In [41]:
```python
import pandas as pd
import matplotlib.pyplot as plt

df = pd.read_csv('data_file.csv')

print(df.to_string())
```

	s	lon	lat	d	f	tt	ts
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2	1	53.518053	8.521122	0.0	NaN	1689851513	20.07.2023 01:11:53
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5	1	53.518174	8.521044	0.0	NaN	1689851555	20.07.2023 01:12:35
6	1	53.518191	8.521099	0.0	NaN	1689851564	20.07.2023 01:12:44
7	1	53.518103	8.521147	0.0	NaN	1689851594	20.07.2023 01:13:14
8	1	53.518070	8.521153	0.0	NaN	1689851604	20.07.2023 01:13:24
9	1	53.518096	8.521138	0.0	NaN	1689851614	20.07.2023 01:13:34
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20	1	53.518163	8.520975	0.0	NaN	1689851772	20.07.2023 01:16:12
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22	1	53.518077	8.521178	0.0	NaN	1689851791	20.07.2023 01:16:31
23	1	53.518081	8.521133	0.0	NaN	1689851800	20.07.2023 01:16:40
24	1	53.518070	8.521192	0.0	NaN	1689851809	20.07.2023 01:16:49
25	1	53.518096	8.521157	0.0	NaN	1689851818	20.07.2023 01:16:58
26	1	53.518098	8.521170	0.0	NaN	1689851827	20.07.2023 01:17:07
27	1	53.518085	8.521146	0.0	NaN	1689851836	20.07.2023 01:17:16
28	1	53.518086	8.521172	0.0	NaN	1689851845	20.07.2023 01:17:25
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65   1   53.528444   8.498335   0.0 NaN   1689852201   20.07.2023 01:23:21
66   1   53.527226   8.496772   0.0 NaN   1689852210   20.07.2023 01:23:30
67   1   53.526417   8.496060   0.0 NaN   1689852220   20.07.2023 01:23:40
68   1   53.526433   8.496089   0.0 NaN   1689852230   20.07.2023 01:23:50
69   1   53.526442   8.496099   0.0 NaN   1689852240   20.07.2023 01:24:00
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72   1   53.526442   8.496108   0.0 NaN   1689852269   20.07.2023 01:24:29
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74   1   53.525561   8.495427   0.0 NaN   1689852289   20.07.2023 01:24:49
75   1   53.524126   8.494197   0.0 NaN   1689852298   20.07.2023 01:24:58
76   1   53.522294   8.492648   0.0 NaN   1689852308   20.07.2023 01:25:08
77   1   53.520554   8.491167   0.0 NaN   1689852318   20.07.2023 01:25:18
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79   1   53.517390   8.488489   0.0 NaN   1689852337   20.07.2023 01:25:37
80   1   53.515892   8.487209   0.0 NaN   1689852347   20.07.2023 01:25:47
81   1   53.514729   8.486179   0.0 NaN   1689852356   20.07.2023 01:25:56
82   1   53.513555   8.484736   0.0 NaN   1689852366   20.07.2023 01:26:06
83   1   53.512247   8.483555   0.0 NaN   1689852376   20.07.2023 01:26:16
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110	1	53.504438	8.478769	0.0 NaN	1689852637	20.07.2023 01:30:37
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115	1	53.504486	8.478882	0.0 NaN	1689852716	20.07.2023 01:31:56
116	1	53.504475	8.478903	0.0 NaN	1689852729	20.07.2023 01:32:09
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826  1  53.518082  8.521202  0.0 NaN  1689859820  20.07.2023 03:30:20
827  1  53.518080  8.521214  0.0 NaN  1689859829  20.07.2023 03:30:29
828  1  53.518076  8.521215  0.0 NaN  1689859839  20.07.2023 03:30:39
829  1  53.518070  8.521248  0.0 NaN  1689859849  20.07.2023 03:30:49
830  1  53.518072  8.521244  0.0 NaN  1689859859  20.07.2023 03:30:59
831  1  53.518064  8.521242  0.0 NaN  1689859868  20.07.2023 03:31:08
832  1  53.518067  8.521254  0.0 NaN  1689859877  20.07.2023 03:31:17
833  1  53.518070  8.521225  0.0 NaN  1689859887  20.07.2023 03:31:27
834  1  53.518076  8.521211  0.0 NaN  1689859897  20.07.2023 03:31:37
```

```
835  1  53.518072  8.521221  0.0 NaN  1689859907  20.07.2023 03:31:47
836  1  53.518079  8.521221  0.0 NaN  1689859916  20.07.2023 03:31:56
837  1  53.518072  8.521239  0.0 NaN  1689859925  20.07.2023 03:32:05
838  1  53.518101  8.521207  0.0 NaN  1689859932  20.07.2023 03:32:12
```

In [42]:
```python
df['ts'] = df[["ts"]].apply(pd.to_datetime)
```

In [43]:
```python
df['ts']
```

Out[43]:
```
0      2023-07-20 01:11:31
1      2023-07-20 01:11:44
2      2023-07-20 01:11:53
3      2023-07-20 01:12:03
4      2023-07-20 01:12:25
              ...
834    2023-07-20 03:31:37
835    2023-07-20 03:31:47
836    2023-07-20 03:31:56
837    2023-07-20 03:32:05
838    2023-07-20 03:32:12
Name: ts, Length: 839, dtype: datetime64[ns]
```

In [44]:
```python
from datetime import datetime
import pandas as pd
import numpy as np
from stdbscan import STDBSCAN
from coordinates import convert_to_utm

def parse_dates(x):
    return datetime.strptime(x, '%Y-%m-%d %H:%M:%S.%f')
```

In [45]:
```python
st_dbscan = STDBSCAN(spatial_threshold=20, temporal_threshold=600,
                     min_neighbors=10)

df = convert_to_utm(df, src_epsg=4326, dst_epsg=32633,
                    col_lat='lat', col_lon='lon')

out = st_dbscan.fit_transform(df, col_lat='lat',
                                  col_lon='lon',
                                  col_time='ts')
```

```
Formal definition string for the old projection: proj=longlat datum=WGS84 no_defs ellps=WGS84 towgs84=0,0,0
Formal definition string for the new projection: proj=utm zone=33 datum=WGS84 units=m no_defs ellps=WGS84 towgs84=0,0,0
```

```
/Users/sandeep/hbrains/notebooks/py-st-dbscan/python/src/coordinates.py:35: FutureWarning: This function is deprecate
d. See: https://pyproj4.github.io/pyproj/stable/gotchas.html#upgrading-to-pyproj-2-from-pyproj-1
  x2, y2 = pyproj.transform(old_proj, new_proj, x1, y1)
/Users/sandeep/hbrains/notebooks/py-st-dbscan/python/src/stdbscan.py:68: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning
-a-view-versus-a-copy
  df[col_cluster] = unmarked
/Users/sandeep/hbrains/notebooks/py-st-dbscan/python/src/stdbscan.py:69: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning
-a-view-versus-a-copy
  df['index'] = range(df.shape[0])
/Users/sandeep/hbrains/notebooks/py-st-dbscan/python/src/stdbscan.py:71: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning
-a-view-versus-a-copy
  df.drop(['index'], inplace=True, axis=1)
/Users/sandeep/hbrains/notebooks/py-st-dbscan/python/src/stdbscan.py:106: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning
-a-view-versus-a-copy
  df[col_cluster] = matrix[:, 3]
```

In [46]: `out.head(10)`

Out[46]:

	lon	lat	ts	cluster
0	70693.234928	5.949458e+06	2023-07-20 01:11:31	1
1	70695.706835	5.949460e+06	2023-07-20 01:11:44	1
2	70691.618136	5.949454e+06	2023-07-20 01:11:53	1
3	70690.864440	5.949452e+06	2023-07-20 01:12:03	1
4	70685.699186	5.949463e+06	2023-07-20 01:12:25	1
5	70687.666681	5.949468e+06	2023-07-20 01:12:35	1
6	70691.504401	5.949470e+06	2023-07-20 01:12:44	1
7	70693.771833	5.949460e+06	2023-07-20 01:13:14	1
8	70693.788775	5.949456e+06	2023-07-20 01:13:24	1
9	70693.117866	5.949459e+06	2023-07-20 01:13:34	1

In [47]:
```python
out['cluster'].describe()
```

Out[47]:
```
count      839
unique       7
top          6
freq       455
Name: cluster, dtype: int64
```
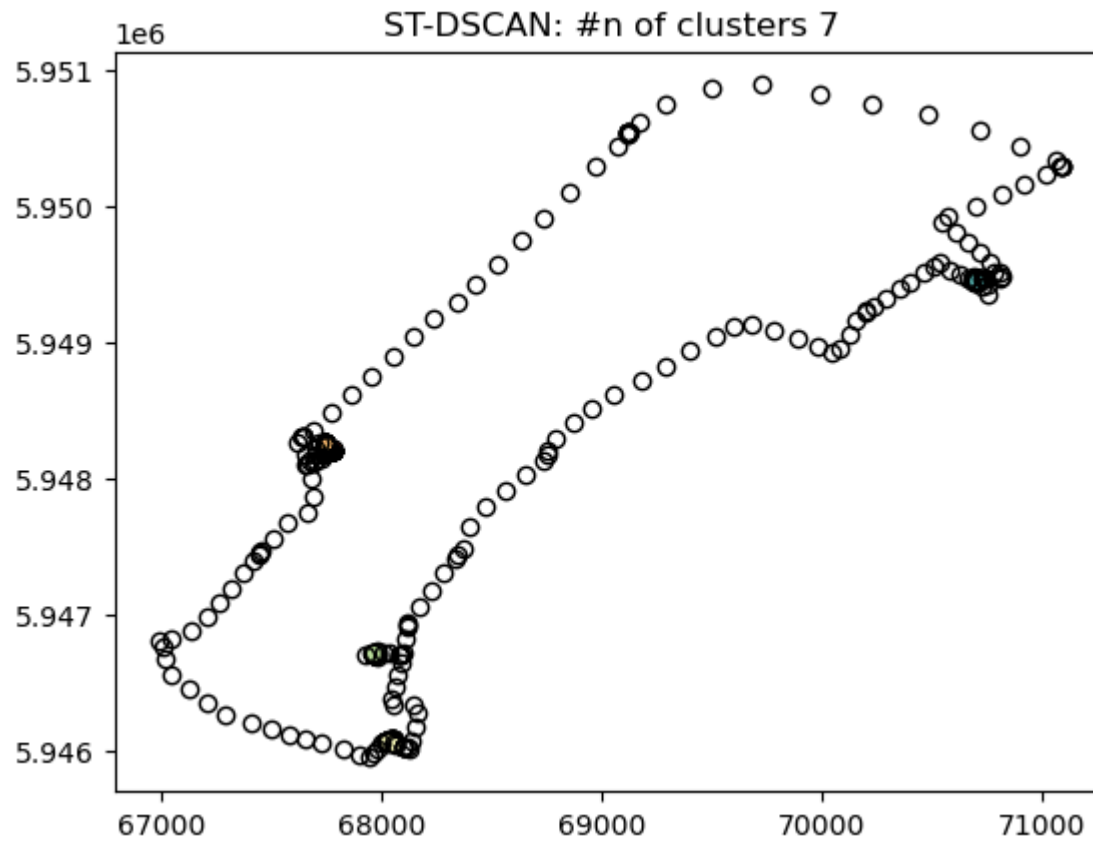
In [48]:
```python
labels = out['cluster'].values
X = out[['lon', 'lat']].values

# Black removed and is used for noise instead.
unique_labels = set(labels)
colors = [plt.cm.Spectral(each)
          for each in np.linspace(0, 1, len(unique_labels))]
for k, col in zip(unique_labels, colors):
    if k == -1:
        # Black used for noise.
        col = [1, 1, 1, 0]

    class_member_mask = (labels == k)

    xy = X[class_member_mask]
    plt.plot(xy[:, 0], xy[:, 1], 'o', markerfacecolor=tuple(col),
```

```
                        markeredgecolor='k', markersize=6)

        plt.title('ST-DSCAN: #n of clusters {}'.format(len(unique_labels)))
        plt.show()
```


ST-DSCAN: #n of clusters 7

In [49]: `out`

Out[49]:

	lon	lat	ts	cluster
0	70693.234928	5.949458e+06	2023-07-20 01:11:31	1
1	70695.706835	5.949460e+06	2023-07-20 01:11:44	1
2	70691.618136	5.949454e+06	2023-07-20 01:11:53	1
3	70690.864440	5.949452e+06	2023-07-20 01:12:03	1
4	70685.699186	5.949463e+06	2023-07-20 01:12:25	1
...	...	...	...	...
834	70697.710661	5.949456e+06	2023-07-20 03:31:37	6
835	70698.309581	5.949456e+06	2023-07-20 03:31:47	6
836	70698.408777	5.949456e+06	2023-07-20 03:31:56	6
837	70699.509505	5.949455e+06	2023-07-20 03:32:05	6
838	70697.718032	5.949459e+06	2023-07-20 03:32:12	6

839 rows × 4 columns

In [ ]: