Study of Skyline Query Evaluation on Corona

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INTRODUCTION

The current use of Wireless Sensor Networks (WSN) in applications such as robotics, environmental monitoring, security systems, forest fire detection, and other research areas are becoming more pervasive and prevalent. Specifically, WSN provide users a means of gathering large volumes of data that are useful when processed and presented correctly. Thus, when Wireless Sensor Networks collect a vast amount of data, making sense out of data is an open complex problem. One approach to solve this problem is to create tools that allow management and interpretation of the data collected from the sensors. These tools are usually known as query processors over WSN. Thus, we have developed a WSN tool that behaves like (implements) a relational database manager and stores the data in a relational database table.

On the other hand, Skyline queries are widely applicable to multi-criteria decision making applications such as emergency situations that must be addressed as soon as possible. For example, consider the problem where the Ministry of Infrastructure needs to monitor the structural health of their bridges (i.e., structural health monitoring). Specifically, they are required to decide whether an existing bridge structure will not collapse under normal load conditions. The Ministry of Infrastructure can record measurements of the temperature and acceleration (i.e., proper acceleration) in order to analyze the risk of the bridge collapsing. Because proper acceleration is the objects acceleration with respect to free fall, it can be measured by an accelerometer. The acceleration is measured using the sensor placement plane on the bridge with respect to the x-axis, y-axis, and z-axis. Also, the temperature of the environment and acceleration from the traffic flow over the bridge can have a significant effect on the bridge structures. Furthermore, suppose that the collapse risk corresponds to maximization of temperature and acceleration, i.e., there is a collapse risk of a bridge if the structure materials are expanded greatly by the heat (high temperature) and at the same time the forces applied to the structure are not offset (maximum acceleration). These measurements may be collected using a sensor network. However, the set of measurements collected by sensors may be large and make it difficult for users to determine which are the relevant measurements that indicate a collapse risk of the bridge. In this sense, Skyline queries may be used to select a set of relevant measurements from a potentially extensive set of measurements. A measurement belongs to the Skyline if it is not dominated by any other measure. It is said that a measurement dominates another measurement if it is as good or better in all attributes and better in at least one attribute (Börzsönyi, Kossmann, & Stocker, 2001). In this example, temperature and acceleration are the measurement attributes.

To illustrate Skyline queries, consider Figure 1 which contains some measurements collected by one of sensors placed in the south end of the bridge. Figure 1 has a 2D representation of the measurements shown in the table of Figure 1, where the horizontal axis rep-

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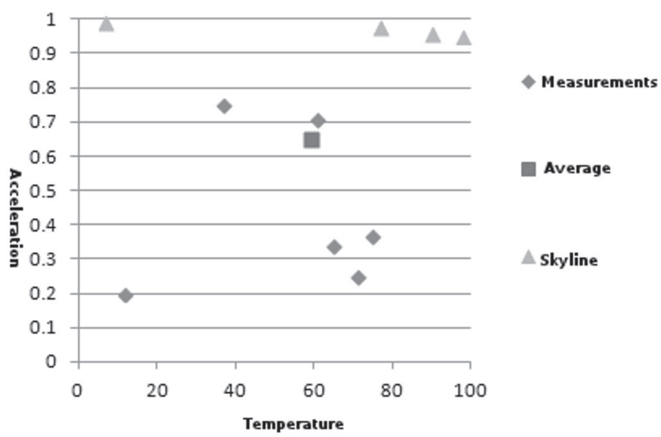
resents the temperature values while the vertical axis represents the acceleration values. The measurements P_3, P_5, P_6 and P_{10} in the table of Figure 1 are either part of the Skyline or incomparable. For instance, P_3 and P_5 are incomparable since the temperature of P_3 is higher than the temperature of P_5 but the acceleration of P_5 is higher than the acceleration of P_3. Moreover, the measurement P_3 dominates the measurement P_1 because P_3 has higher values in temperature and acceleration than P_1. P_3 also dominates P_1, P_2, P_4, P_7, P_8 and P_9. Notice that the Skyline or the measurements P_3, P_5, P_6 and P_{10} may be indicating that there is a collapse risk at the south end of the bridge because the temperature and acceleration are high.

Furthermore, suppose that a second sensor is located at the north end of the bridge. Figure 2 contains a representation on the Cartesian plane of the second sensor measurements, whose values are given in the table of Figure 2. For the second sensor, the Skyline comprises P_7 and P_9. Because the temperature and acceleration of these measurements are not high, there is no collapse risk at the north end of the bridge.

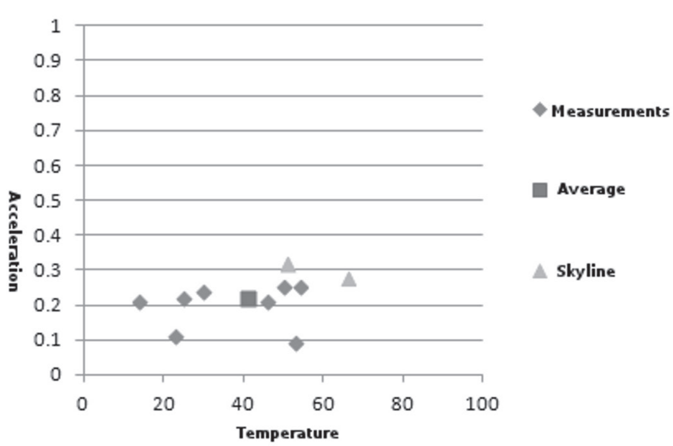
If we observe Figures 1 and 2, it can be noted that there may be a risk condition at the south end of the bridge monitored by the first sensor, while the north end monitored by the second sensor has no risk conditions. The high values in temperature and acceleration

Figure 1. Measurements of the first sensor



Measurement	Temperature (°F)	Acceleration
P_1	71	0.25
P_2	37	0.75
P_3	77	0.98
P_4	65	0.34
P_5	7	0.99
P_6	98	0.95
P_7	12	0.2
P_8	75	0.37
P_9	61	0.71
P_{10}	90	0.96
Average	**59.3**	**0.65**

Figure 2. Measurements of the second sensor



Measurement	Temperature (°F)	Acceleration
P_1	30	0.24
P_2	23	0.11
P_3	50	0.25
P_4	53	0.09
P_5	46	0.21
P_6	25	0.22
P_7	51	0.32
P_8	54	0.25
P_9	66	0.28
P_{10}	14	0.21
Average	**41.2**	**0.22**