In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
```

In [2]:
```
union_find_df = pd.read_csv('union_find.csv')
union_find_df
```

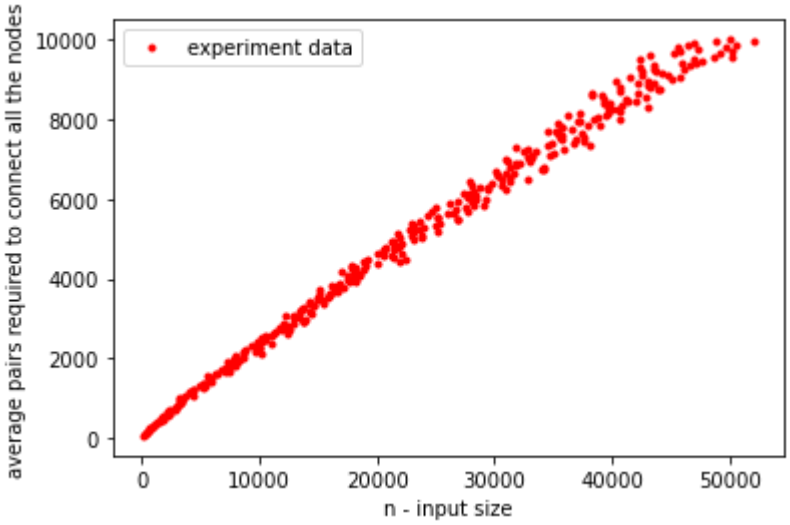
Out[2]:

	inputSize	pairCount
0	64	160.6
1	94	235.4
2	124	324.5
3	154	449.4
4	184	525.0
...	...	...
327	9874	50509.1
328	9904	46921.9
329	9934	48843.1
330	9964	52037.7
331	9994	49968.8

332 rows × 2 columns

In [3]:
```
input_size_arr = union_find_df[['inputSize']].to_numpy().reshape((-1, 1))
pair_count_arr = union_find_df[['pairCount']].to_numpy().reshape((-1, 1))
```

In [4]:
```
def scatter_plot(y = None):
    plt.plot(pair_count_arr, input_size_arr, "r.", label = "experiment data")
    if y is not None: plt.plot(y, input_size_arr, "b", label = "prediction")
    plt.xlabel('n - input size')
    plt.ylabel('average pairs required to connect all the nodes')
    plt.legend()
    plt.show()
scatter_plot()
```

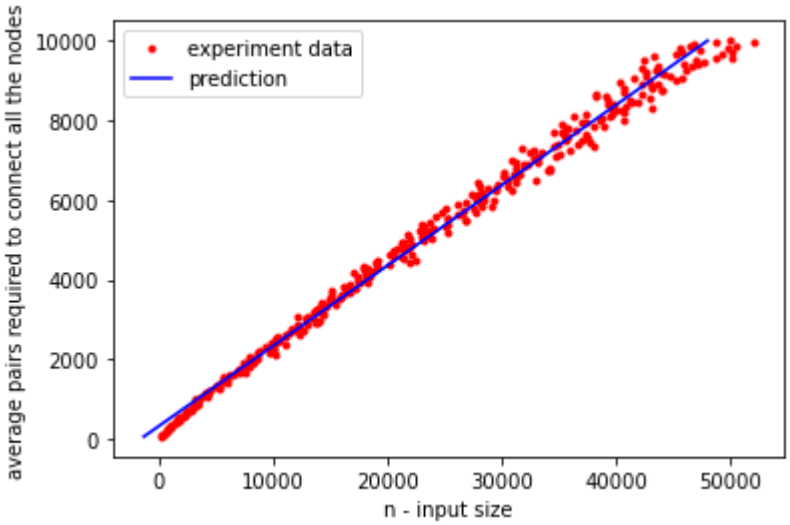


In [5]:
```
# since this looks like linear relation, let me try lineat regression
from sklearn import datasets, linear_model
regr = linear_model.LinearRegression()
```

In [6]:
```
regr.fit(input_size_arr, pair_count_arr)
pair_count_pred = regr.predict(input_size_arr)
regr.coef_
```

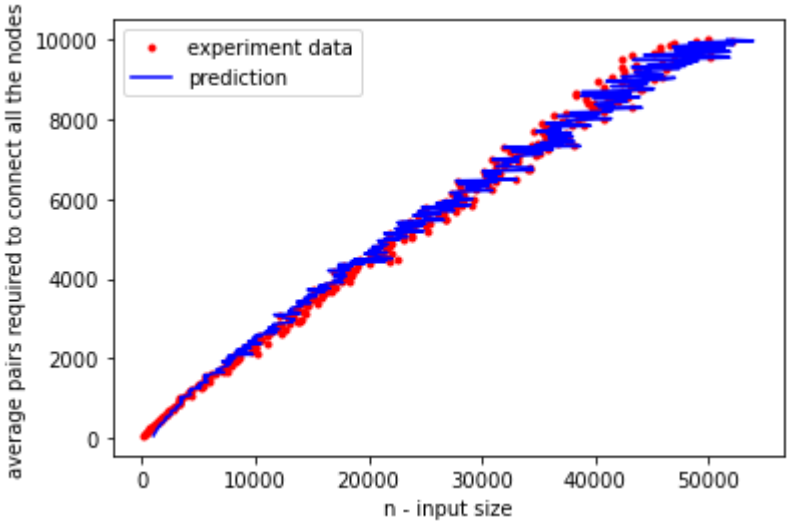
Out[6]:
```
array([[4.9730793]])
```

In [7]:
```
# plotting the predected line
scatter_plot(pair_count_pred)
```



The above line fits quite well for the **middle part** of the scatter plot,
however notice the **begenning (n: 0 - 10k)** and the **ending (n: 40k - 50k)**,
both the sections look to be falling away from the pridected line,
this suggests that the plot is not exactly a straight line
(number of pairs required to form 1 component is **not linearly proportional** to input size).

In [8]:
```
# lets try to fit it with a linearithmic plot (n lg n)
# pair_count_exp = np.copy(pair_count_arr)
# tuning intercept and coefficient manually to fit the curve with scatter plot
intercept = 950
coefficient = 0.065
pair_count_exp = coefficient * pair_count_arr * np.log2(pair_count_arr) + intercept
# plotting the predicted
scatter_plot(pair_count_exp)
```



After some manual coefficient and intercept tuning,
this new plot seems to be a much better fit to the experiment data.
Hence the relationship => **m = a *n* log2(n) + b**
where -
m: average number of pairs,
n: input size
and (a, b) are constants whose experimental value is (0.065, 950) respectively