administrator can also update the data. This database system makes it possible to store a large amount of weather data with high security and long-term storage and at the same time improve the ease of use of the data.

Here is the descripton of the system. The weather recording system needs users to sign up or login to the system. Our system also has an administrator accout to manage users. To the fuctions that showing the data: firstly, Our system will show the basic weather data like temperature, precipitation and so on in the form of table, and users could choose the time period as well as the cities to get the data they want. The second function is that users can know about the information of the weather stations and cities from which our system get the weather data from. What's more, we have five interesting and complex trend queries which will be described in detail in section 2. Users will get the information that is derived from the basic data to be showed in different kinds of charts, for example, they can learn about the change of temperature over a long time period or compare the precipitation at different cities during the same year.

2 Quality of the user interface design including the application-specific network or graph of web pages and the integration of the complex trend queries

2.1 Design of the application-specific network

The system is started from the web page of login, which is showed in the Figure 1. Then, we have three different conditions. The first is when the account that entered is administrator, the system will go to the page that is particularly designed for the administrator to manage all the user. At userManage page, the administrator can delete user, modify user information (Administrator is not allowed to change user's password) or check out the statistics of the number of new user. The second condition is that when the user needs to sign up and create a new account, the system will be directed to the page which is designed for creating new account. At this page, the user only need to enter username and password to create a new account, and after the creation, the web page will direct to the welcome page automatically. The third condition is the most common condition, the user login with his/her username and password correctly, then they will see the welcome page. We currently decide to use the temperature data form of basic data to be the welcome page of out system. The welcome page has several fuctions, users can get to the basic data page, station information page, city information page and trend queries page. Exactly, we are going to put all these parts in a side-menu, so that the users can get to each part from every page. What's more, users can also click on the sign of head portrait and go to the userInfo page at which users could change their names and passwords. After making sure to change, the administrator will get the notice of change.

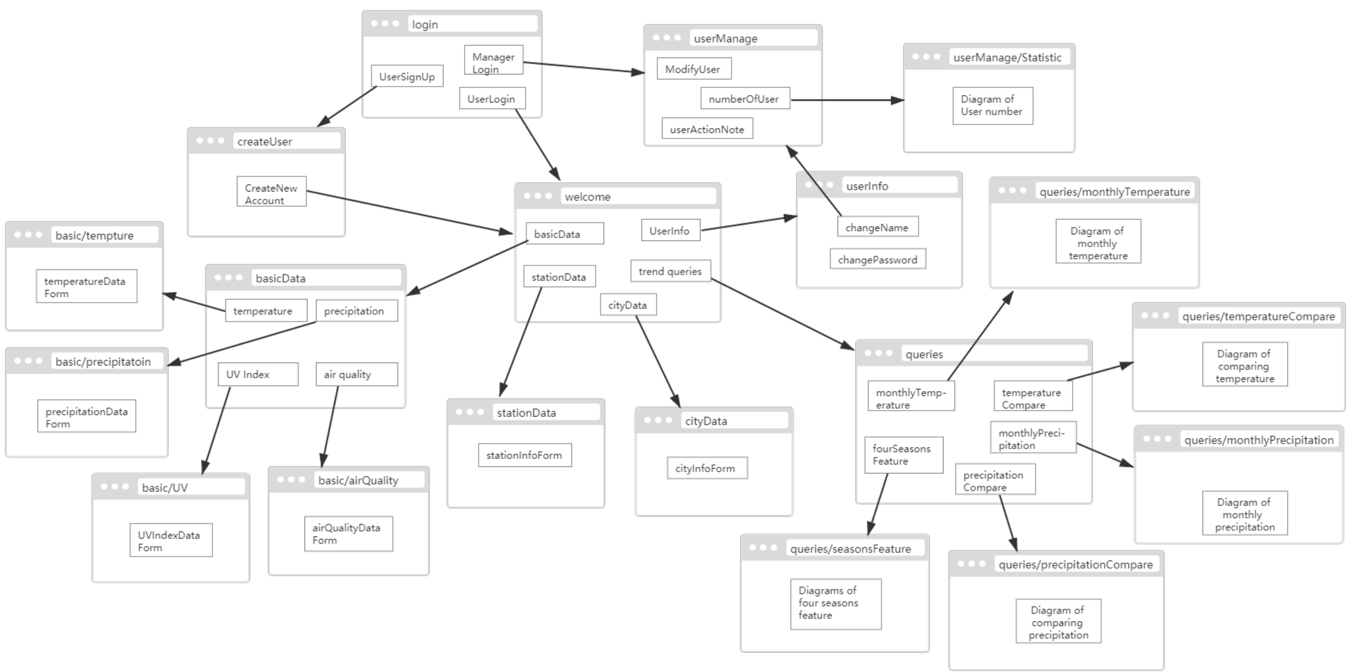

Figure 1: application-specific network

2.2 Design of each web page

Users and administrators enter their username and password to log in to the weather recording system.

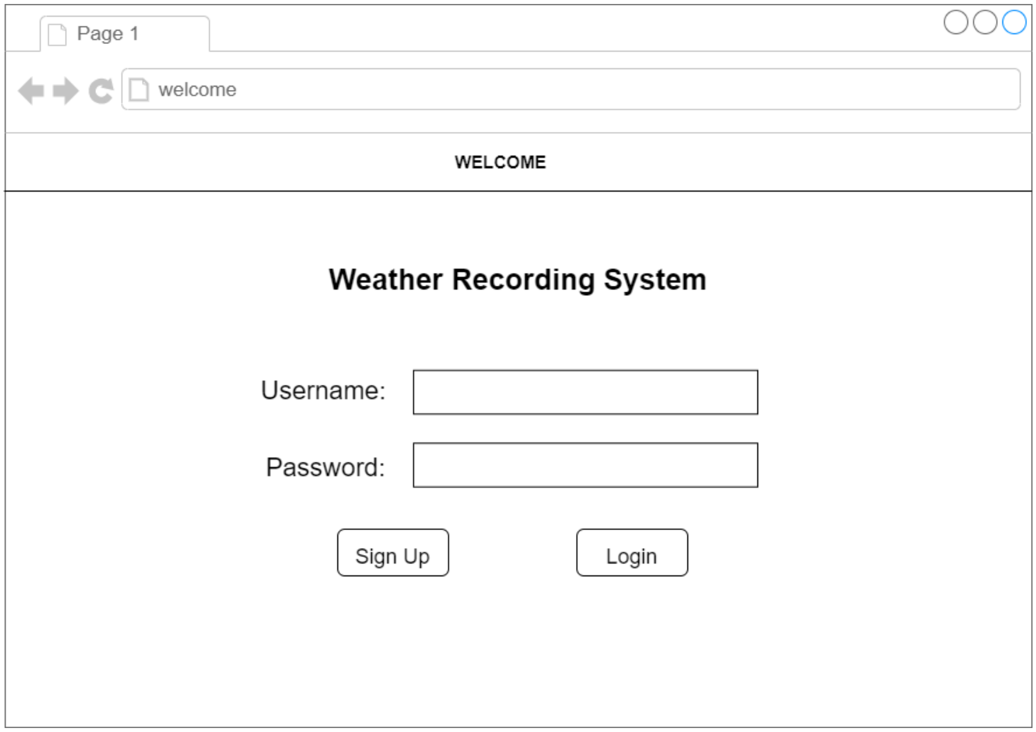

Figure 2: Login

After logging into the account, the administrator can receive messages from users, thus adding and modifying user information. To facilitate the operation, the administrator can use the complex query function for user information.

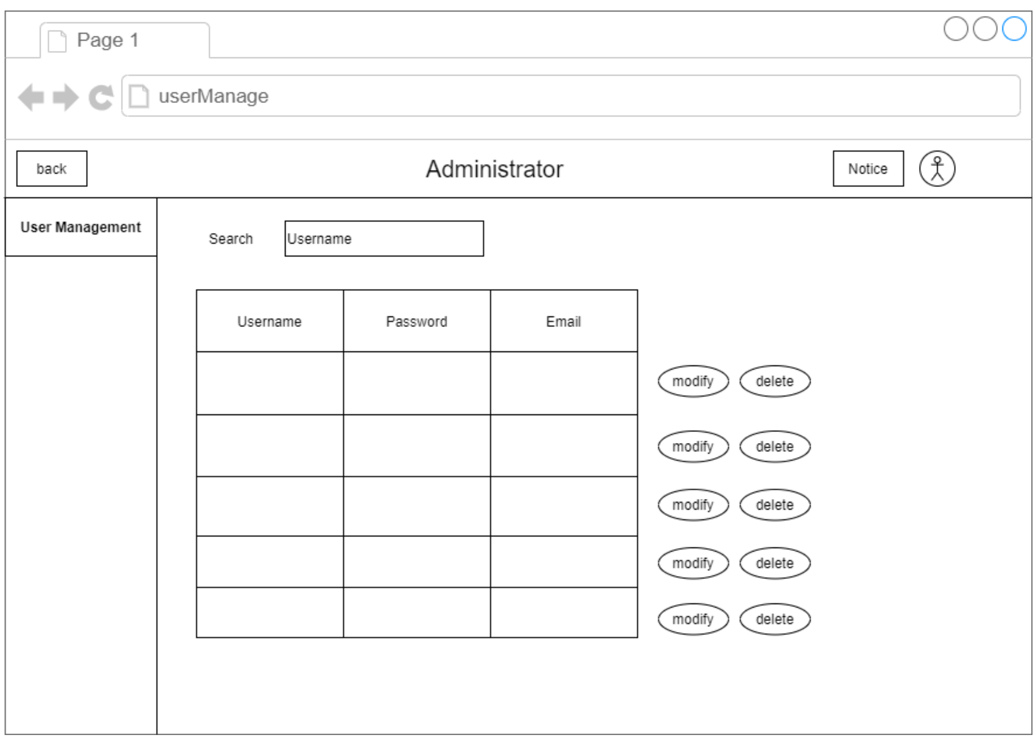

Figure 3: User Manage

If the user does not have an account, click the 'Sign Up' button. Jump to the registration page, and enter the username, password and email to sign up.

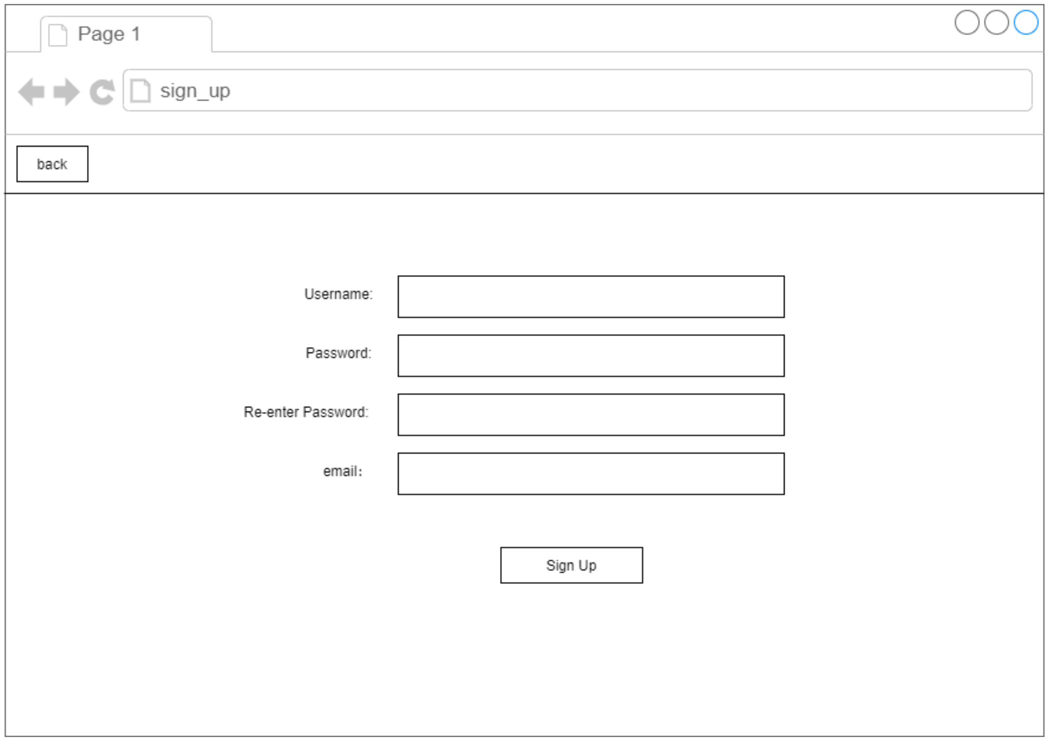

Figure 4: Sign Up

The administrator can choose the from time and to time, then the diagram will show the number of new users who sign up to the system over the time period.

