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Distributed signal processing in radio communication

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Bachelors's thesis presentation

Average consensus algorithm on the graph

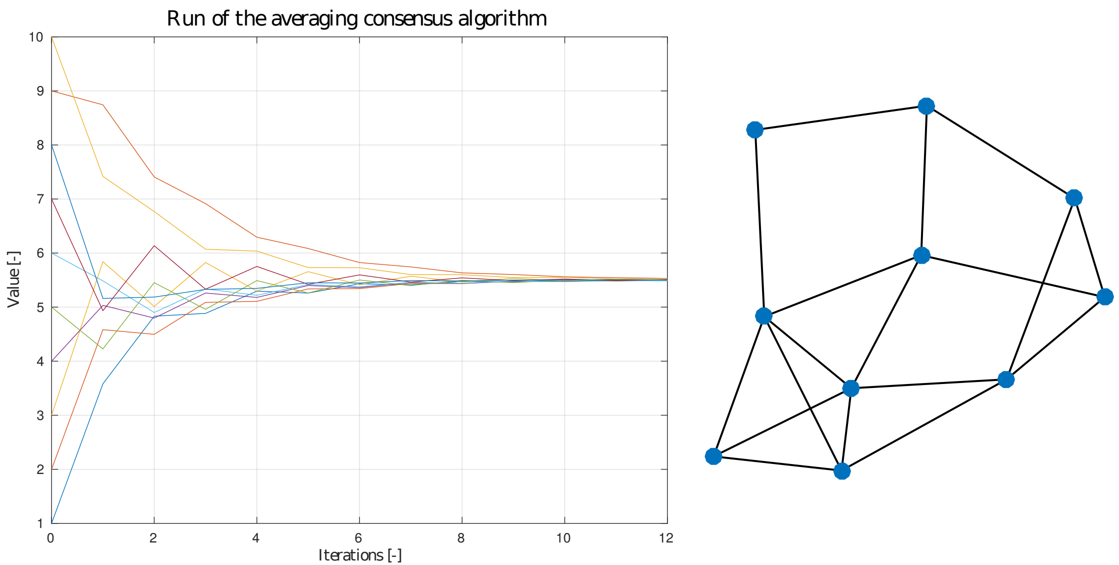

Figure 1 Run of Average consensus algorithm (left) on the graph (right)

Graph theory

- Define basic terms
- Focus on matrix representation of graph
- Laplacian of the graph and its spectrum

$$\boldsymbol{L}(G) = \boldsymbol{D}(G) - \boldsymbol{A}(G) \tag{1}$$

- $\boldsymbol{L}(G)$ bears relevant information about the graph

$$G \Leftrightarrow \boldsymbol{L}(G) \tag{2}$$

Average consensus algorithm on the graph

- Update scheme

$$x_i(t+1) = x_i(t) + \sum_{j=1; j\neq i}^{N} p_{i,j}(x_j(t) - x_i(t)) \tag{3}$$

- Expressed as matrix multiplication

$$\boldsymbol{x}(t+1) = \boldsymbol{P}\boldsymbol{x}(t) \tag{4}$$

- Suits

$$\boldsymbol{P} = \boldsymbol{I} - \alpha \boldsymbol{L}, \ \alpha = \frac{1}{\Delta} \in \mathbb{R} \tag{5}$$

Noisy updates

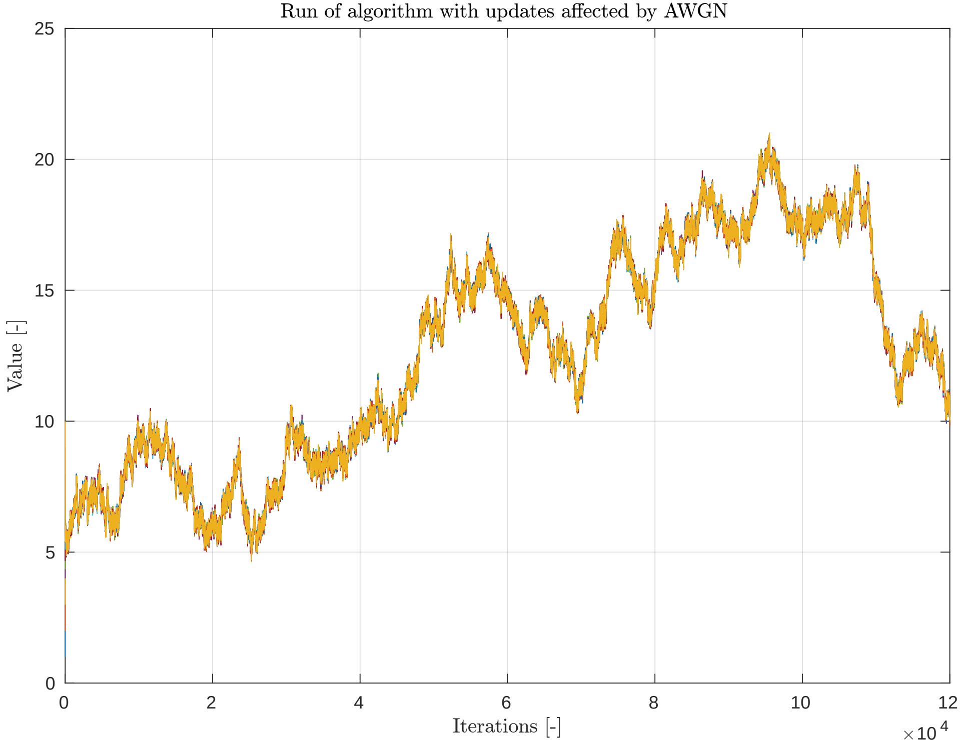

Figure 2 Updates affected by zero-mean additive noise

Noisy updates - solution

- Decreasing step size

$$\alpha \rightarrow \{\gamma(t) | \gamma(t+1) < \gamma(t)\}_{t=1}^{\infty} \quad (6)$$

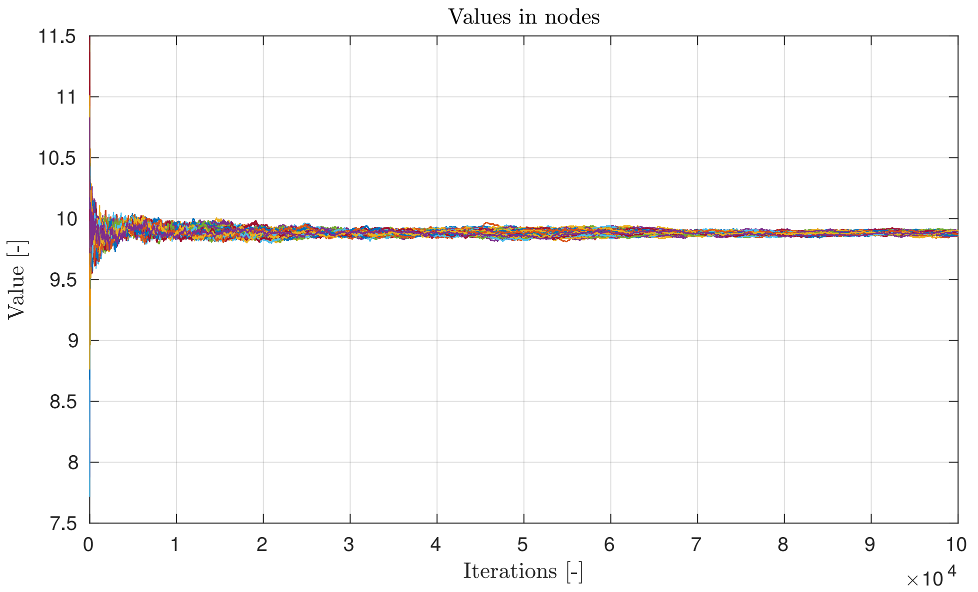

Figure 3 Run of algorithm with decreasing step size

Noisy updates - solution (2)

- Converges in sense of decreasing variance

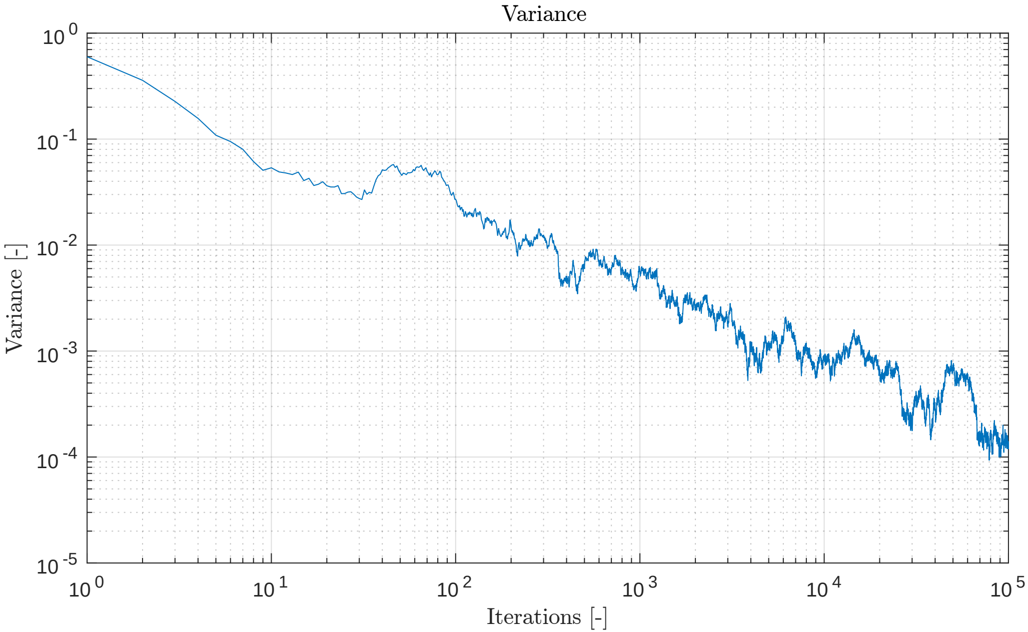

Figure 4 Decreasing variance from previous example using decreasing step size

Examples of application: dynamic target tracking

- Damaged version of algorithm (decreased α)
- Robustness

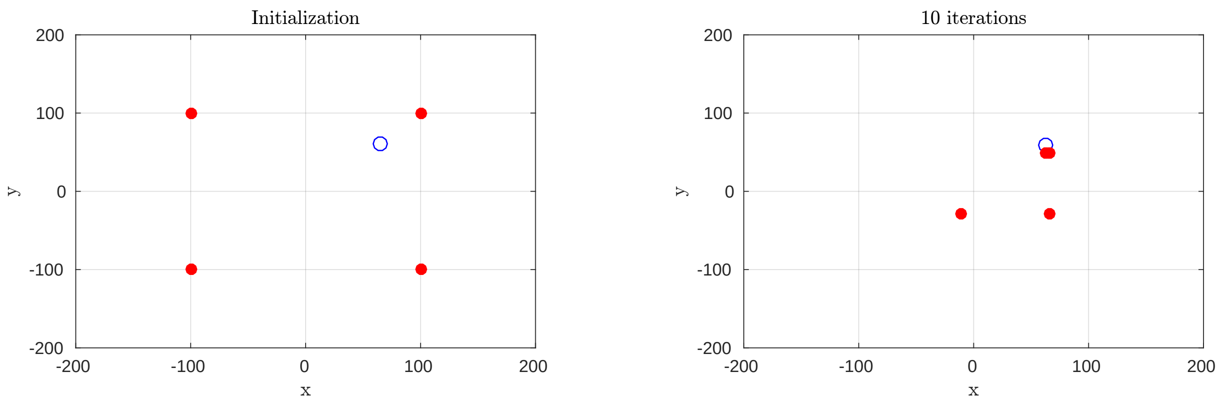

Figure 5 Initialization and 10th iteration of Target tracking simulation.

Examples of application: dynamic target tracking (2)

- Target stops moving after 500 iterations

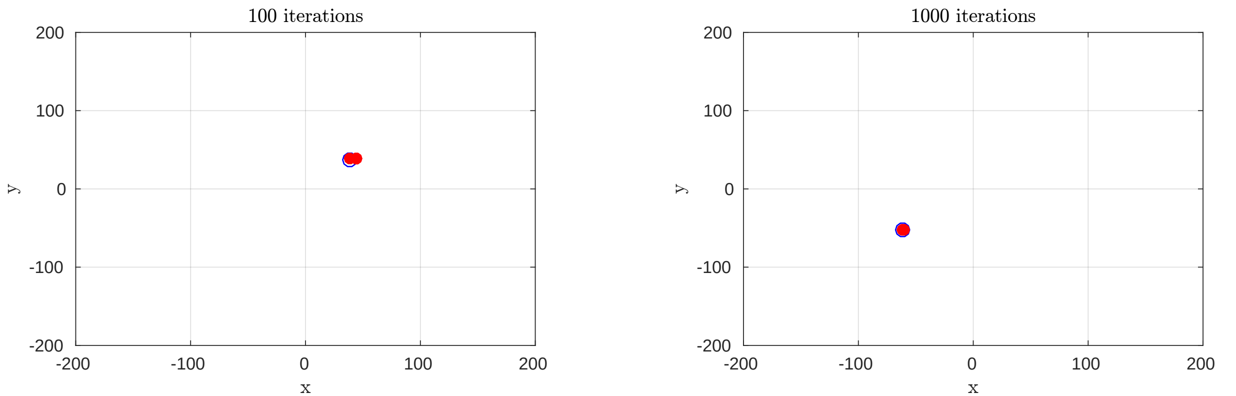

Figure 6 10th and 1000th iteration of Target tracking simulation

Examples of application: time synchronization

- Time in nodes represented as some big number
- In simulation increases according to (non ideal) internal oscillator

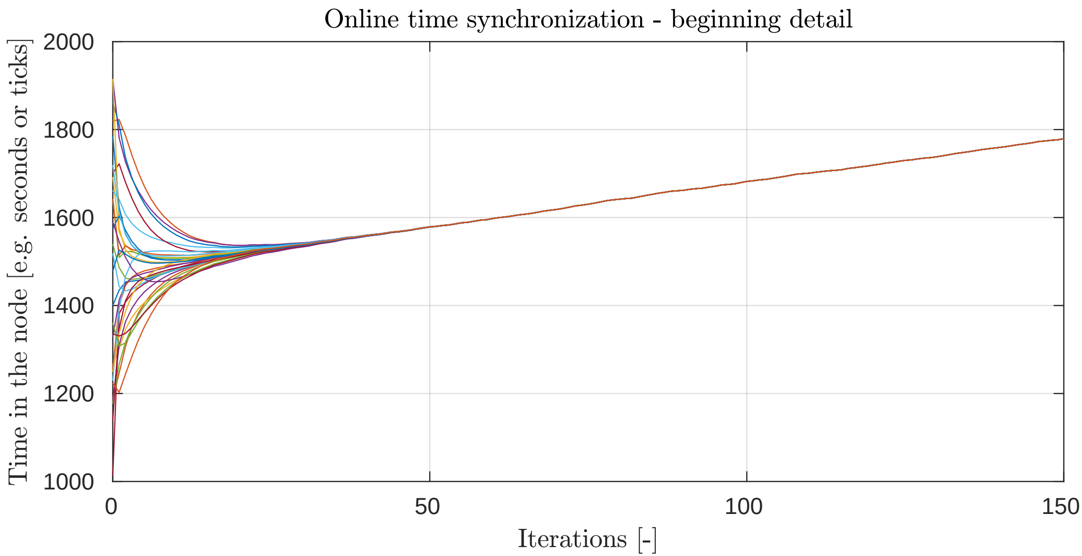

Figure 7 Run of time base synchronization

Thank you for your attention.

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Questions?