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A Review on Quantised Compressive Sampling in Dense Wireless Sensor Networks

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Abstract:-Compressive Sampling is an developing principle that is founded on the circumstances that a comparatively trivial number of arbitrary projections of a motion can comprise maximum of its outstanding information. In this paper, we have reviewed the concept of Compressive Wireless Sensing for WSNs in which a fusion cente repossesses indication area data samples from a collaborative of spatially dispersed sensor nodes. Energy and bandwidth are threatened resources in WSNs and the relevant metrics of attention i.e. 1) the latency elaborated in data retrieval; and 2) the accompanying power distortion. It is usually predictable that the given adequate prior information about the sensed information there exist provisions that have very positive power distortion latency trade-offs. Compressive wireless sensing is a worldwide structure in the sense that it necessitates no prior information about the sensed statistics. This paper presents review on WSNs and compressive sensing.

INDEX TERMS: WSNS, COMPRESSIVE SENSING, SENSOR NODES, WIRELESS SENSING.

1. INTRODUCTION

Wireless Sensor Networks (WSNs) are networks that consist of sensors which are distributed in an ad hoc manner. These sensors work with each other to sense some physical phenomenon and then the information gathered is processed to get relevant results [1]. Wireless sensor networks form an infrastructure less wireless network where nodes are independent and self-organizing. It is Low-power microscopic sensors with wireless communication capability. Wireless sensor networks consist of protocols and algorithms with self-organizing capabilities. In many critical applications WSNs are very useful such as military surveillance, environmental, traffic, temperature, pressure, vibration, monitoring and disaster areas.

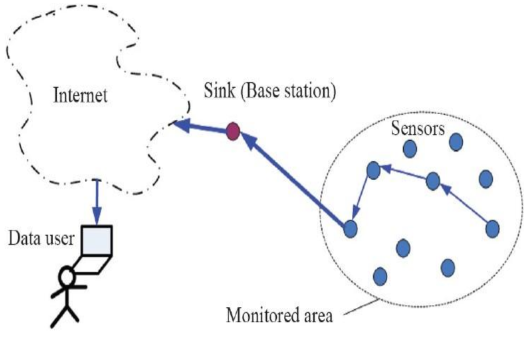

Figure 1.1 wireless sensor network

All sensor nodes process data and transmit it to base station also called sink. In WSNs these sensor nodes are power constrained due to limited battery resource [2]. So using the battery in efficient way becomes critical issue. A number of protocols play an important role to reduce useful energy consumption [6].Direct communication and multi-hop data transmission used initially. But due to limited power of sensor nodes these techniques don't work effectively.

With the rise of compressive inspecting hypothesis [20] & [21], we have seen another road of examination in the field of in-system information squeezing. Compressive remote sensing (CWS) [20] seems, by all accounts, to be ready to decrease the inactivity of information assembling in a solitary jump arrange by conveying straight projections of sensor readings through synchronized amplitude modulated simple transmissions. Because of the troubles in simple synchronization, CWS is less handy for vast scale sensor systems. [20]Influences compressive testing for information constancy, rather than information gathering, in a WSN.

Additionally [21] theorize the potential of utilizing compressive testing hypothesis for information conglomeration in a multi-bounce WSN. Be that as it may, no genuine plan has been accounted for dependent upon this beginning thought. At the point when compressive testing is connected to in-system information layering, it will bring an abundance of comparable profits as circulated source coding including straightforward encoding methodology, sparing of between hub information trade, and decoupling of layering from directing. Moreover, compressive testing has two extra preferences. In the first place, it can manage irregular sensor readings nimbly. This playing point will be nitty-gritty in the following segment. Second, information remaking is definitely not delicate to parcel misfortunes. In compressive inspecting, all messages gained by the sink are similarly paramount. Nonetheless, in disseminated source coding, gained information are predefined as fundamental or side data. Losing fundamental data will cause lethal slips to the decoder. All these fancied benefits make compressive inspecting a making a guarantee to solution to the information gathering issue in expansive scale remote sensor systems.

2. WIRELESS SENSOR NETWORK

Recent progresses in wireless communications [2], digital electronics and micro-electro-mechanical system have empowered the development of sensor nodes that have small size and also have low energy, low cost and that are multifunctional. These sensor nodes are capable of sensing and communicating. Consisting of hundreds to thousands of sensor nodes that are densely deployed either within the region or very close to it, wireless sensor network [1] is power constrained. Power conservation is the major issue in WSN. Figure 2 shows the working of wireless sensor network. Restricted energy nodes that cannot be replaced can be carried by sensor nodes.

3. DATA AGGREGATION IN WSN

In WSN, sensor nodes sense data from the sensing region and pass it to the base station or sink. As information from neighboring sensor nodes[3] may be redundant and correlated, it is very difficult for the base station to process or compute large amount of information. In addition, sensor nodes have their own power because of redundant transmissions and power loss, lifetime of sensor nodes can decline. In order to prolong the lifetime, a practical solution was introduced which is referred to as Data Aggregation[3,4]. The main objective of data aggregation to accumulate and aggregate the information[3,5] from various sensors in order to eliminate redundancy and save power.

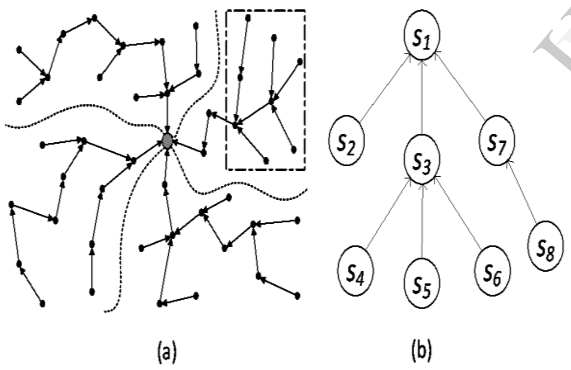

Figure 2Data gathering in a typical routing tree

Wireless sensor networks serve a broad range of applications in various areas like health, military and security[2]. Such as, the physiological information about a patient can be monitored remotely by a doctor. The doctor can understand the present condition of the patient's health. By using wireless sensor network, it will become easy to detect the presence of foreign chemical agents in air and water. It is also easy to identify to type, amount and location of the pollutant.

Routing protocols [6] help to achieve power efficiency in wireless sensor networks. In order to minimize power consumption, clustering is used. In clustering, the sensor nodes elect a cluster head and the nodes which belong to the cluster transmit their information to the cluster head and data is aggregated at the cluster head and then transmitted to the base station.

Two types of networks exist which are homogeneous and heterogeneous[6] in nature. The networks in which all the sensor nodes have same amount of energy are called homogeneous wireless sensor networks. The examples of the protocols that are cluster based and are of homogeneous networks include hybrid energy-efficient distributed clustering(HEED)[8], low-energy adaptive clustering hierarchy(LEACH)[9] and power efficient gathering in sensor information system(PEGASIS)[10]. The performance of these protocols is poor in case of heterogeneous networks. The sensor nodes which have less power will die faster than the nodes having more power because the homogeneous protocols are not capable of treating each and every node in terms of power. The networks in which some of the sensor nodes have extra power as compared to other nodes in the network are called heterogeneous wireless sensor networks. In case of these networks, the deployment of nodes is done with distinct initial energy.

4. Heterogeneous wireless sensor networks

Consider an area of $M \times M$ square metres and the number of sensor nodes be denoted by N. There are 3 types of nodes in heterogeneous networks: two, three and multi level regarding their power levels and that is why they are known as two, three and multi level heterogeneous networks.

I) Two level Heterogeneous networks

There are two power levels of sensor nodes, normal and advanced nodes in these networks. The power level of each normal node is E_o and the power level of each advanced node is $E_o(1+\alpha)$. Given the total number of nodes is N so the number of advanced nodes is Nm where m is the fraction of advanced nodes and the number of normal nodes is $N(1-m)$. So, the total power of the entire network is given by:

$$E_T = N(1-m)E_o + Nm(1+\alpha)E_o = NE_o(1+\alpha m)(1)$$

Thus it can be said that the two level heterogeneous networks have αm times more power than homogeneous networks.

II) Three level heterogeneous networks

There are three power levels of sensor nodes, normal, advanced and super nodes in these networks. The power of each normal node is E_o, the power of each advanced node of fraction m with α times more power than normal nodes is $E_o(1+\alpha)$ and the power of each super node of fraction m_o with b times more power than normal nodes is $E_o(1+b)$. Given the total number of nodes is N so the number of super nodes is Nmm_o and the number of advanced nodes is $Nm(1-m_o)$.So, the total power of the entire network is given by:

$$E_T = N(1-m)E_o + Nm(1-m_o)(1+\alpha)E_o + Nm_oE_o(1+b)$$

$$E_T = NE_o(1+m(\alpha+m_ob)) \quad (2)$$

Thus, the three level heterogeneous networks have $(\alpha+m_ob)$ times more power than homogeneous networks.

III) Multilevel heterogeneous networks

There are three power levels of sensor nodes. The initial power of sensor nodes is distributed over the close set$[E_o.E_o(1+\alpha_m)]$, where the lower bound is denoted by E_o and the maximal power value is α_m. The sensor node u_i is equipped with power of $E_o(1+\alpha_i)$, that is α_i times more power than E_o. So, the total power of the entire network is given by:

$$E_T = \sum_{i=1}^{N} E_o(1+\alpha_i) = E_o(N+\sum_{i=1}^{N}\alpha_i) \quad (3)$$

More power is utilized by cluster heads than cluster members therefore the power level of nodes becomes different from each other during some of the rounds. So, the networks having heterogeneity are essential than homogeneous ones.

5. HETEROGENEOUS PROTOCOLS

I)DEEC

For dealing with sensor nodes of heterogeneous networks, DEEC is proposed by [18]. The initial and residual power levels of sensor nodes are used to select cluster head. Let the number of rounds for a sensor node u_i to be a cluster head be n_i. In the network, the optimum number of cluster heads during each and every round is $k_{op} * N$. Nodes having more power will become cluster head more often than the nodes having low power. Consider the probability of a sensor node u_i of becoming a cluster head be p_i, so high power nodes have larger p_i value in comparison with k_{op}.

Let the average power of network during t^{th} round is as follows[18]:

$$\bar{E}(t) = \frac{1}{N}\sum_{i=1}^{N} E_i(t) \quad (4)$$

Probability will be given by:

$$p_i = k_{op}[1-\frac{\bar{E}(t)-E_i(t)}{\bar{E}(t)}] = k_{op}\frac{E_i(t)}{\bar{E}(t)} \quad (5)$$

During each and every round, the average number of cluster heads is as[18]:

$$\sum_{i=1}^{N} p_i = \sum_{i=1}^{N} k_{op}\frac{E_i(t)}{\bar{E}(t)} = k_{op}\sum_{i=1}^{N}\frac{E_i(t)}{\bar{E}(t)} = N * k_{op} \quad (6)$$

Assume G be a set of sensor nodes that are eligible to become cluster head at round t. Each sensor node selects a random number in [0,1]. If this number is less than the threshold value[18], then this node becomes cluster head in the present round.

$$T(u_i) = \begin{cases} \frac{p_i}{1-p_i(t \bmod \frac{1}{p_i})}, & if\ u_i \in G \\ 0, & otherwise \end{cases} \quad (7)$$

In two level heterogeneous networks the value of k_{op} is given by[18]:

$$p_n = \frac{k_{op}}{1+\alpha m}$$

$$p_a = \frac{k_{op}(1+\alpha)}{1+\alpha m} \quad (8)$$

In equation (5), p_n and p_a will be used for two level heterogeneous networks:

$$P_i = \begin{cases} \frac{k_{op}E_i(t)}{(1+\alpha m)\bar{E}(t)}, & if\ u_i\ is\ a\ normal\ node \\ \frac{k_{op}(1+\alpha)E_i(t)}{(1+\alpha m)\bar{E}(t)}, & if\ u_i\ is\ an\ advanced\ node \end{cases} \quad (9)$$

This can be extended to multi level network which is given as:

$$p_m = \frac{k_{op}N(1+\alpha)}{(N+\sum_{i=1}^{N}\alpha_i)} \quad (10)$$

In equation (5), p_m will be used for two level heterogeneous networks:

$$p_i = \frac{k_{op}N(1+\alpha)E_i(t)}{(N+\sum_{i=1}^{N}\alpha_i)\bar{E}(t)} \quad (11)$$

The average power for the round t of the network is given by:

$$\bar{E}(t) = \frac{1}{N}E_T(1-\frac{t}{R}) \quad (12)$$

Where R represents the total number of rounds of the lifetime of the network and is given by:

$$R = \frac{E_T}{E_r} \quad (13)$$

Where E_r = total power dissipated in the entire network during a round[18].

6. Data aggregation technique

In typical WSNs, sensor nodes are usually resource-constrained and battery-limited. In order to save resources and energy, data must be aggregated to avoid overwhelming amounts of traffic in the network. There has been extensive work on data aggregation schemes in sensor networks. The aim of data aggregation is that eliminates redundant data transmission and enhances the lifetime of energy in wireless sensor network. Data aggregation is the process of one or several sensors then collects the detection

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result from other sensor. The collected data must be processed by sensor to reduce transmission burden before they are transmitted to the base station or sink. The wireless sensor network has consisted three types of nodes: Simple regular sensor nodes, aggregator node and queer. Regular sensor nodes sense data packet from the environment and send to the aggregator nodes basically these aggregator nodes collect data from multiple sensor nodes of the network, aggregates the data packet using some aggregation functions like sum, average, count, max min and then sends aggregates result to upper aggregator node or the queer node who generate the query.

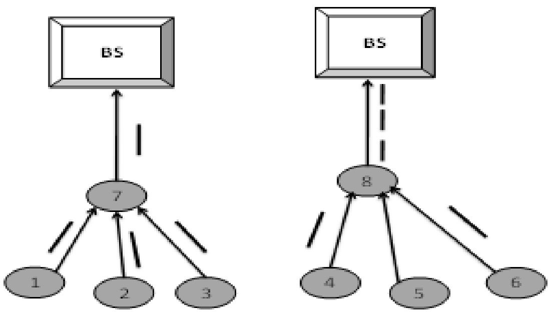

Figure 3 Data aggregation model and Non-data aggregation model.

It can be the base station or sometimes an external user who has permission to interact with the network. Data transmission between sensor nodes, aggregators and the querier consumes lot of energy in wireless sensor network. Figure 3 contain two models, one is data aggregation model.

And the second is non-data aggregation model in which sensor nodes 1, 2, 3,4,5,6 are regular nodes that collecting data packet and reporting them back to the upper nodes where sensor nodes 7, 8 are aggregators that perform sensing and aggregating at the same time. In this aggregation model 4 data packet travelled within the network and only one data packet is transmitted to the base station (sink) and other non-data aggregation model also 4 data packet travelled within the network and all data packets are sent to the base station (sink), means with the help of data aggregation process we decrease the number of data packet transmission and also save energy of the sensor node in the wireless sensor network. With the help of data aggregation we enhance the lifetime of wireless sensor network. Sink have a data packet with energy efficient manner with minimum data latency. So data latency is very important in many applications of wireless sensor network such as environment monitoring, health, monitoring, where the freshness of data is also an important factor. It is critical to develop energy-efficient data-aggregation algorithms so that network lifetime is enhanced. There are various data aggregation techniques in WSN:

1. Cluster-Based Approach: In energy-constrained sensor networks of large size, it is inefficient for sensors to transmit the data directly to the sink. Cluster based approach is hierarchical approach. In cluster-based approach, whole network is divided in to several clusters. Each cluster has a cluster-head which is selected among cluster members. Cluster-heads do the role of aggregator which aggregate data received from cluster members locally and then transmit the result to base station (sink). Recently, several cluster-based network organization and data-aggregation protocols have been proposed for the wireless sensor network. Figure 4 shows a cluster-based sensor network organization. The cluster heads can communicate with the sink directly via long range transmissions or multi hopping through other cluster heads.

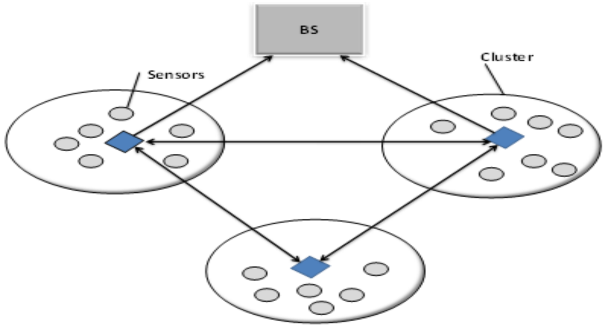

Figure 4 Cluster based sensor network. The arrows indicate wireless communication links.

2. Tree-Based Approach: The tree based approach is defining aggregation from constructing an aggregation tree. The form of tree is minimum spanning tree, sink node consider as a root and
Source node consider as leaves. Information flowing of data start from leaves node up to root means sink (base station). Disadvantage of this approach, like wireless sensor network are not free from failure, in case of data packet loss at any level of tree, the data will be lost not only for single level but for whole related sub tree as well. This approach is suitable for designing optimal aggregation techniques.

3. Hybrid-Based Approach: Hybrid approach followed between tree and cluster based scheme. In this, the data aggregation structure can adjusted according to specific network situation and to some performance statistics.

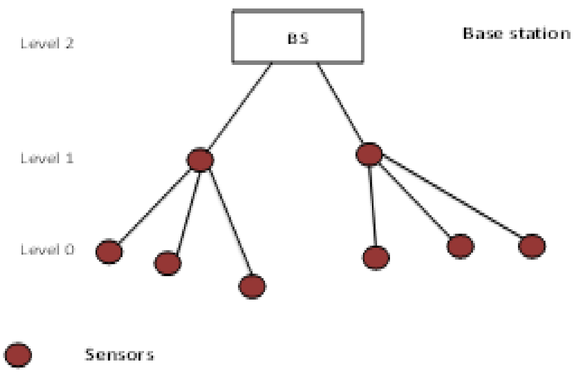

Figure 5Tree-based Data aggregation in WSNs.

7. CS Advantages and its Application in WSN

1) The more modest the intelligibility [19], the fewer specimens are required, henceforth CS underscores on

low cognizance frameworks. The estimation framework might be even irregular or commotion like, on the grounds that any arbitrarily produced orthonormal premise has low lucidness with the conversion lattices, for example, Fourier or wavelet.

2) The ensuing under inspected indicator [19] endures very nearly no data misfortune if about any arbitrary set of m coefficients are caught. The amount of caught examples m may be far short of what the sign dimensionality, if the intelligibility between inspecting and representation bases is a little limited worth.

The CS hypothesis recommends [19] a cement and greatly proficient securing convention: first example the indicator in a confused area. Incongruity is the main perquisite; one can essentially utilize arbitrary testing. The testing framework needs not to be versatile to the indicator, i.e. this arbitrary sub sampling system can apply to any system topology and characteristic occasion recording. This makes CS to emerge as one of the best proposed sub-Nyquist inspecting methods for WSN. At the same time as we see in the following segment, we can far superior use CS by acknowledging geometrical properties of the nature.

8. CONCLUSION& FUTURE WORK

Despite the fact that compacted sensing has been imagined as a helpful strategy to enhance the execution of remote sensor systems (WSNs), it is still not clear how precisely it will be connected and how huge the upgrades will be. In this paper, we have reviewed different techniques useful for WSNs. The survey has shown that the compress sensing if used in data aggregation in WSNs will improve the network lifetime at a great extent. So in near future we ill propose a new data aggregation algorithm by using the various compression techniques to improve the results further.

REFERENCES

[1] P.N.Renjith and E.Baburaj, “An Analysis on Data Aggregation in Wireless Sensor Networks,” International Conference on Radar, Communication and Computing, SKP Engineering College, Tiruvannamalai,TN.,India. pp. 62-71, Dec. 2012.

[2] I.Akyldiz, W.Su, Y.Sankarasubramanian and E. Cayirci, “Wireless Sensor networks: a survey,” IEEE Computer, vol. 38, no. 4, pp. 393-422, 2002.

[3] R.Rajagopalan and P.Varshney, “Data-Aggregation Techniques in Sensor Networks: A Survey,” IEEE Comm. Surveys Tutorials, vol. 8, no. 4, pp. 48-63, Oct.-Nov. 2006.

[4] S.Madden, M.J.Franklin, J.M.Hellerstein, and W.Hong, “TAG: A Tiny Aggregation Service for Ad-Hoc Sensor Networks,” Proc. Fifth Symp. Operating Systems Design and Implementation, 2002.

[5] S.Tilak, N.Abhu-Gazhaleh, W.R.Heinzelman, “A taxonomy of wireless micro-sensor network models,” ACM SIGMOBILE Mobile Comp. Commun. Rev. , vol. 6, no. 2, pp. 28-36, Apr. 2002.

[6] N. Javaid, T.N. Qureshi, A.H. khan, A.Iqbal, E. Akhtar, M.Ishfaq, "EDDEEC: Enhanced Developed Distributed Energy-Efficient Clustering for Heterogeneous Wireless Sensor Networks", International Workshop on Body Area Sensor Networks in conjunction with 4th International Conference on Ambient Systems, Networks and Technologies, Halifax, Nova Scotia, Canada, 2013.

[7] I. Akyldiz, W.Su, Y. Sankarasubramanian and E. Cayirci, “A survey on sensor networks,” IEEE CommunicationMag., vol. 40, no. 8, pp. 102-114, Aug. 2002.

[8] O. Younis and S. Fahmy, “HEED: a Hybrid, Energy-Efficient Distributed Clustering Approach for Ad Hoc Sensor Networks”, IEEE Trans. Mobile Computing, vol. 3, no. 4, Dec. 2004, pp. 366-79.

[9] W.Heinzelman, A.Chandrakasan, H.Balakrishan, “An application-specific protocol architecture for wireless microsensor networks”, IEEE Transaction on Wireless Communication, vol. 1, no. 4, pp. 660-670, 2002.

[10] S.Lindsey, C.S.Raghavenda, “PEGASIS: power efficient gathering in sensor information systems”,in: Proceedings of the IEEE Aerospace Conference, Big Sky, Montana, March 2002.

[11] Olivier Dousse, PetteriMannersalo, Patrick Thiran, “Latency of Wireless Sensor Networks with Uncoordinated Power Saving Mechanisms,” MobiHoc’04, May 24–26, 2004, Roppongi, Japan.

[12] HuseyinOzgur Tan and Ibrahim Korpeoglu, “Power Efficient Data Gathering and Aggregation in Wireless Sensor Networks”.

[13] S. Cho, and A. Chandrakasan, “Energy-efficient protocols for low duty cycle wireless microsensor networks”, Proceedings of the 33rd Annual Hawaii International Conference on SystemSciences, Maui, HI Vol. 2 (2000), p. 10.

[14] N. Bulusu, D. Estrin, L. Girod, J. Heidemann, “Scalable coordination for wireless sensor networks: self-configuring localization systems”, International Symposium on Communication Theory and Applications (ISCTA 2001), Ambleside, UK, July 2001.

[15] C. Intanagonwiwat, R. Govindan, D. Estrin, “Directed diffusion: a scalable and robust communication paradigm for sensor networks” Proceedings of the ACM Mobi-Com’00, Boston, MA, 2000, pp. 56–67.

[16] S. Meguerdichian, F. Koushanfar, G. Qu, M. Potkonjak, “Exposure in wireless ad-hoc sensor networks”, Proceedings of ACM MobiCom’01, Rome, Italy, 2001, pp. 139–150.

[17] G. Smaragdakis, I. Matta, Bestavros, “SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor network”, in: Second international Workshop on sensor and Actor Network Protocols and Applications (SANPA 2004), 2004.

[18] L.Qing, Q.Zhu, M. Wang, “Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor network”, ELSEVIER, Computer Communications 29, 2006, pp 2230-2237.

[19] Mahmudimanesh, M., Khelil, A., &Yazdani, N. (2009, January). Map-based compressive sensing model for wireless sensor network architecture, a starting point.In Mobile Wireless Middleware, Operating Systems, and Applications-Workshops (pp. 75-84). Springer Berlin Heidelberg.

[20] Luo, C., Wu, F., Sun, J., & Chen, C. W. (2009, September). Compressive data gathering for large-scale wireless sensor networks. In Proceedings of the 15th annual international conference on Mobile computing and networking (pp. 145-156). ACM.

[21] Rabbat, Michael, Jarvis Haupt, Aarti Singh, and Robert Nowak. "Decentralized compression and predistribution via randomized gossiping." In Proceedings of the 5th international conference on Information processing in sensor networks, pp. 51-59. ACM, 2006.