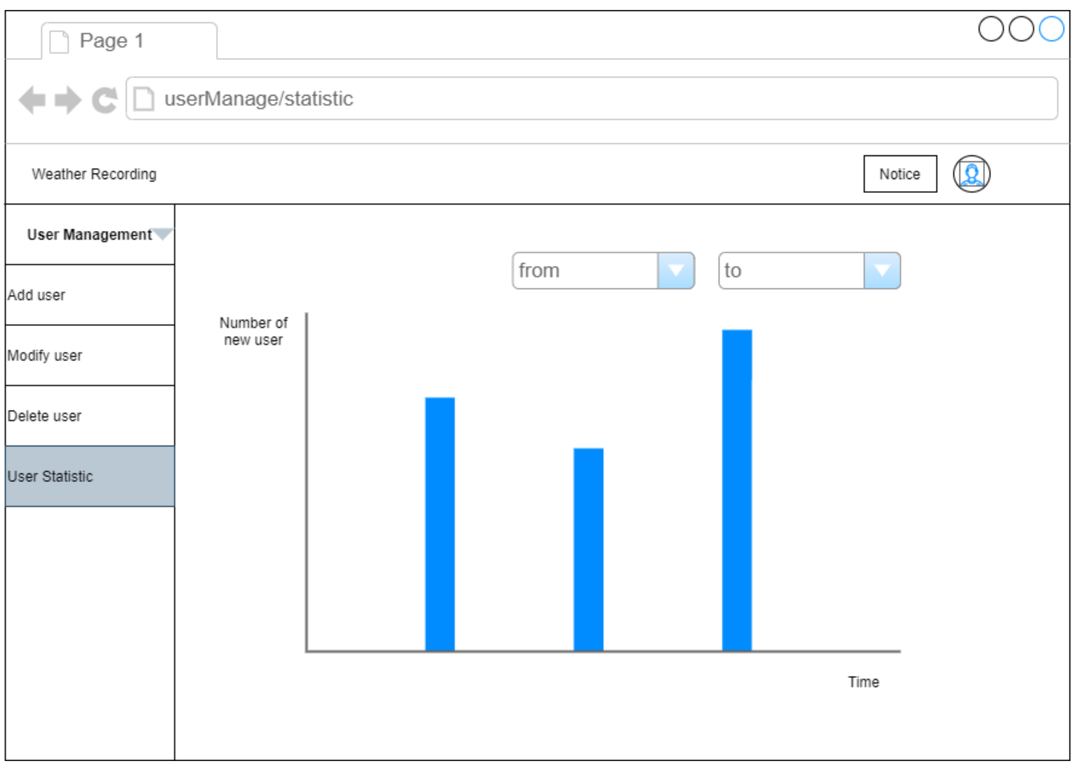

Figure 5: userManage/statistic

After clicking the sign of head portrait, the users can go to the page of userInfo and change their name and password. They could also go back by clicking the back button.

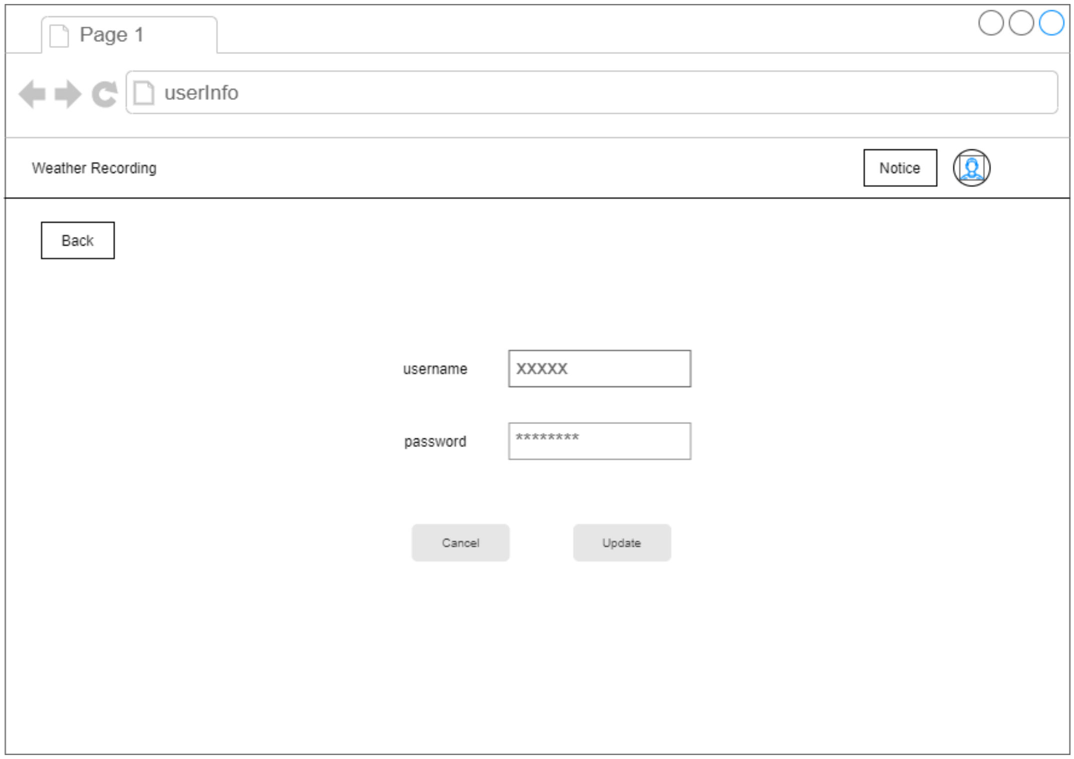

Figure 6: userInfo

The web page of temperature data of basic data part, which is also the welcome page of the system. We will show the default data in the form, and the users can choose the from and to time as well as cities to get the data they want. The system also support keyword search.

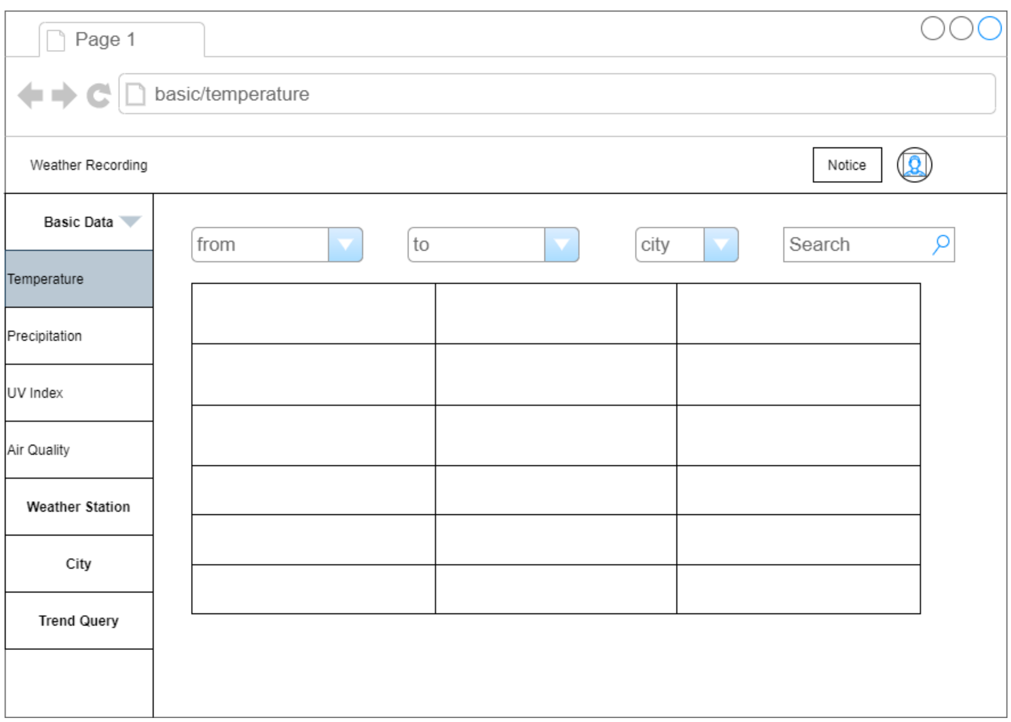

Figure 7: basic/temperature

The other part of basic data, precipitation data, UV Index data and air quality data, their web pages look almost same as the temperature data, so we are not going to show these pages in detail.

The station information web page can tell users about information of the weather stations from which we get the weather records.

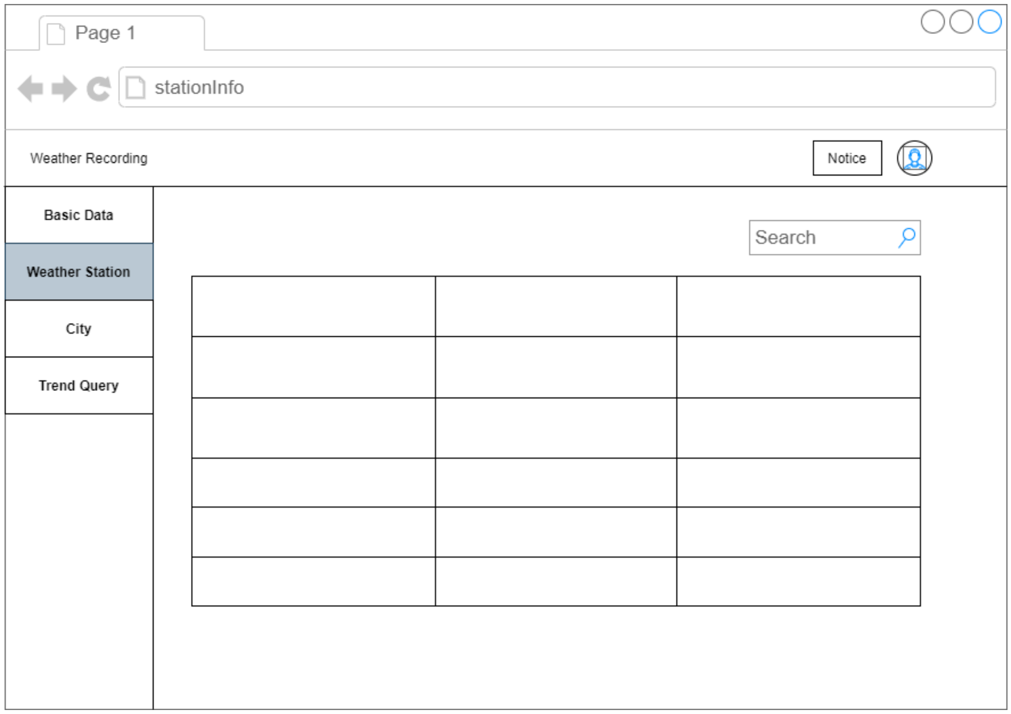

Figure 8: stationInfo

The city information web page can tell users about information of the cities from which we get the weather records.

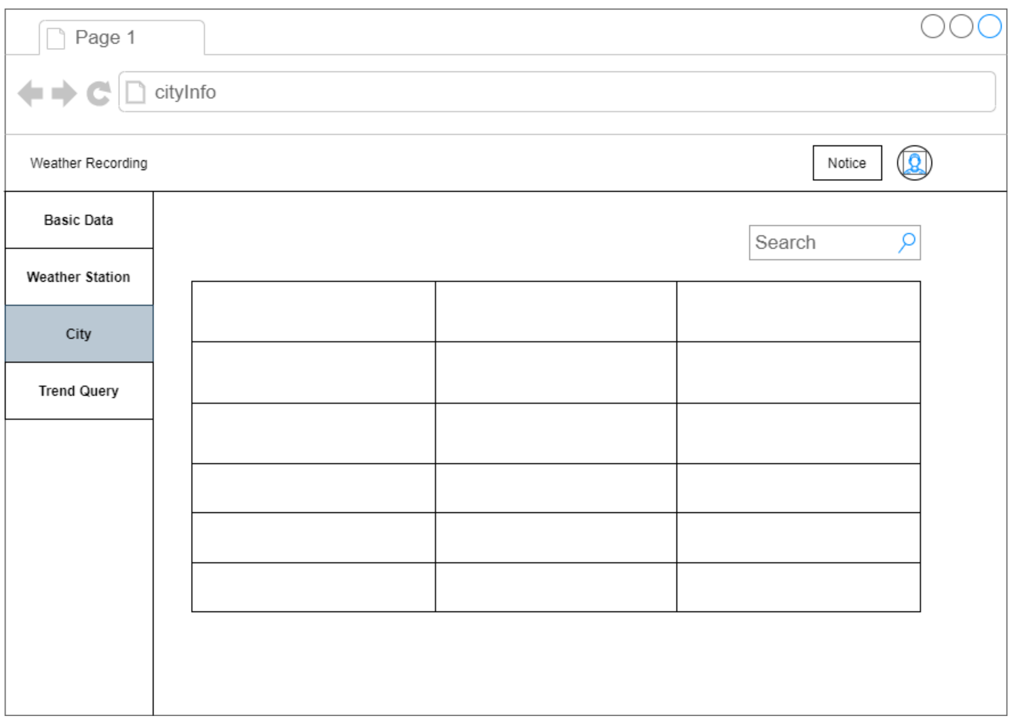

Figure 9: cityInfo

The Trend of Monthly Temperature web page is going to use the line chart to show the derived data of the basic data of temperature. User could choose from time and to time, which are all at the month time granularity. Users can also choose the certain weather station to get the data of the station. Users could figure out the changing of monthly temperature over the time period.

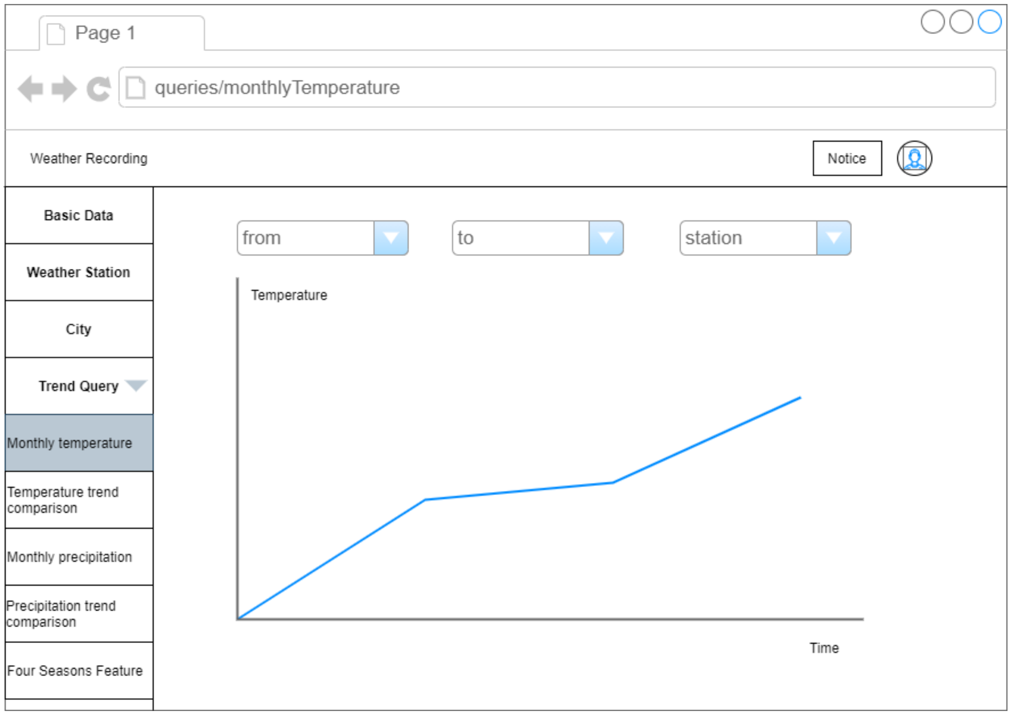

Figure 10: Monthly Temperature

The Trend of Temperature Comparison web page is going to use the line chart to show the difference of temperature between different cities. User could choose the certain year, and they can choose the cities they want to compare. Users could compare the temperature between several cities in the same year.

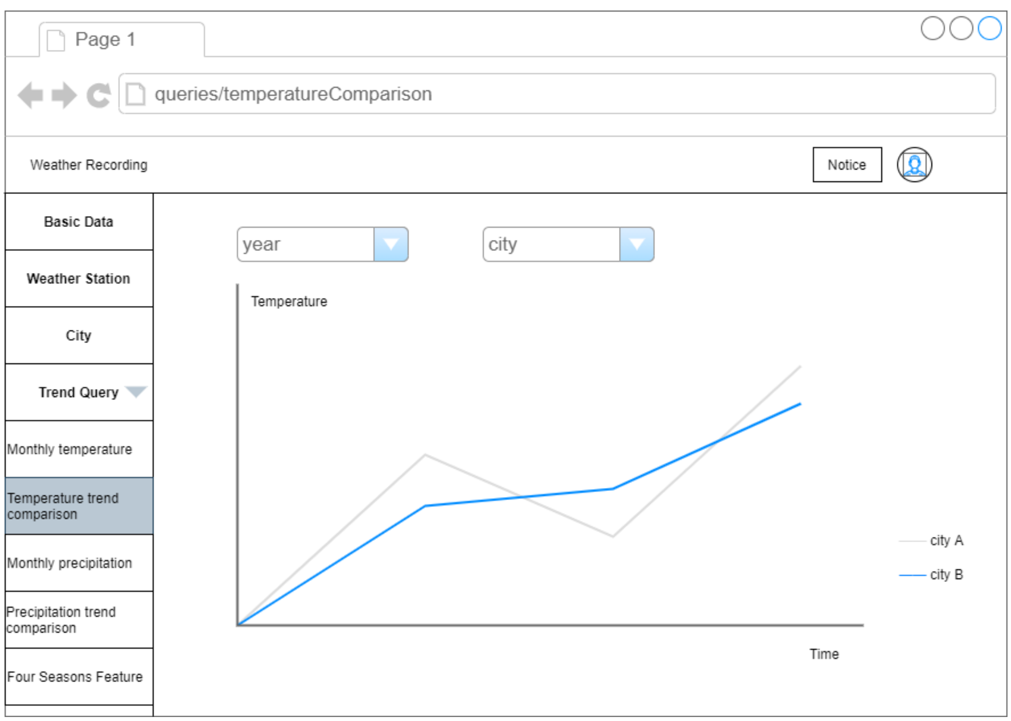

Figure 11: Temperature Compare

The Trend of Precipitation web page is going to use a bar chart to show the derived data of the basic data of precipitation. User could choose from time and to time, which are all at the month time granularity. Users can also choose the certain weather station to get the data of the station. Users could figure out the changing of monthly precipitation over the time period.

Figure 12: Monthly Precipitation

The Trend of Precipitation Comparison web page is going to use the line chart to show the difference of precipitation between different cities. User could choose the certain year, and they can choose the cities they want to compare. Users could compare the precipitation between several cities in the same year.

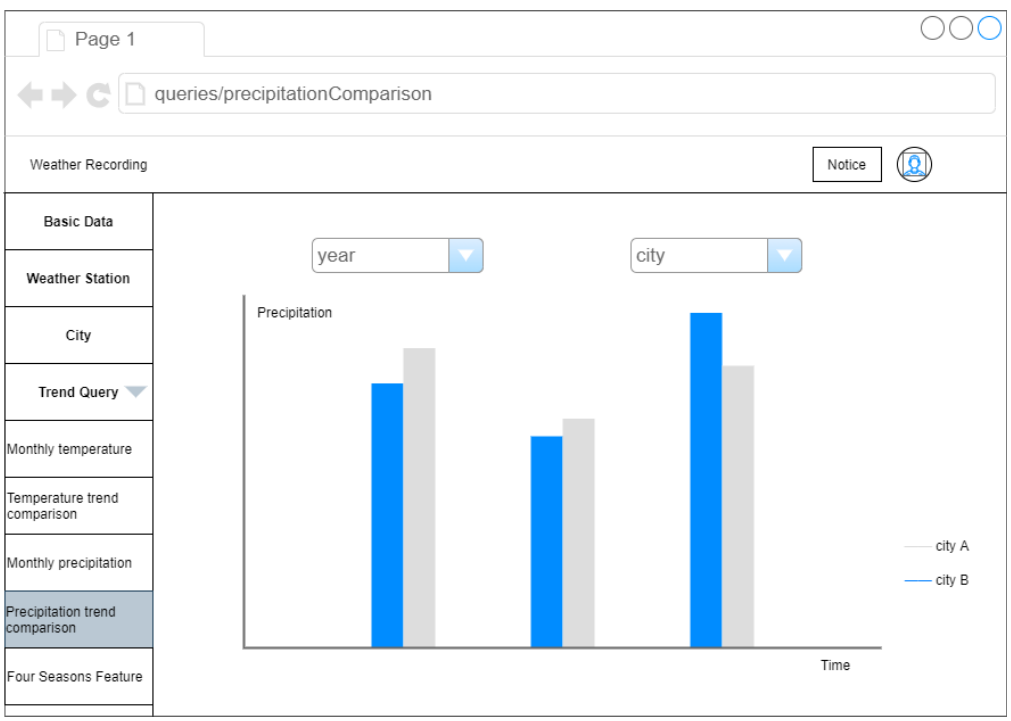

Figure 13: Precipitation Compare

The Trend of Four Seasons Feature web page is going to use two chart to figure out the features of four seasons of the city by showing temperature and precipitation of one year. User could choose the certain year, and they can choose only one city they want to know.

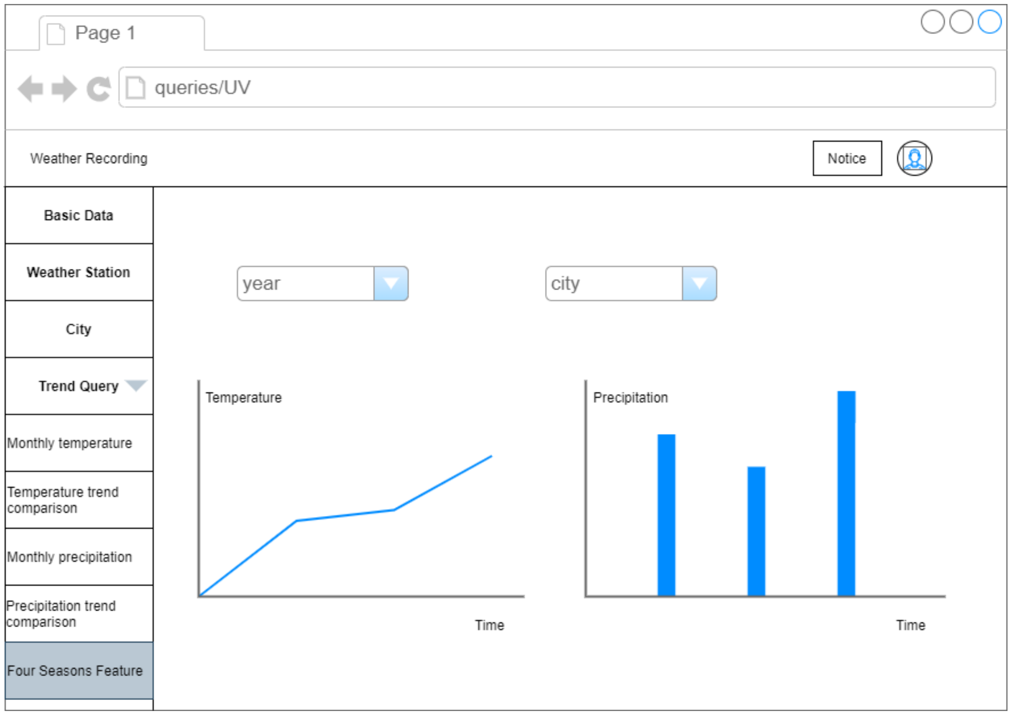

Figure 14: Seasons Feature

2.3 Complex trend queries

2.3.1 Trend of Monthly Temperature

Description
Users could learn about the trend of temperature change at different cities from our system. Users can choose the time period from one month to another month, they also need to choose one city to show the data. For example, users have to choose a time from '2020/08' to '2021/08', and the city 'Gainesville'. Then, the system will calculate the monthly average temperature of Gainesville from '2020/08' to '2021/08' according to the data sets. So, In the line chart, the x-axis is month and the y-axis is average temperature(Monthly).

Integration into the web pages
The integration into the web page of Monthly Temperature is showed in Figure 10, the system provides the line chart to help user learn the temperature change.

Output
The output of the Monthly Temperature query is data that contains time of month and the average temperature of the month.

2.3.2 Trend of Temperature Comparison

Description
Users could learn about the trend of temperature comparison between different cities from our system. Users can choose the year which they are concerned with, and they also need to choose at least two cities so that they could show the difference. For example, users will choose year 2020, then choose the city 'Gainesville' and 'Miami'. Then, the system will show two lines in the line chart and each curve is built by the average monthly temperature according to the data sets. So, In the line chart, the x-axis is month and the y-axis is average temperature(Monthly), but there are more than one lines.

Integration into the web pages
The integration into the web page of Temperature Comparison is showed in Figure 11, the system provides the line chart to help user learn the camparison of different cities.

Output
The output of the Temperature Comparison query is the data that contains city, time of month and the average temperature of the month over the choosen year.

2.3.3 Trend of Monthly Precipitation

Description
Users could learn about the trend of precipitation change at different cities from our system. Users can choose the time period from one month to another month, they also need to choose one city to show the data. For example, users have to choose a time from '2020/01' to '2020/12', and the city 'Tanpa'. Then, the system will calculate the monthly average temperature of Tanpa from '2020/01' to '2020/12' according to the data sets. So, In the bar chart, the x-axis is month and the y-axis is average precipitation(Monthly).

Integration into the web pages
The integration into the web page of Monthly Precipitation is showed in Figure 12, the system provides the bar chart to help user learn the precipitation situation.

Output
The output of the Monthly Precipitation query is data that contains time of month and the average precipitation of the month.

2.3.4 Trend of Precipitation Comparison

Description
Users could learn about the trend of precipitation comparison between different cities from our system. Users can choose the year which they are concerned with, and they also need to choose at least two cities so that they could show the difference. For example, users will choose year 2019, then choose the city 'Tanpa' and 'Miami'. Then, the system will show two different color bars in the bar chart and each bar is built by the average monthly precipitation according to the data sets. So, In the bar chart, the x-axis is month and the y-axis is average precipitation(Monthly), but there are different colors of bars.

Integration into the web pages
The integration into the web page of Precipitation Comparison is showed in Figure 13, the system provides the line chart to help user learn the difference between precipitation of different cities.

Output
The output of the Precipitation Comparison query is the data that contains city, time of month and the average precipitation of the month over the choosen year.

2.3.5 Trend of Seasons Feature

Description
Users could learn about the Seasons Feature at different cities from our system. Users can choose the certain year as well as the city to show the data. For example, users have to choose the year 2020, and the city 'Gainesville'. Then, the system will show two charts, one is the temperature chart and the other is precipitation chart. The user could figure out from the charts about whether the city has four distinctive seasons, or belongs to tropical climate.

Integration into the web pages
The integration into the web page of Seasons Feature is showed in Figure 14, the system combine two charts to help user learn the feature of the seasons of the certain city.

Output
The output of the Seasons Feature query is the data that contains two parts. The first part is the data of daily average temperature of the choosen year in order to show a curve of the temperature change, and the second part of the data is the average precipitation of each month during the year.

3 Quality of the conceptual database design based on the Entity-Relationship Model and a careful analysis of the deployed data sources

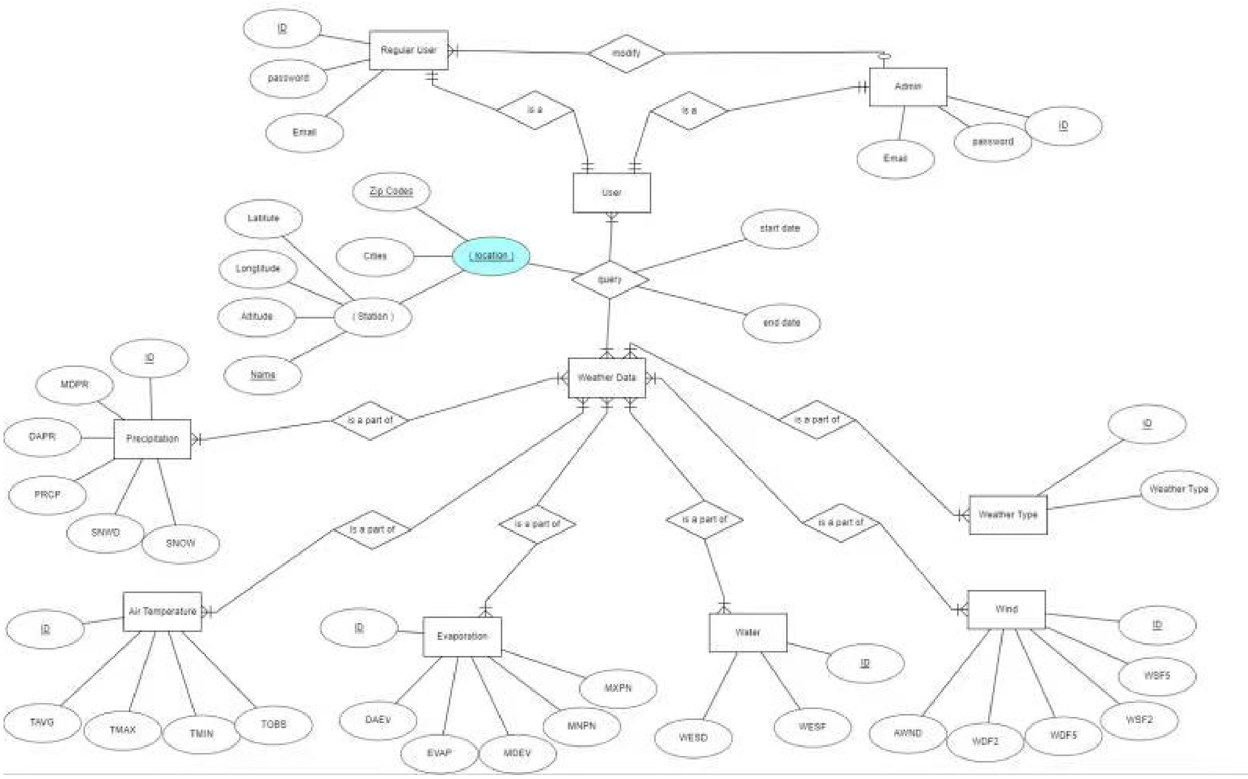

Figure 15: ER-Diagram

According to the overall design of the system and the functional modules described above, we selected daily weather data from multiple cities from NOAA.gov. We selected a large number of data files based on the city name to construct the database to be used in the system. The data is selected by selecting cities, time periods and statistical methods. In this data set, the historical weather data of each city comes from weather stations in different locations in the city. For each weather station, it is determined by its name, and a detailed geographic location consisting of latitude, longitude and altitude. The data file composition of each city is roughly the same. According to our classification of entities, weather data can be classified into evaporation, precipitation, wind, air temperature, water, and weather types.

Evaporation, which often used in meteorology to compare with precipitation. The comparative data is important to illustrate how dry and wet a place is. It includes attributes such as Daily maximum temperature of water in an evaporation pan (MXPN), Daily minimum temperature of water in an evaporation pan (MNPN), and Evaporation of water from evaporation pan (EVAP). The units of MXPN and MNPN are degrees Fahrenheit, and the unit of EVAP is inches.

Precipitation refers to the depth of liquid or solid (melted) water that falls from the sky to the ground within a certain period of time, without evaporation, infiltration, or loss, but the depth that it accumulates on the horizontal surface. It includes the commonly used Multiday precipitation total (use with DAPR and DWPR, if available) (MDPR), Number of days included in the multiday precipitation total (MDPR) (DAPR), Precipitation (PRCP), Snow depth (SNWD), Snowfall (SNOW). The units of PRCP, SNWD and SNOW are all inches.

Wind includes attributes like Average wind speed (AWND), Direction of fastest 2-minute wind (WDF2), Direction of fastest 5-second wind (WDF5), Fastest 2-minute wind speed (WSF2), Fastest 5-second wind speed (WSF5). The units of AWND, WSF2 and WSF5 are miles per hour, and the units of WDF2 and

WDF5 are degrees.

Air temperature is composed of Average Temperature. (TAVG), Maximum temperature (TMAX), Minimum temperature (TMIN), Temperature at the time of observation (TOBS). Their units are all degrees Fahrenheit. In addition, we can easily calculate the temperature difference through TMAX and TMIN, which can be used as a derived attribute.

Water is mainly described by Water equivalent of snow on the ground (WESD), Water equivalent of snowfall (WESF), in inches.

The '**' in Weather types (WT**) consists of several fixed values, and each value represents a different weather type. For details, please refer to the table below.

Value	Weather Type
01	Fog, ice fog, or freezing fog (may include heavy fog)
02	Heavy fog or heaving freezing fog (not always distinguished from fog)
03	Thunder
04	Ice pellets, sleet, snow pellets, or small hail
05	Hail (may include small hail)
06	Glaze or rime
07	Dust, volcanic ash, blowing dust, blowing sand, or blowing obstruction
08	Smoke or haze
09	Blowing or drifting snow
10	Tornado, waterspout, or funnel cloud
11	High or damaging winds
12	Blowing spray
13	Mist
14	Drizzle
15	Freezing drizzle
16	Rain (may include freezing rain, drizzle, and freezing drizzle)
17	Freezing rain
18	Snow, snow pellets, snow grains, or ice crystals
19	Unknown source of precipitation
20	Ground fog
21	Fog, ice fog, or freezing fog (may include heavy fog)

Select the weather data of Miami from October 1, 2020 to September 30, 2021 as a sample to show. The details are shown in the figure below.

```
          STATION                                 NAME  LATITUDE  LONGITUDE  \
5923  USW00012839  MIAMI INTERNATIONAL AIRPORT, FL US   25.7881   -80.3169
5924  USW00012839  MIAMI INTERNATIONAL AIRPORT, FL US   25.7881   -80.3169
5925  USW00012839  MIAMI INTERNATIONAL AIRPORT, FL US   25.7881   -80.3169
5926  USW00012839  MIAMI INTERNATIONAL AIRPORT, FL US   25.7881   -80.3169
5927  USW00012839  MIAMI INTERNATIONAL AIRPORT, FL US   25.7881   -80.3169
5928  USW00012839  MIAMI INTERNATIONAL AIRPORT, FL US   25.7881   -80.3169

      ELEVATION        DATE  AWND  DAPR  EVAP  MDPR  ...  WDMV  WESF  WSF2  \
5923        8.8  2021-09-04  2.46   NaN   NaN   NaN  ...   NaN   NaN  23.9
5924        8.8  2021-09-05  2.91   NaN   NaN   NaN  ...   NaN   NaN  14.1
5925        8.8  2021-09-06  3.13   NaN   NaN   NaN  ...   NaN   NaN  14.1
5926        8.8  2021-09-07  2.68   NaN   NaN   NaN  ...   NaN   NaN  14.1
5927        8.8  2021-09-08  2.46   NaN   NaN   NaN  ...   NaN   NaN  16.1
5928        8.8  2021-09-09  3.80   NaN   NaN   NaN  ...   NaN   NaN  18.1

      WSF5  WT01  WT02  WT03  WT08  WT09  WT11
5923  32.0   1.0   NaN   1.0   NaN   NaN   NaN
5924  19.0   NaN   NaN   1.0   NaN   NaN   NaN
5925  21.9   NaN   NaN   1.0   1.0   NaN   NaN
5926  19.9   NaN   NaN   1.0   NaN   NaN   NaN
5927  19.9   NaN   NaN   1.0   NaN   NaN   NaN
5928  21.0   NaN   NaN   1.0   NaN   NaN   NaN

[6 rows x 32 columns]
```

