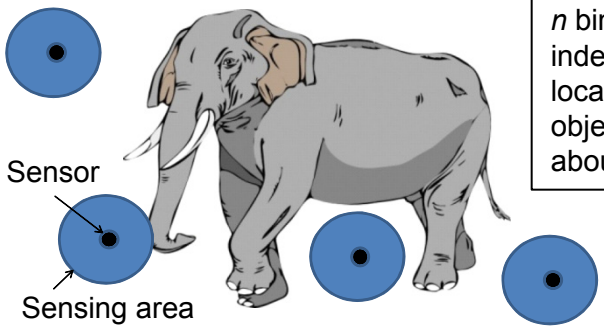
Local information and global view

Can we obtain global view based on many pieces of local information?

***Abstract*— The "Blind Men and an Elephant" is an old Indian story about a group of blind men who encounter an elephant and do not know what it is. This story describes the difficulties in capturing and understanding a large concept or global view based on only local information. Today, modern technologies enable us to easily get and retain local information. At the same time, simply collecting local information does not give us a global view, as evident in this old story. We give a concrete example to theoretically and mathematically discuss this old story and analyze what we can know based on the collected local information.**

Can latest ICT technologies overcome the story "Blind men and an elephant"?

— Why collecting many pieces of local information may not become a global view? —



n binary sensors distributed randomly and independently in **Ω** without GPS or a localization function report whether the target object can be detected. What can we determine about its size, shape, and location?

- The number of sensors detecting follows a Binomial distribution $B(n,p_d)$.
- Let T be the target object, and let $\mathcal{A}$ be the sensing area. When they are convex, p_d is given by the following.

$$p_d = F(\mathcal{T},\mathcal{A})/F(\Omega,\mathcal{A}),\ F(x,y) \equiv |x|\cdot|y| + 2\pi(\|x\| + \|y\|)$$

(|x|: perimeter length of x, ||x||: area size of x)

B(n, pd) is determined only by the perimeter length and the size of the target object, and is independent of other parameters concerning its shape. Estimation for perimeter and size is possible, estimation for other parameters are impossible.

⇒ We can obtain only a portion of global information.

How can we obtain more global information from collected local information?

It may be possible if the sensing area is not convex. By using composite sensor nodes, which consist of multiple sensor nodes arranged in a predetermined layout, that are randomly distributed without GPS or a localization function, estimation for additional information such as angles of vertexes and the number of target objects becomes possible.

What happens in other spaces?

Formulation in a discrete space enables us to apply this theory to the issue of whether we can estimate the quality of each part of the network by probing each end-to-end quality.

Related works

[1] H. Saito, S. Shimogawa, "Shape Estimation Using Networked Binary Sensors," *INFOCOM*, 2009.
[2] H. Saito, S. Tanaka, S. Shioda, "Stochastic Geometric Filter and Its Application to Shape Estimation for Target Objects," *IEEE Trans. Signal Processing*, Vol. 59, No. 10, pp. 4971-4984, 2011.
[3] H. Saito, S. Shimogawa, S. Tanaka, S. Shioda, "Estimating Parameters of Multiple Heterogeneous Target Objects Using Composite Sensor Nodes," *IEEE Trans. Mobile Computing*, Vol. 11, No. 1, pp. 125-138, 2012.

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