Figure 16:

Using tools such as pandas and numpy to conduct a simple analysis on this data set. It shows same basic information about the data set. Based on the data analysis, the required information can be used in subsequent specific implementations to enrich functions and optimize user experience.

```
RangeIndex: 9544 entries, 0 to 9543
Data columns (total 32 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   STATION    9544 non-null   object
 1   NAME       9544 non-null   object
 2   LATITUDE   9544 non-null   float64
 3   LONGITUDE  9544 non-null   float64
 4   ELEVATION  9544 non-null   float64
 5   DATE       9544 non-null   object
 6   AWND       1093 non-null   float64
 7   DAPR       94 non-null     float64
 8   EVAP       276 non-null    float64
 9   MDPR       94 non-null     float64
 10  MNPN       258 non-null    float64
 11  MXPN       257 non-null    float64
 12  PGTM       0 non-null      float64
 13  PRCP       9439 non-null   float64
 14  SNOW       3633 non-null   float64
 15  SNWD       349 non-null    float64
 16  TAVG       365 non-null    float64
 17  TMAX       2640 non-null   float64
 18  TMIN       2724 non-null   float64
 19  TOBS       1640 non-null   float64
 20  WDF2       1093 non-null   float64
 21  WDF5       1091 non-null   float64
 22  WDMV       273 non-null    float64
 23  WESF       1 non-null      float64
 24  WSF2       1093 non-null   float64
 25  WSF5       1091 non-null   float64
 26  WT01       331 non-null    float64
 27  WT02       17 non-null     float64
 28  WT03       337 non-null    float64
 29  WT08       96 non-null     float64
 30  WT09       1 non-null      float64
 31  WT11       1 non-null      float64
dtypes: float64(29), object(3)
```

Figure 17:

This table shows the summary information of the selected data set. Including the number of entries, column names, and the count of non-empty entries for each column.

	LATITUDE	LONGITUDE	ELEVATION	AWND	DAPR	\
count	9544.000000	9544.000000	9544.000000	1093.000000	94.000000	
mean	25.817779	-80.300783	3.120956	8.331473	4.287234	
std	0.130466	0.084939	2.516112	3.530211	3.384412	
min	25.626802	-80.438633	0.000000	1.570000	2.000000	
25%	25.695679	-80.379100	1.500000	5.820000	2.000000	
50%	25.788100	-80.316509	2.400000	8.050000	3.000000	
75%	25.950000	-80.216920	3.700000	10.510000	4.000000	
max	26.057653	-80.133400	11.000000	21.470000	18.000000	

	EVAP	MDPR	MNPN	MXPN	PGTM	...	WDMV	\
count	276.000000	94.000000	258.000000	257.000000	0.0	...	273.000000	
mean	0.270254	1.279255	59.414729	79.252918	NaN	...	39.536264	
std	0.448618	1.411578	25.689301	32.864219	NaN	...	29.305467	
min	-2.730000	0.000000	0.000000	0.000000	NaN	...	0.000000	
25%	0.160000	0.277500	57.250000	84.000000	NaN	...	19.300000	
50%	0.260000	0.795000	70.000000	91.000000	NaN	...	37.300000	
75%	0.340000	1.620000	75.000000	98.000000	NaN	...	55.300000	
max	2.500000	6.080000	86.000000	106.000000	NaN	...	195.100000	

	WESF	WSF2	WSF5	WT01	WT02	WT03	WT08	WT09	WT11
count	1.0	1093.000000	1091.000000	331.0	17.0	337.0	96.0	1.0	1.0
mean	0.0	19.204575	25.148488	1.0	1.0	1.0	1.0	1.0	1.0
std	NaN	4.623926	5.968845	0.0	0.0	0.0	0.0	NaN	NaN
min	0.0	8.100000	12.100000	1.0	1.0	1.0	1.0	1.0	1.0
25%	0.0	16.100000	21.000000	1.0	1.0	1.0	1.0	1.0	1.0
50%	0.0	18.100000	25.100000	1.0	1.0	1.0	1.0	1.0	1.0
75%	0.0	21.900000	28.000000	1.0	1.0	1.0	1.0	1.0	1.0
max	0.0	40.000000	53.000000	1.0	1.0	1.0	1.0	1.0	1.0

[8 rows x 29 columns]

Figure 18:

For example, we can count the frequency of the daily maximum temperature (TMAX) in the area and display it in the form of graphs, which can furtherly help us analyze the trend of extreme temperature changes in a certain city.

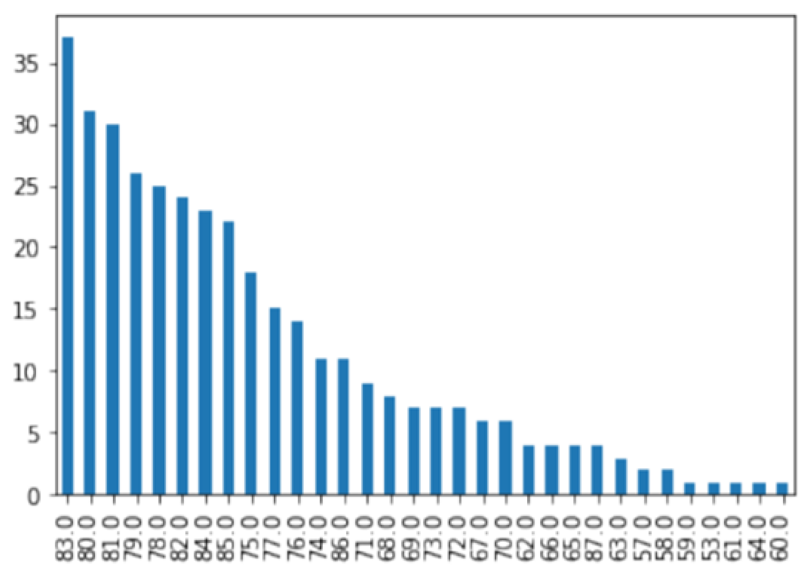

Figure 19: