Dynaaminen yhtenäisyys

March 9, 2016

Dynaaminen yhtenäisyys

Tehdään kyselyitä verkkoon

- Lisää kaari verkkoon
- Poista kaari verkosta
- Laske verkon yhdistyneiden komponenttien määrä
- Ovatko solmut a ja b samassa yhdistyneessä komponentissa

Union-find

Union-find rakenteella voidaan tehdä kyselyt

- Lisää kaari verkkoon $O(\log n)$ ajassa
- ~~Poista kaari verkosta~~
- Laske verkon yhdistyneiden komponenttien määrä $O(1)$ ajassa
- Ovatko solmut a ja b samassa yhdistyneessä komponentissa $O(\log n)$ ajassa

Union-find

Union-find rakenteella voidaan tehdä kyselyt

- Lisää kaari verkkoon $O(\log n)$ ajassa
- ~~Poista kaari verkosta~~
- Laske verkon yhdistyneiden komponenttien määrä $O(1)$ ajassa
- Ovatko solmut a ja b samassa yhdistyneessä komponentissa $O(\log n)$ ajassa
- Peruuta aikaisempaan tilaan $O(1)$ ajassa

Offline algoritmi

- Jokaiseen kaareen liitetään alkamisaika ja loppumisaika

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Lisää (1, 3)
Lisää (3, 4)
Lisää (4, 5)
Poista (3, 4)
Lisää (2, 5)
Lisää (2, 4)
Poista (2, 5)
Poista (2, 4)
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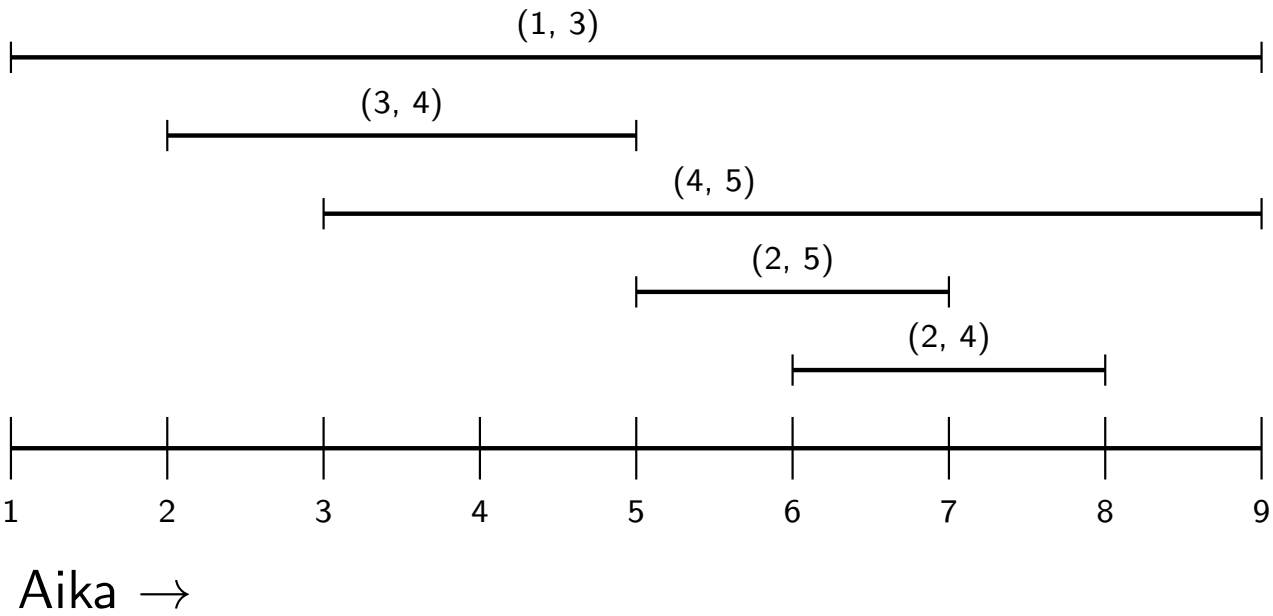

Offline algoritmi

- Nyt voidaan tehdä divide and conquer tyyppinen algoritmi joka selvittää jokaiselle ajanhetkelle minkälainen verkko silloin on

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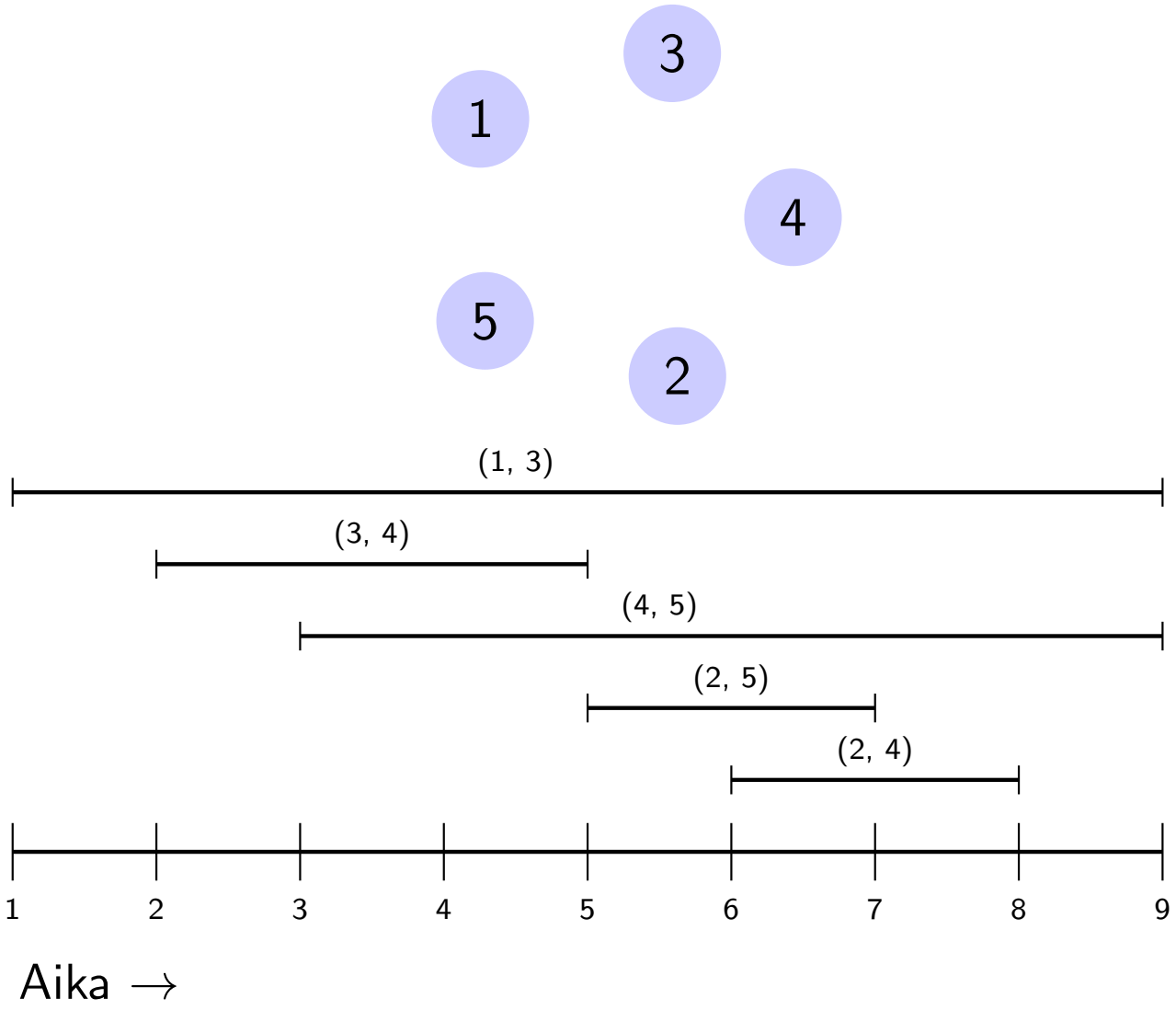

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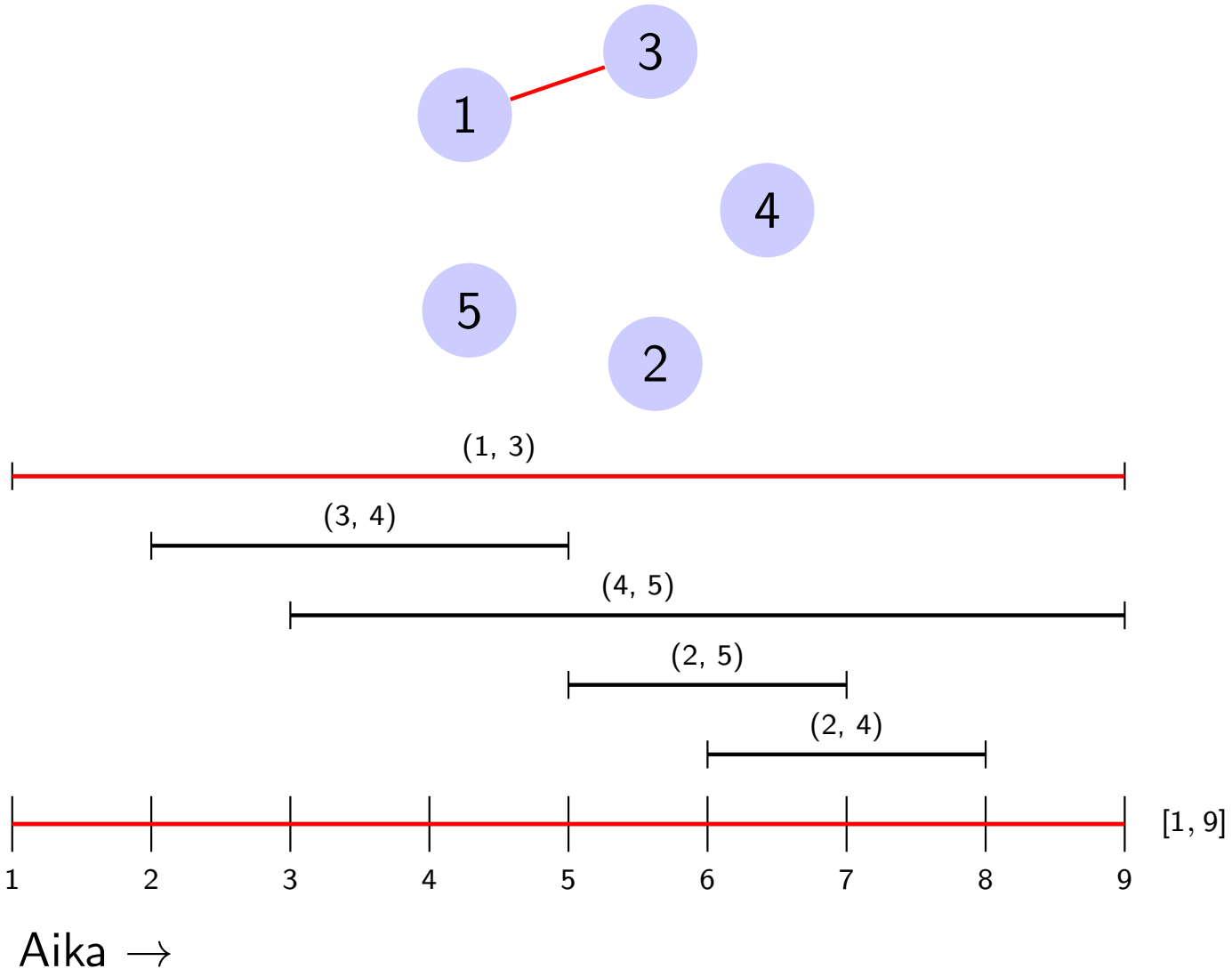

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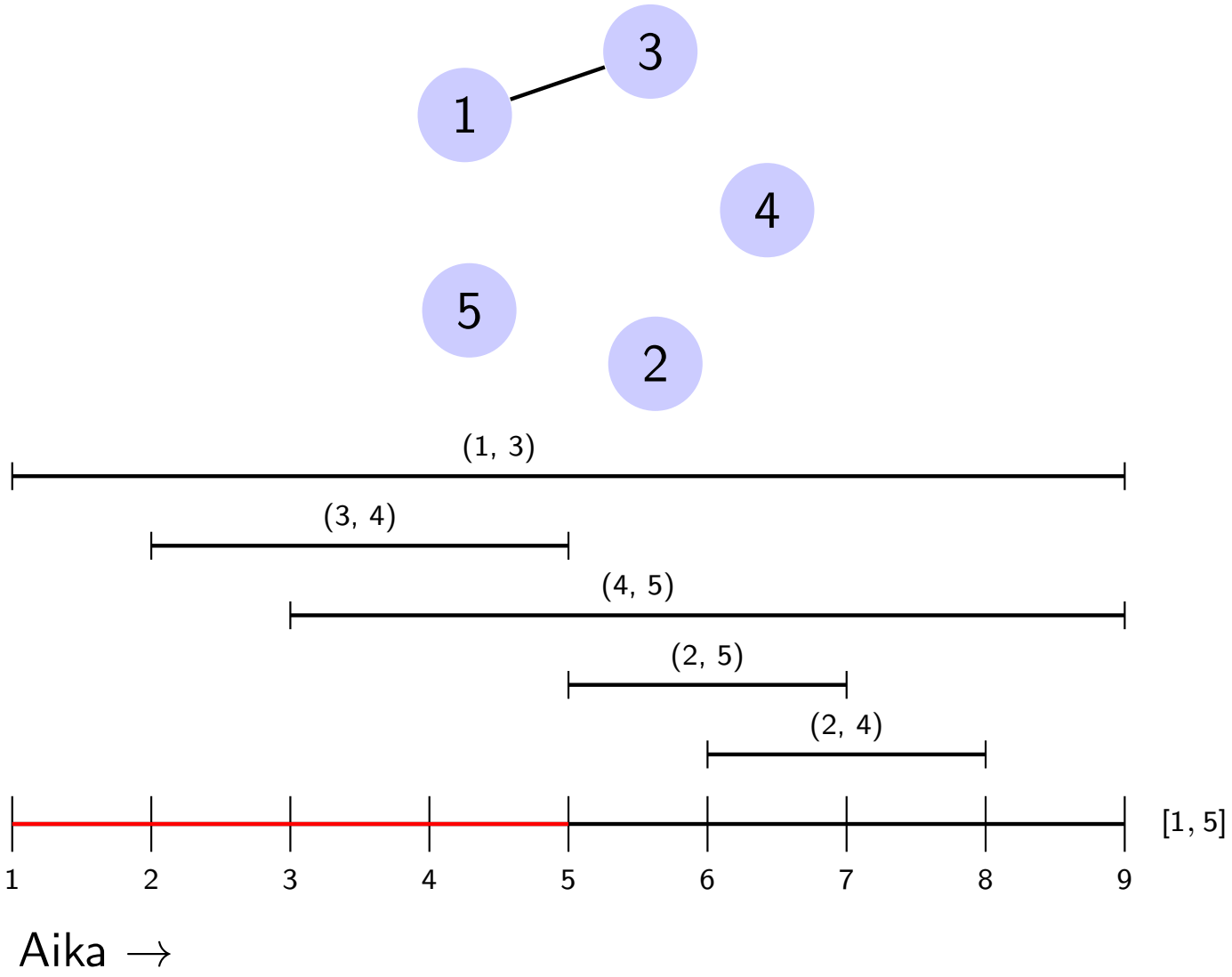

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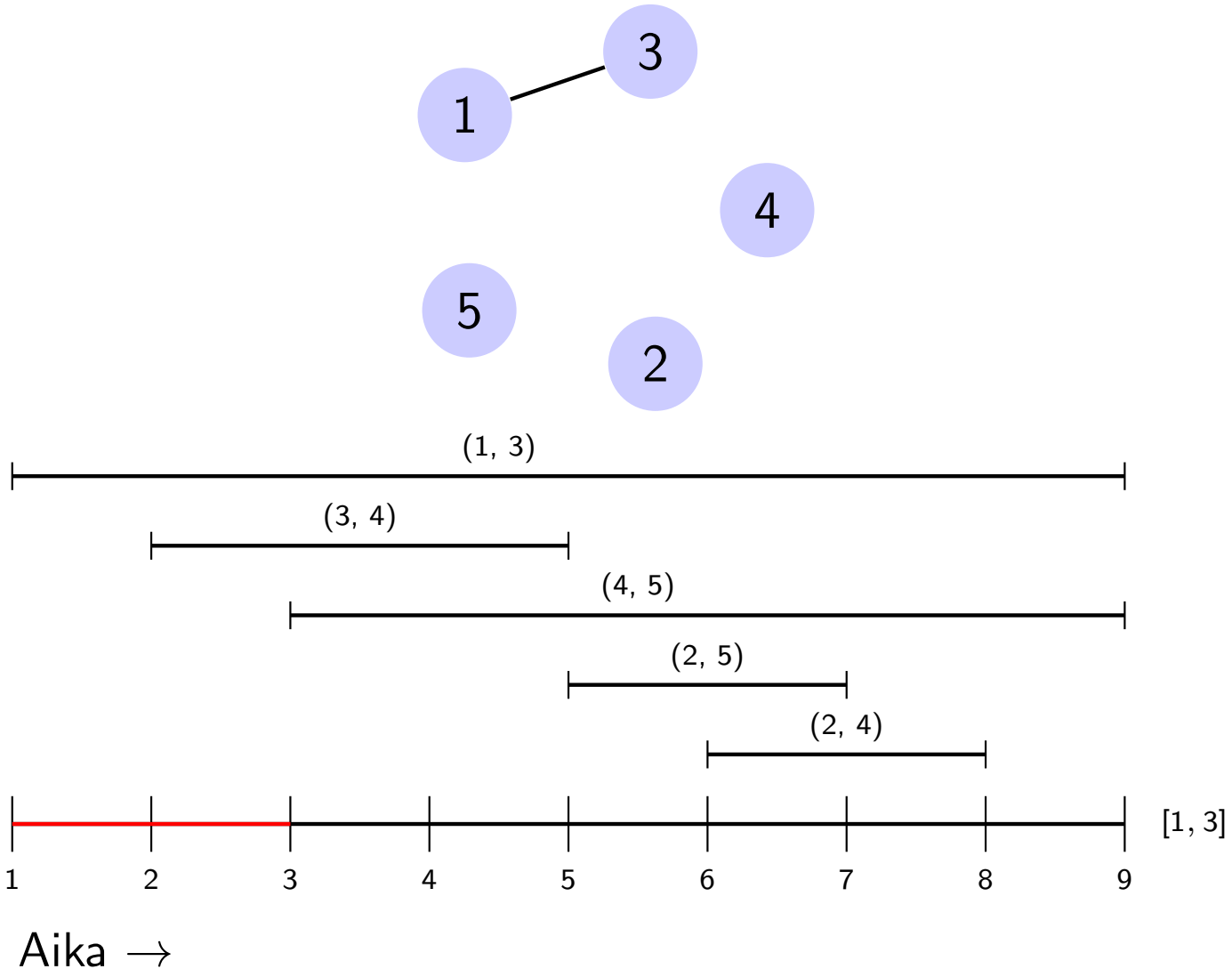

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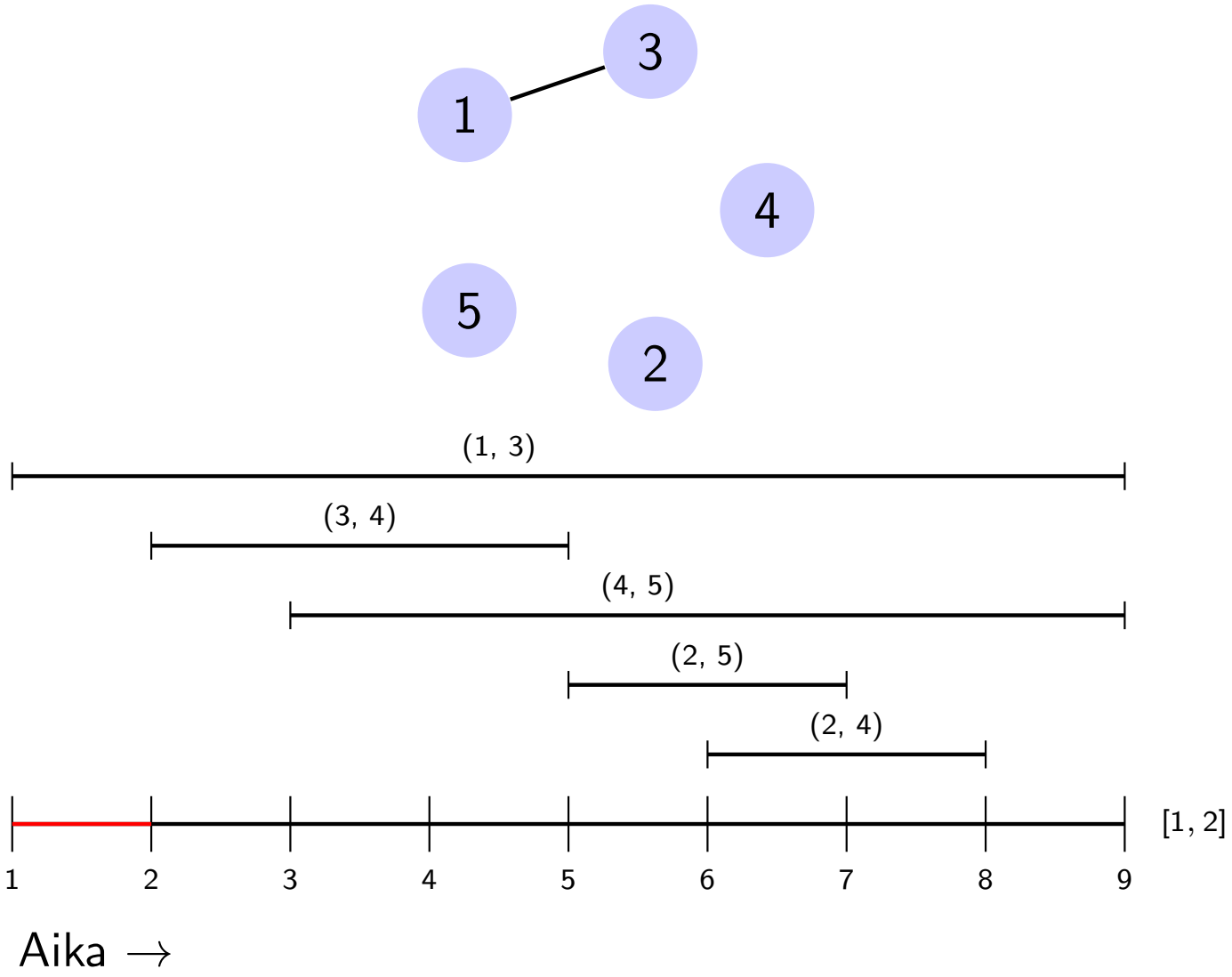

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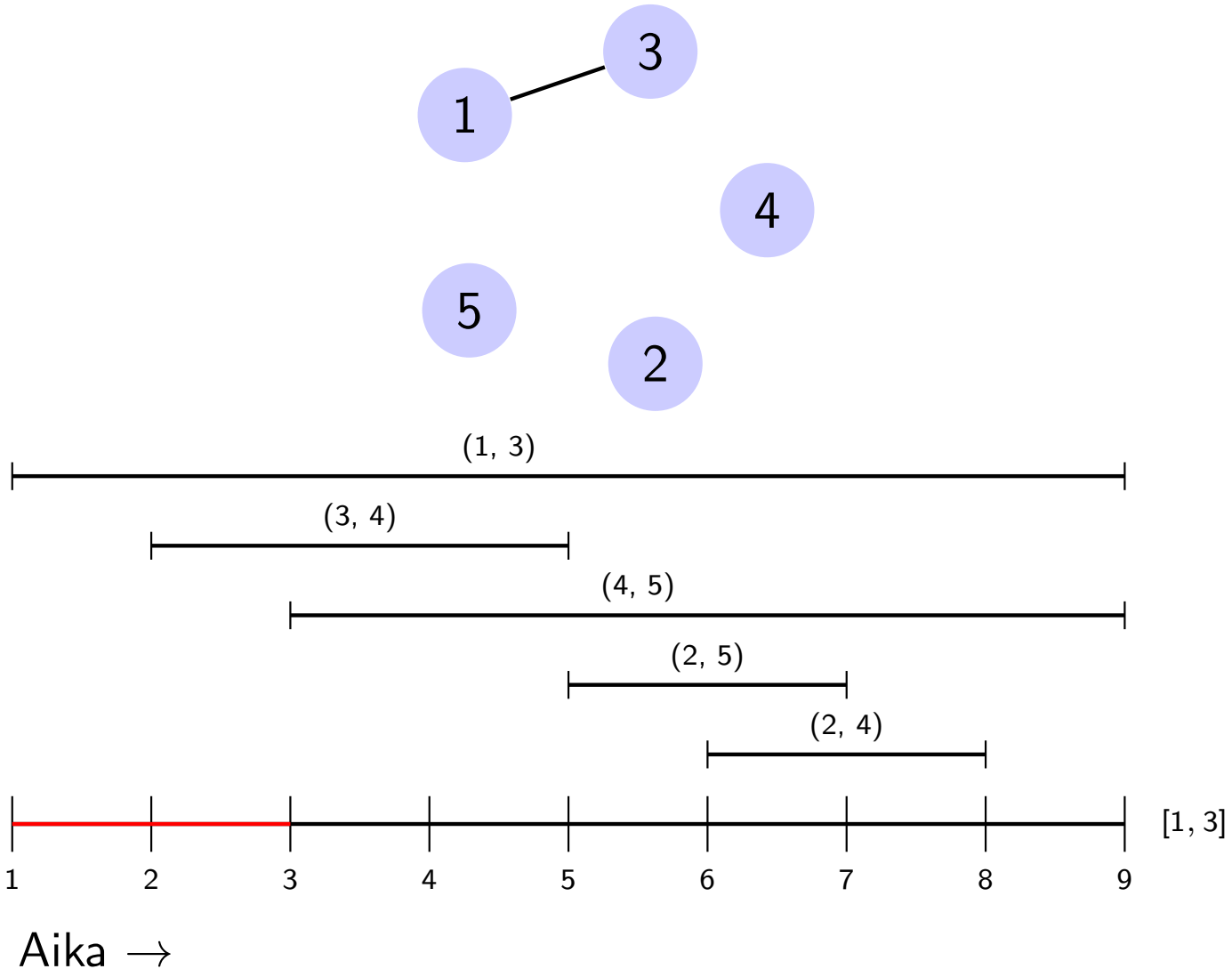

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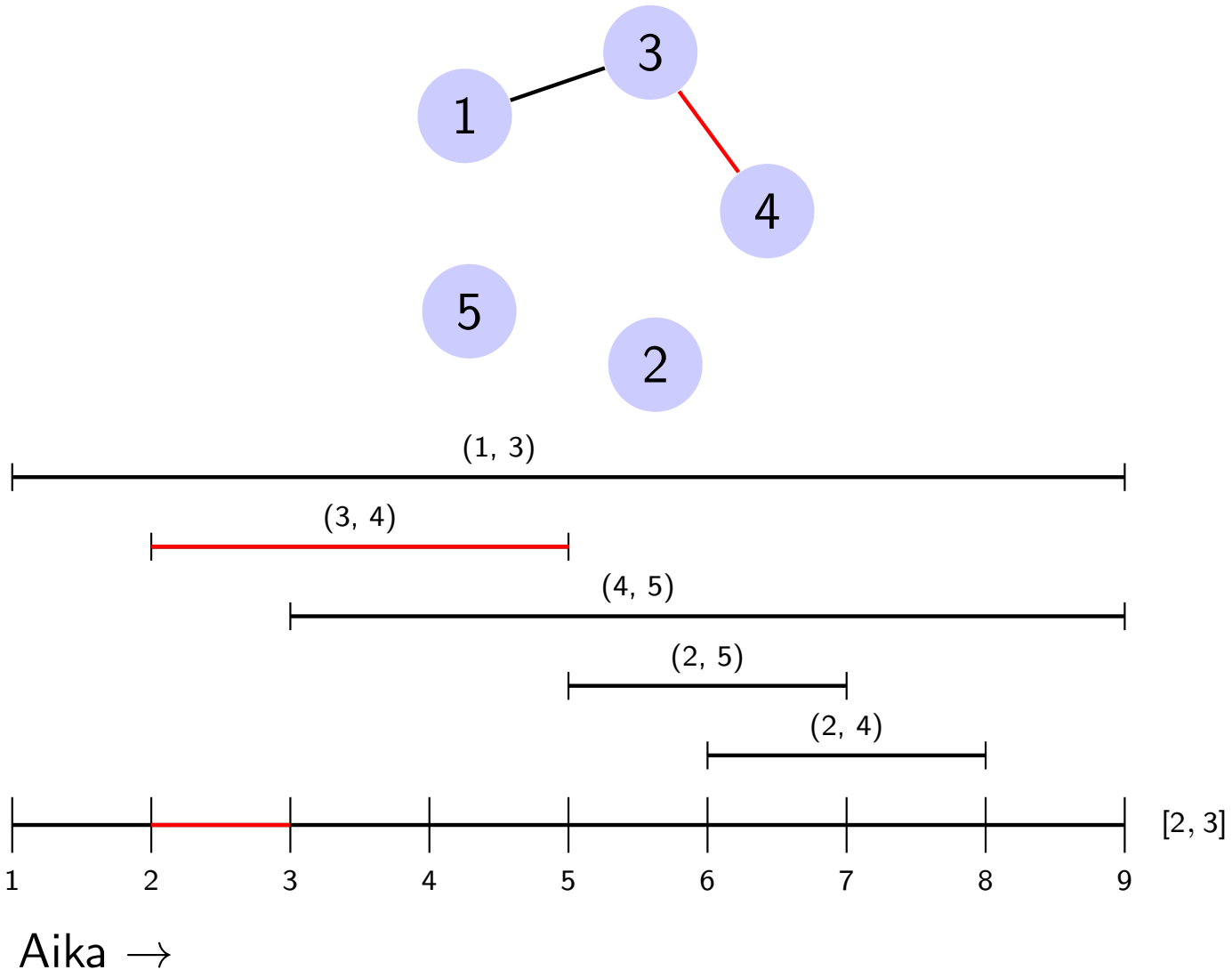

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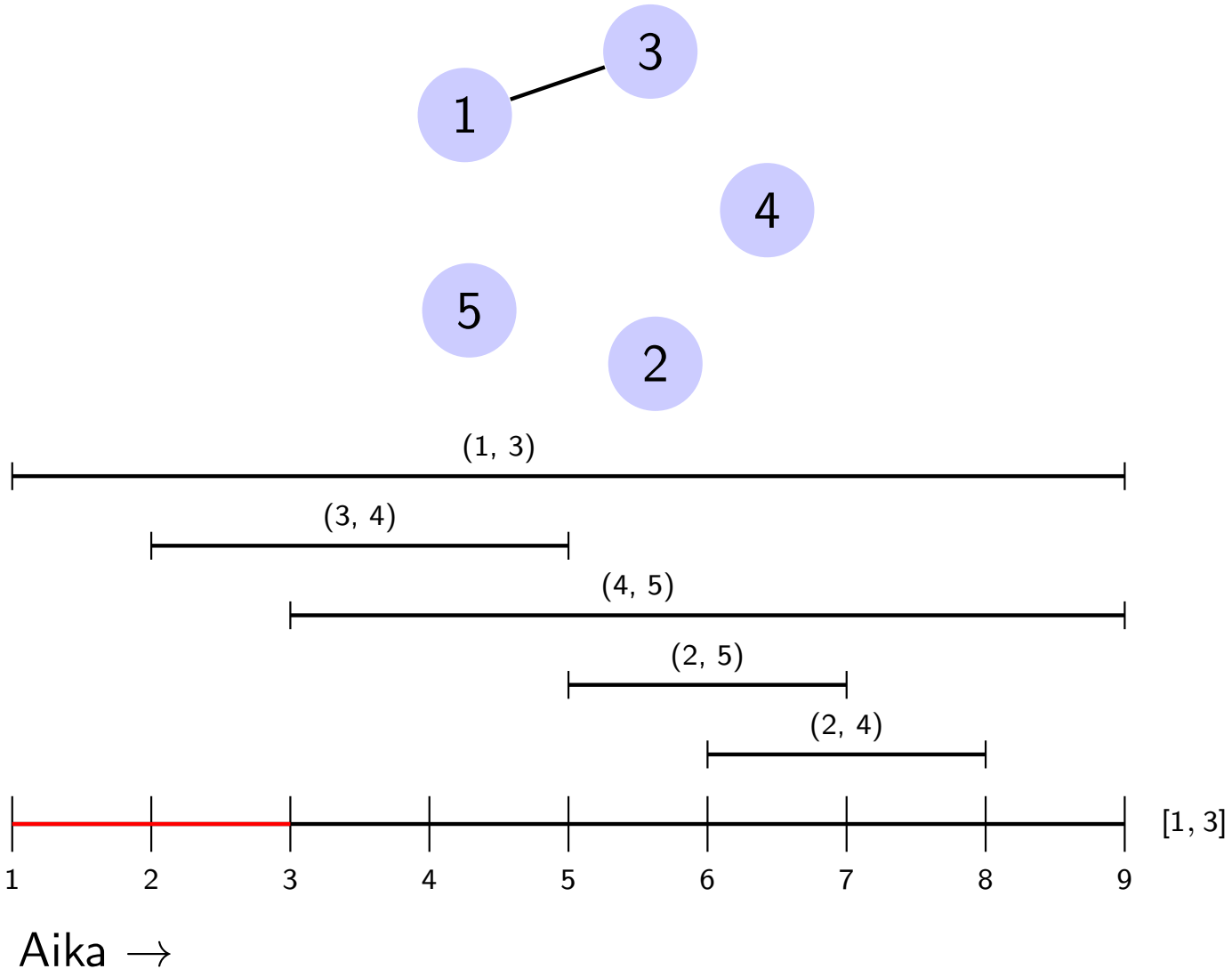

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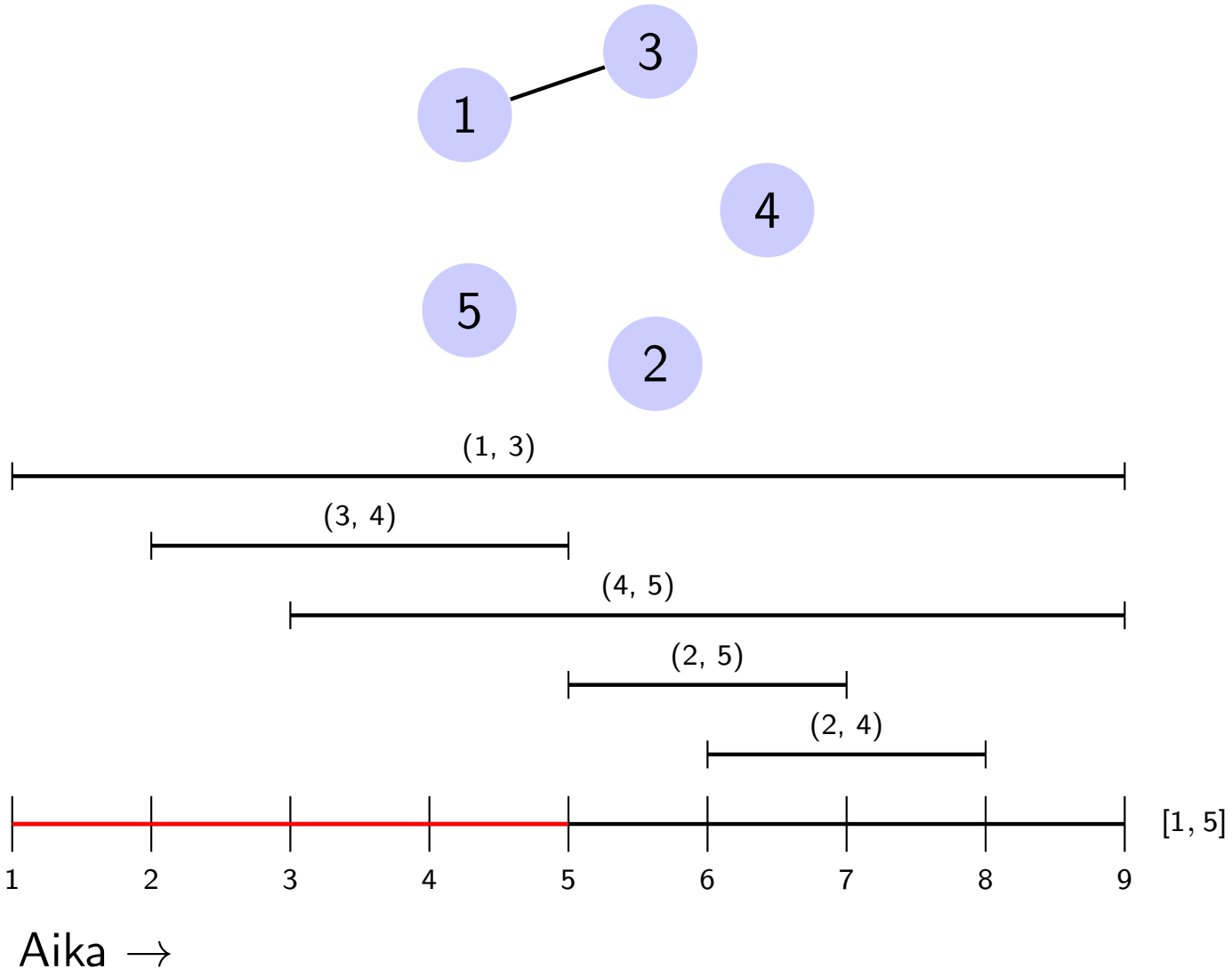

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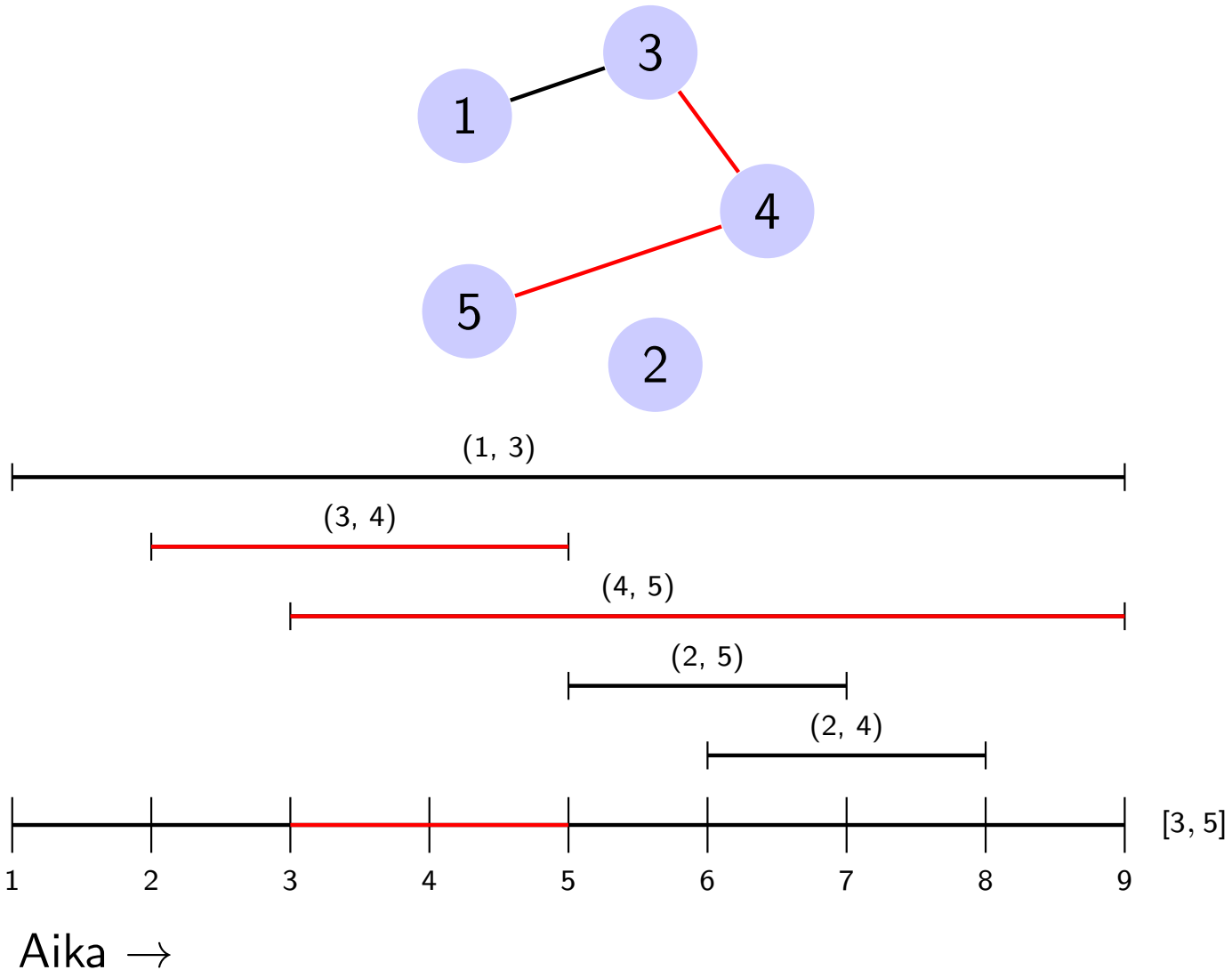

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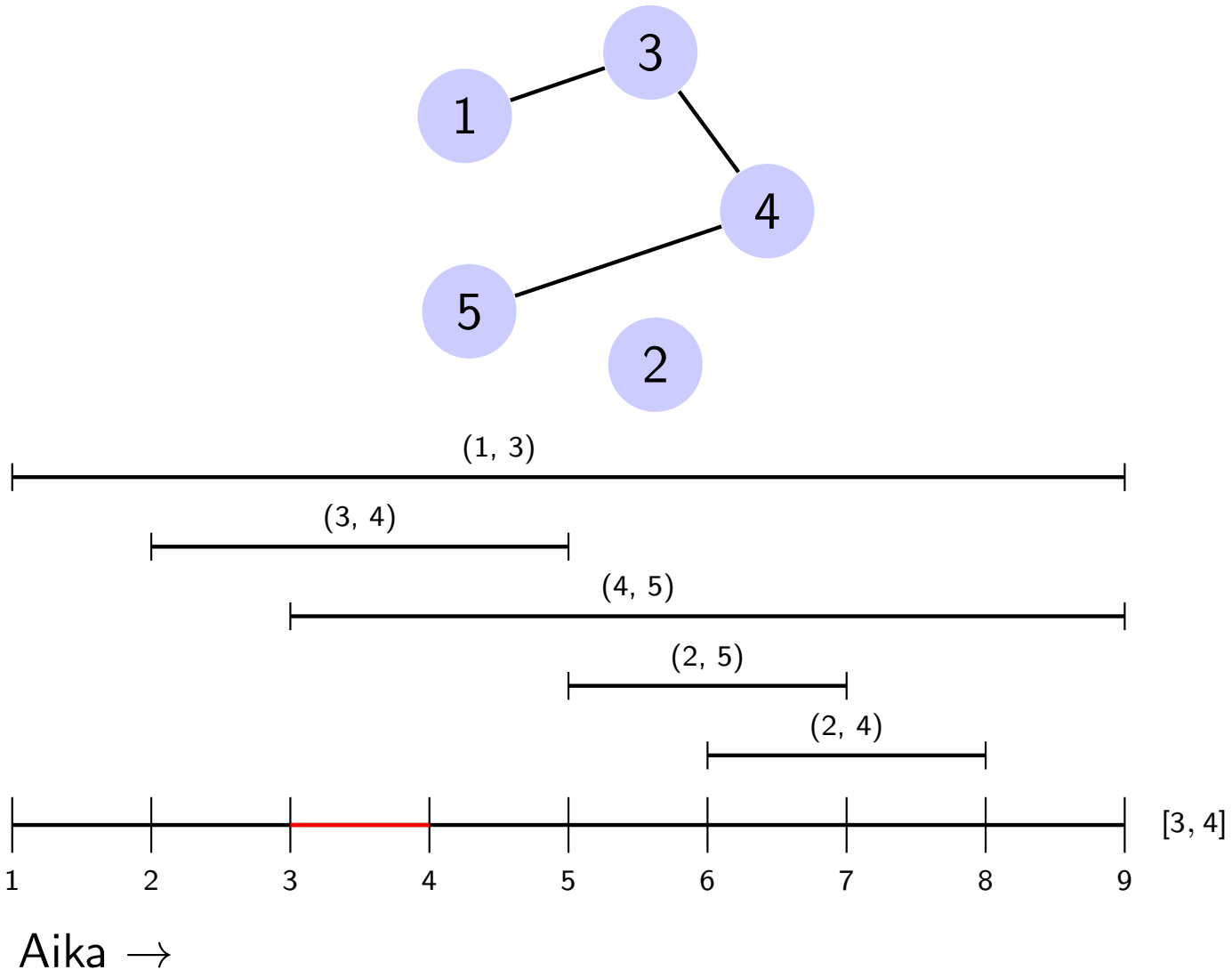

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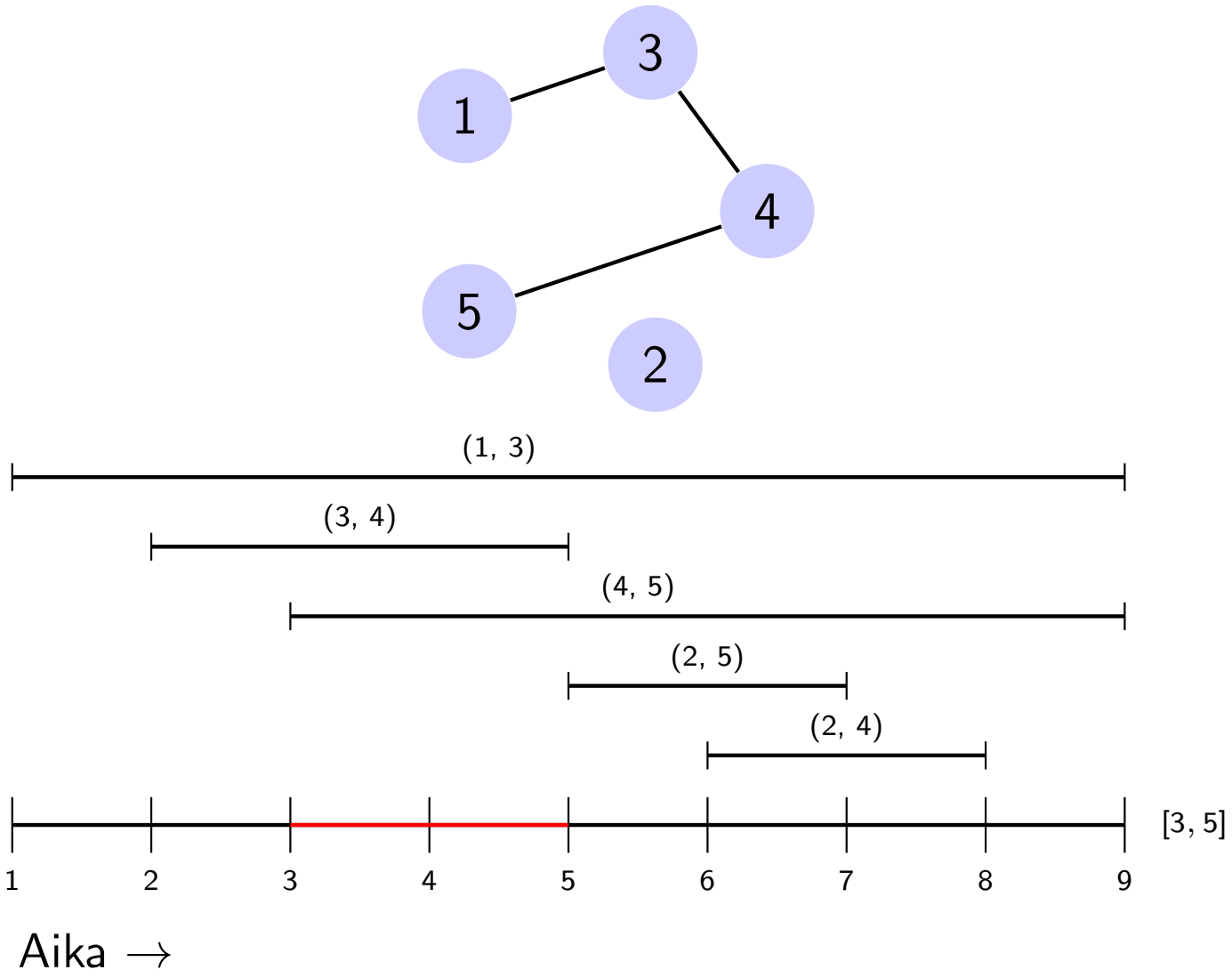

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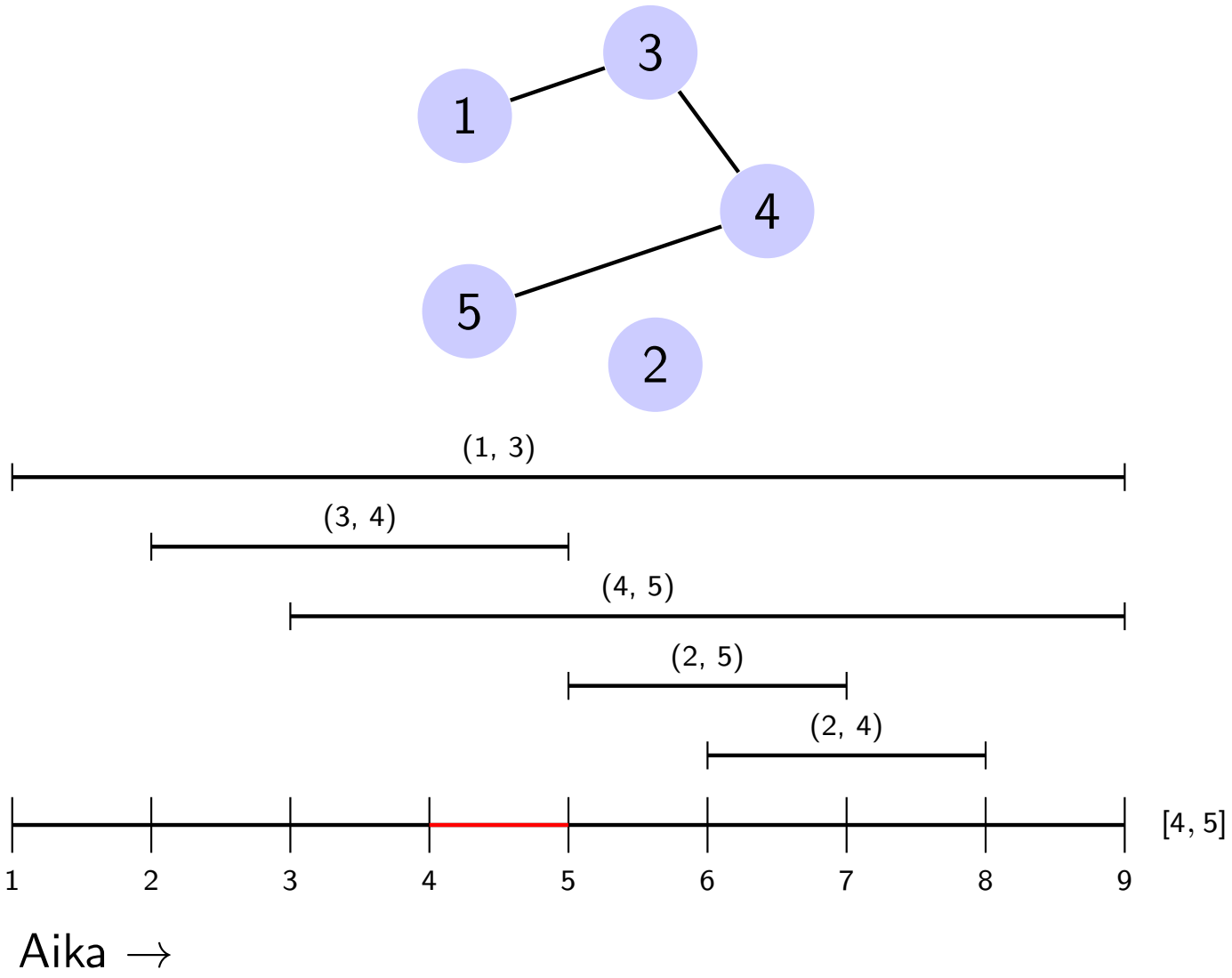

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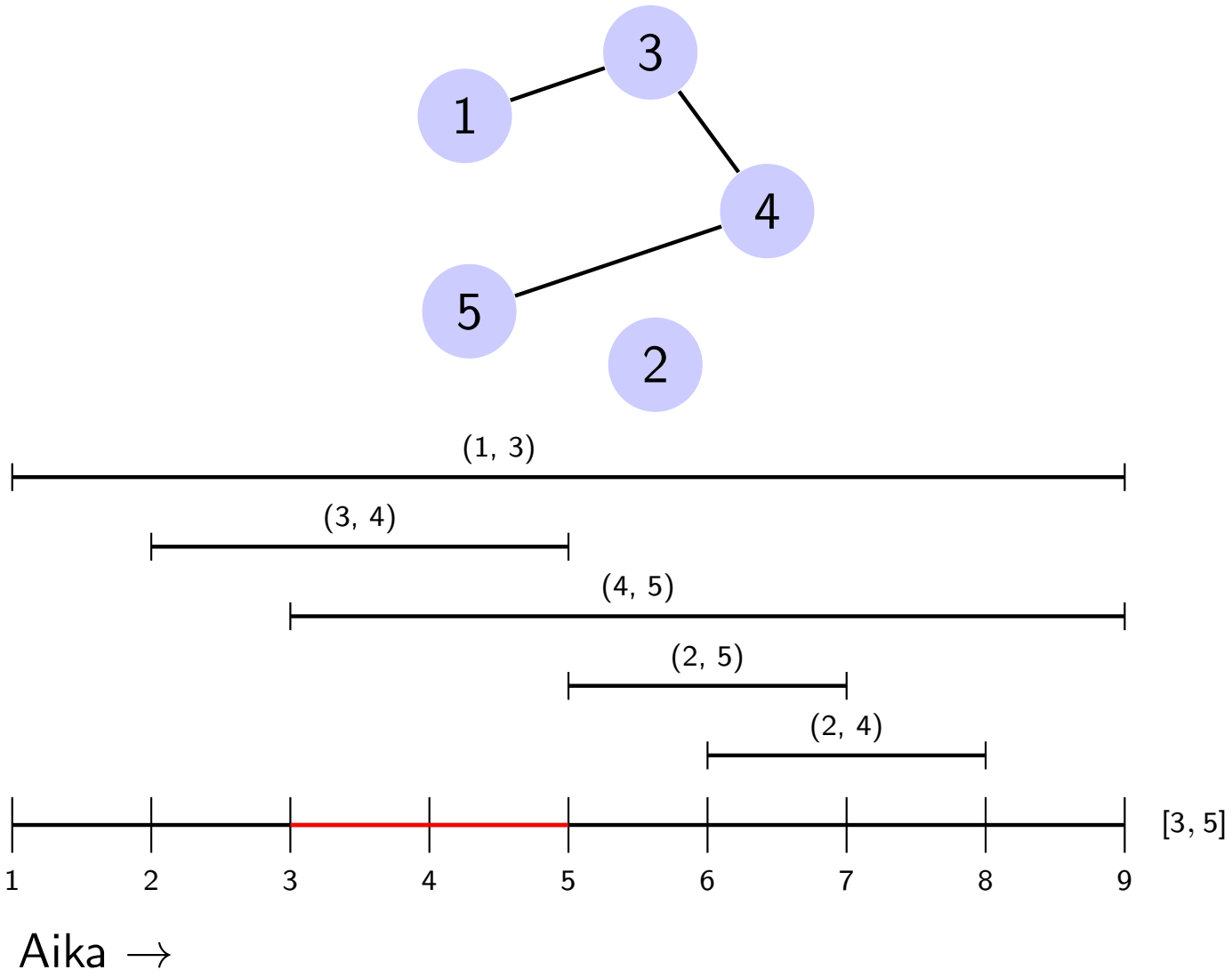

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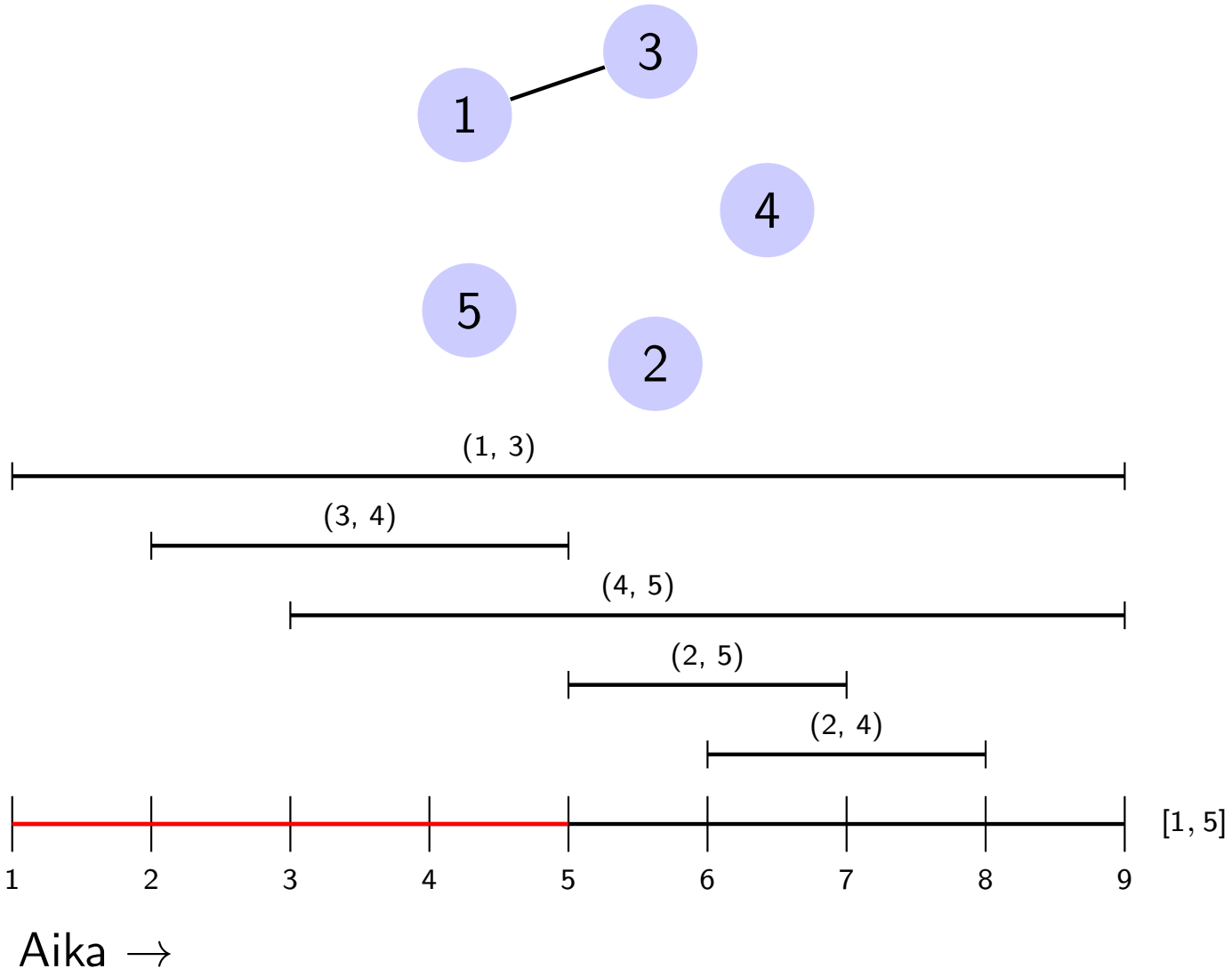

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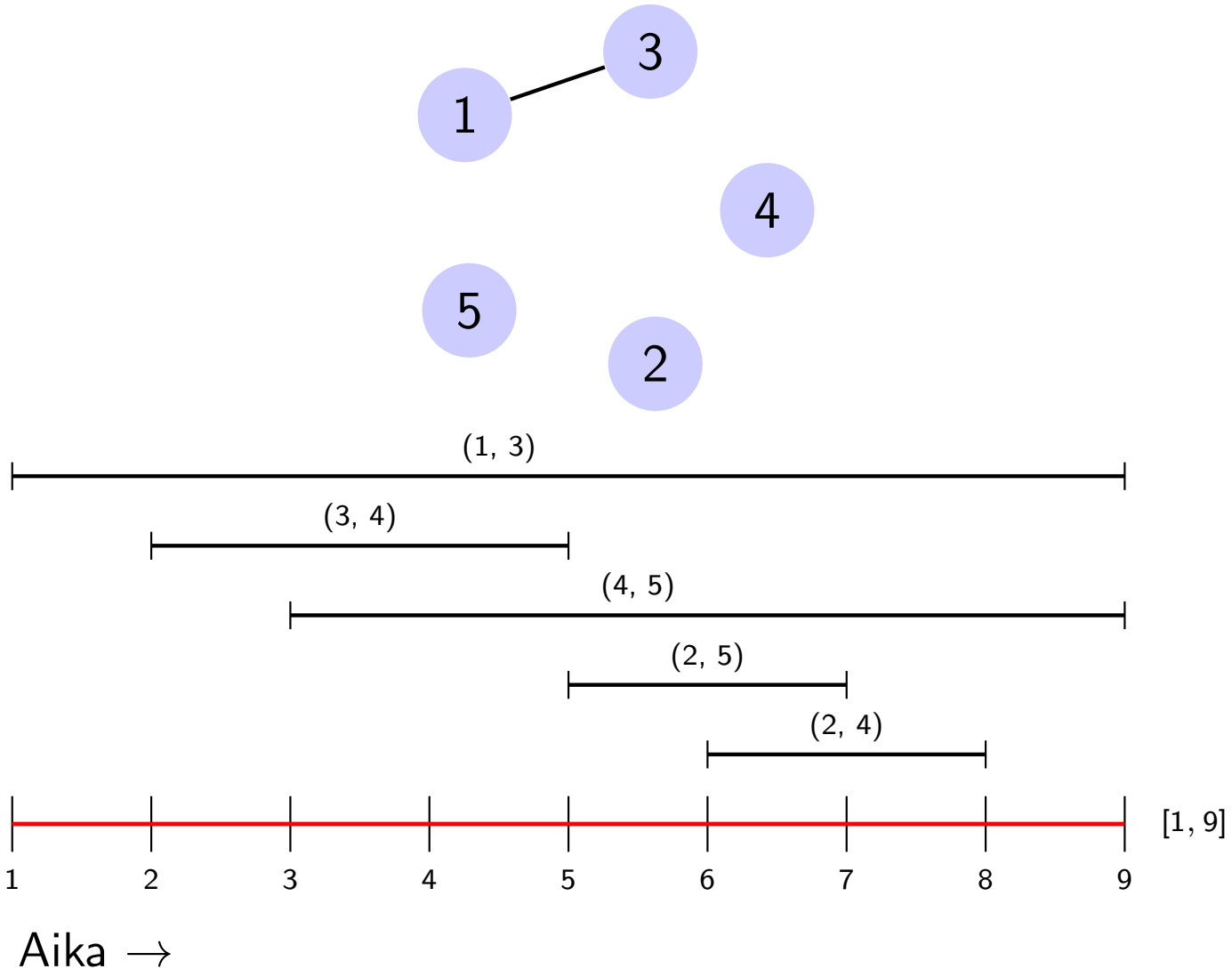

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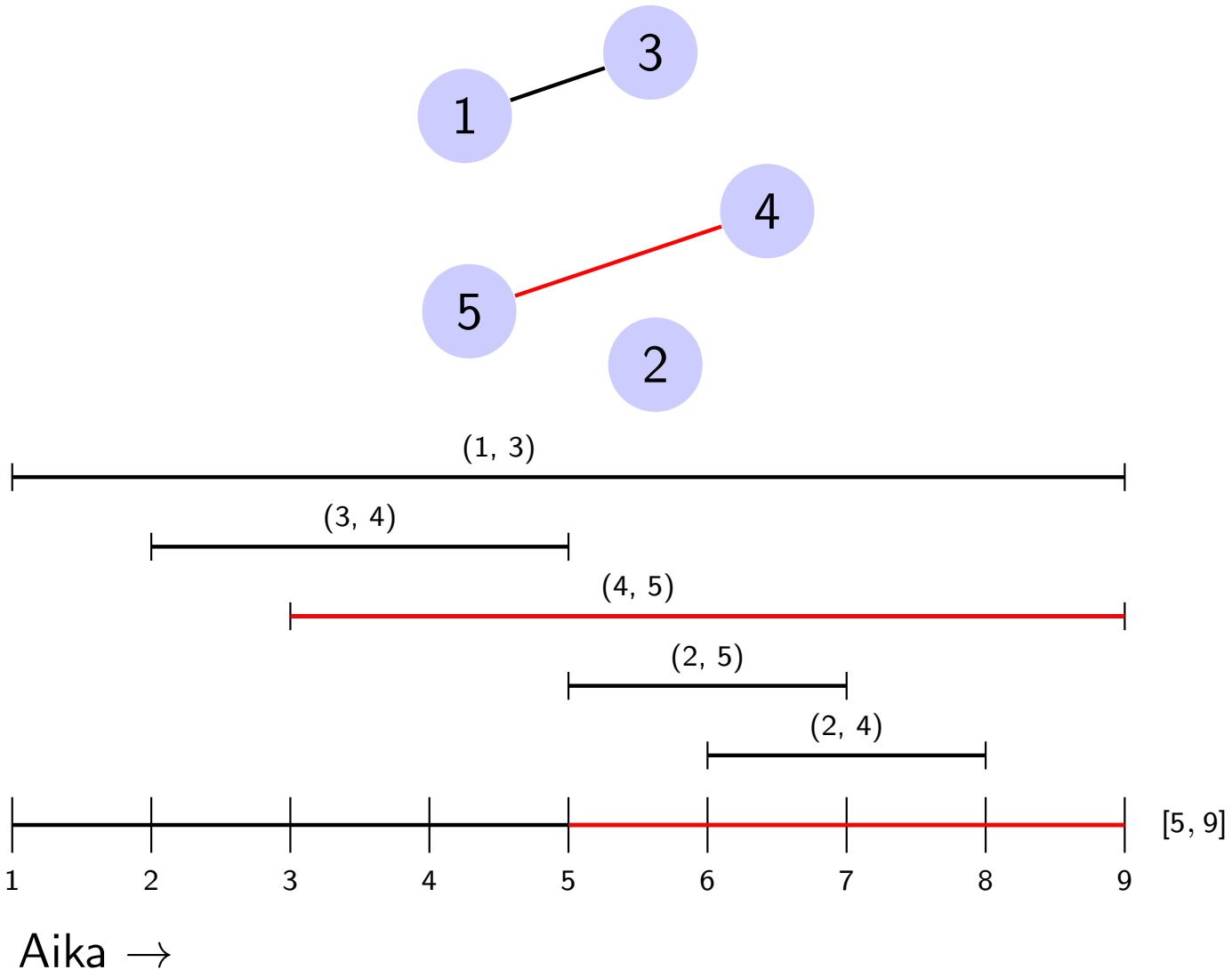

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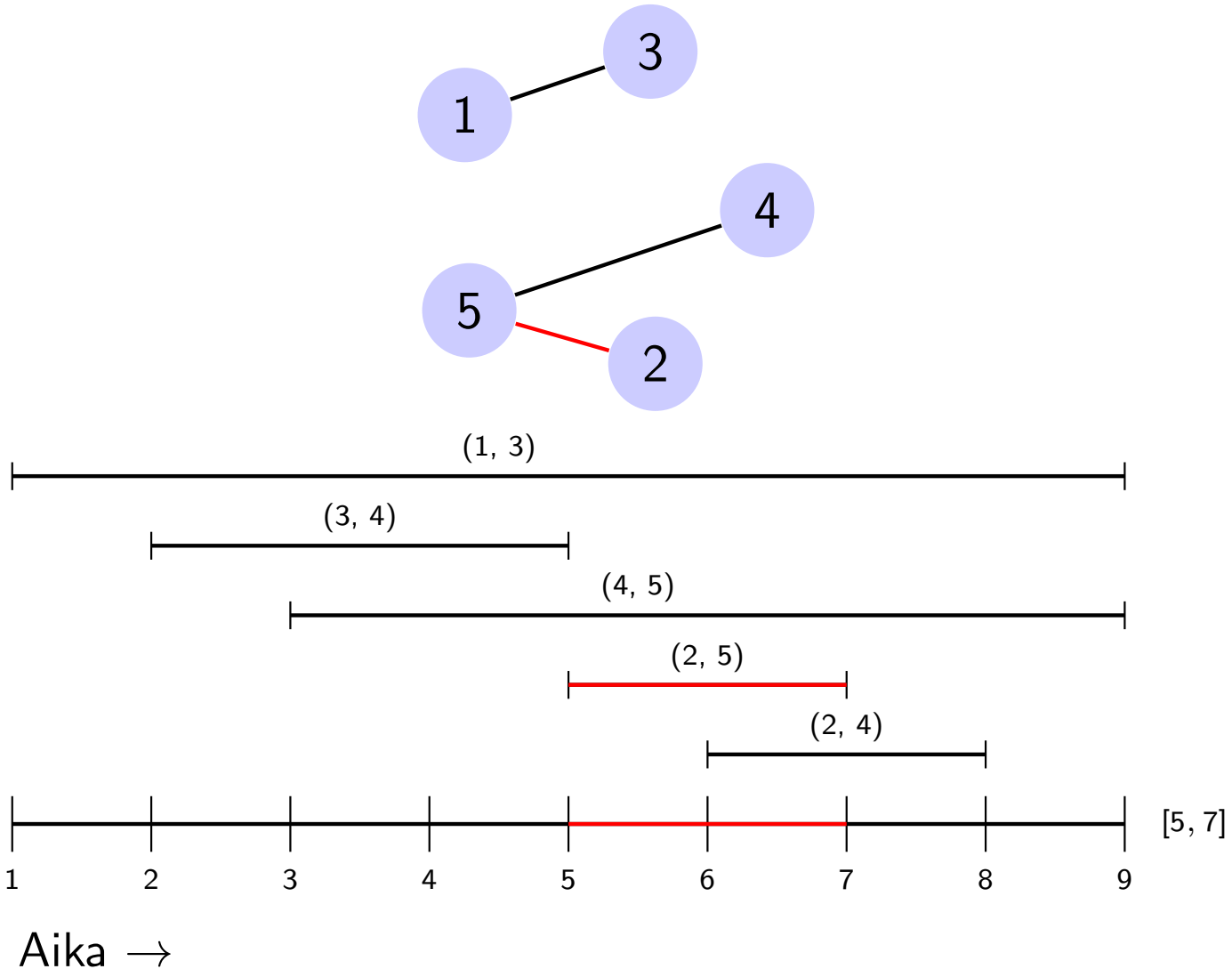

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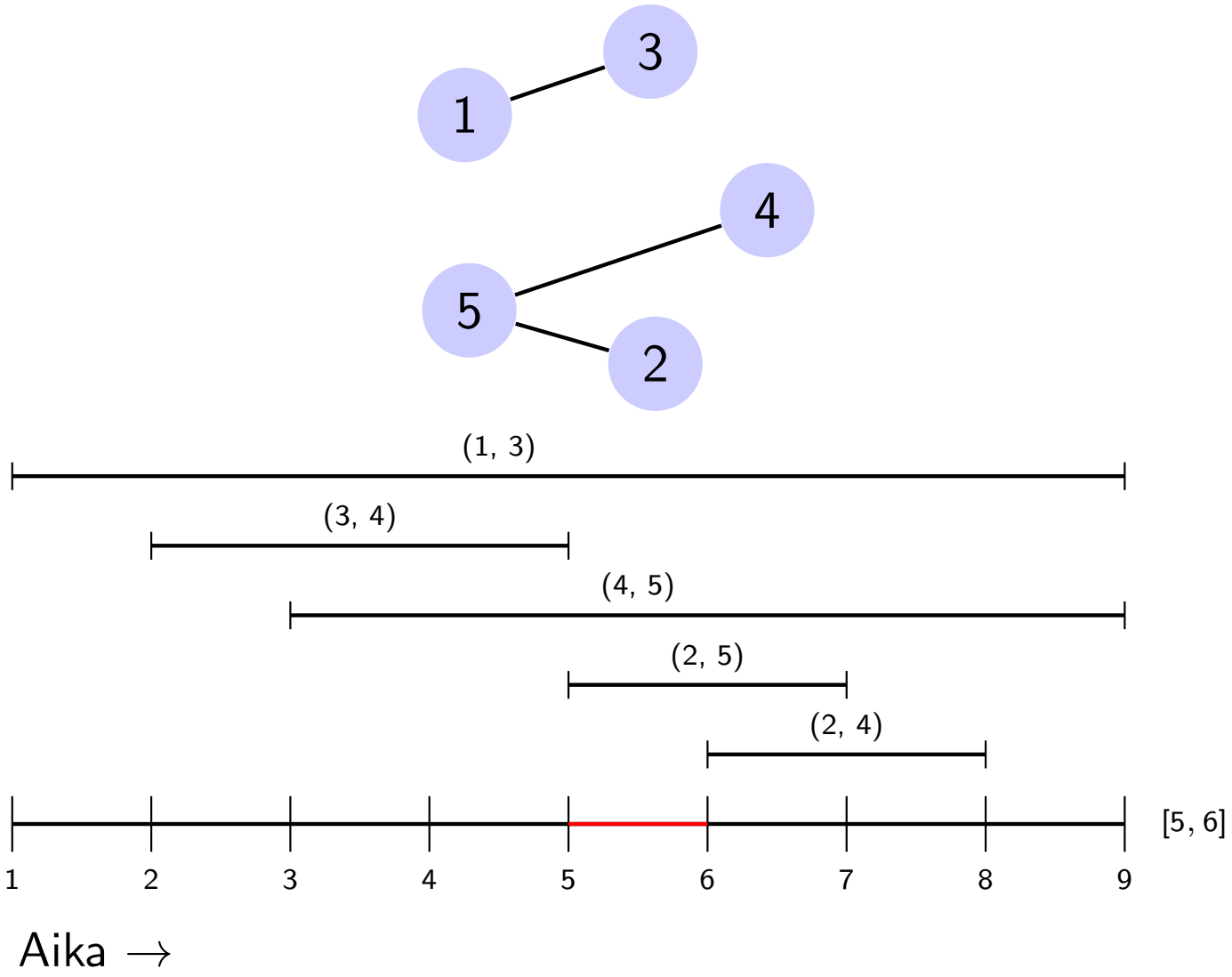

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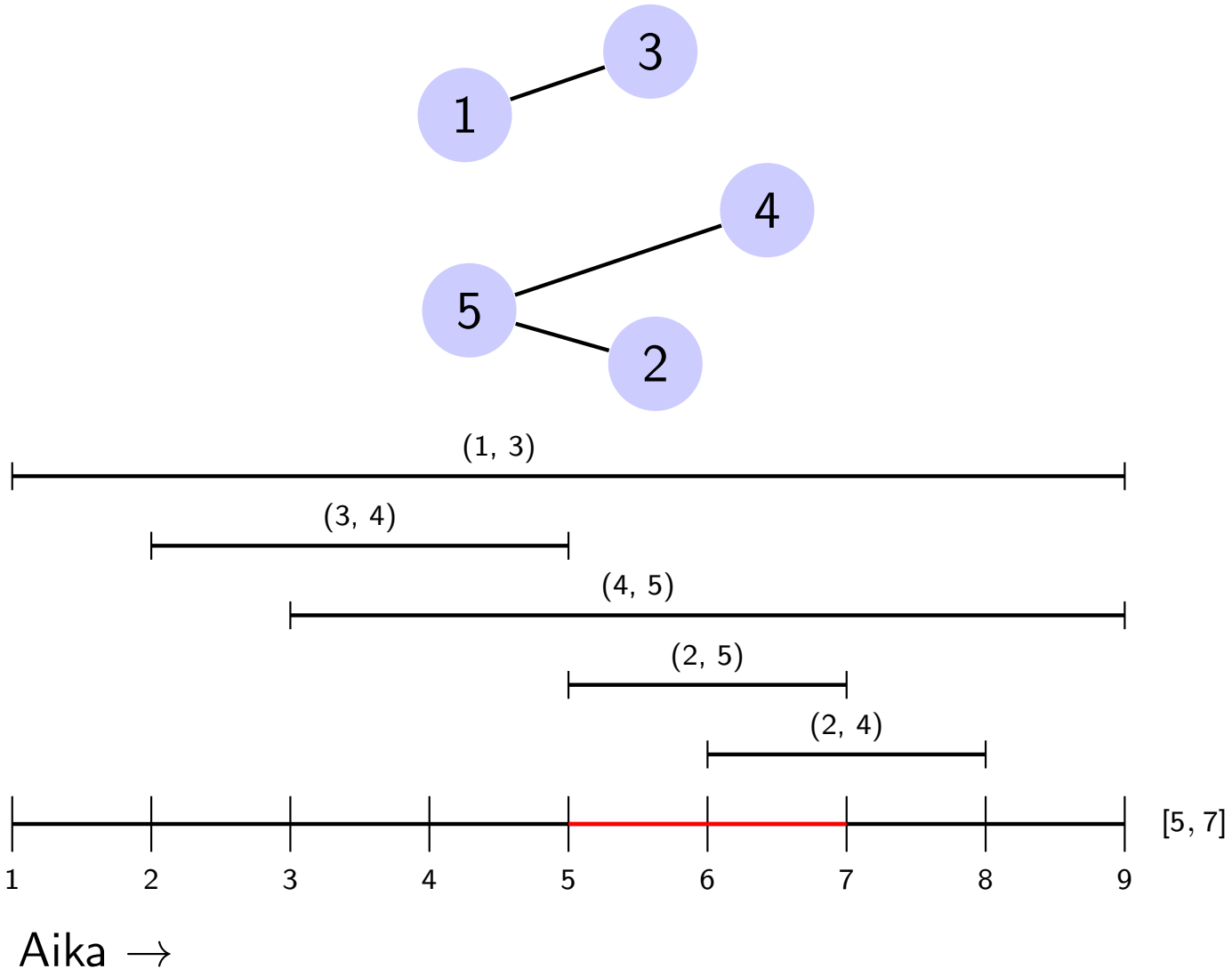

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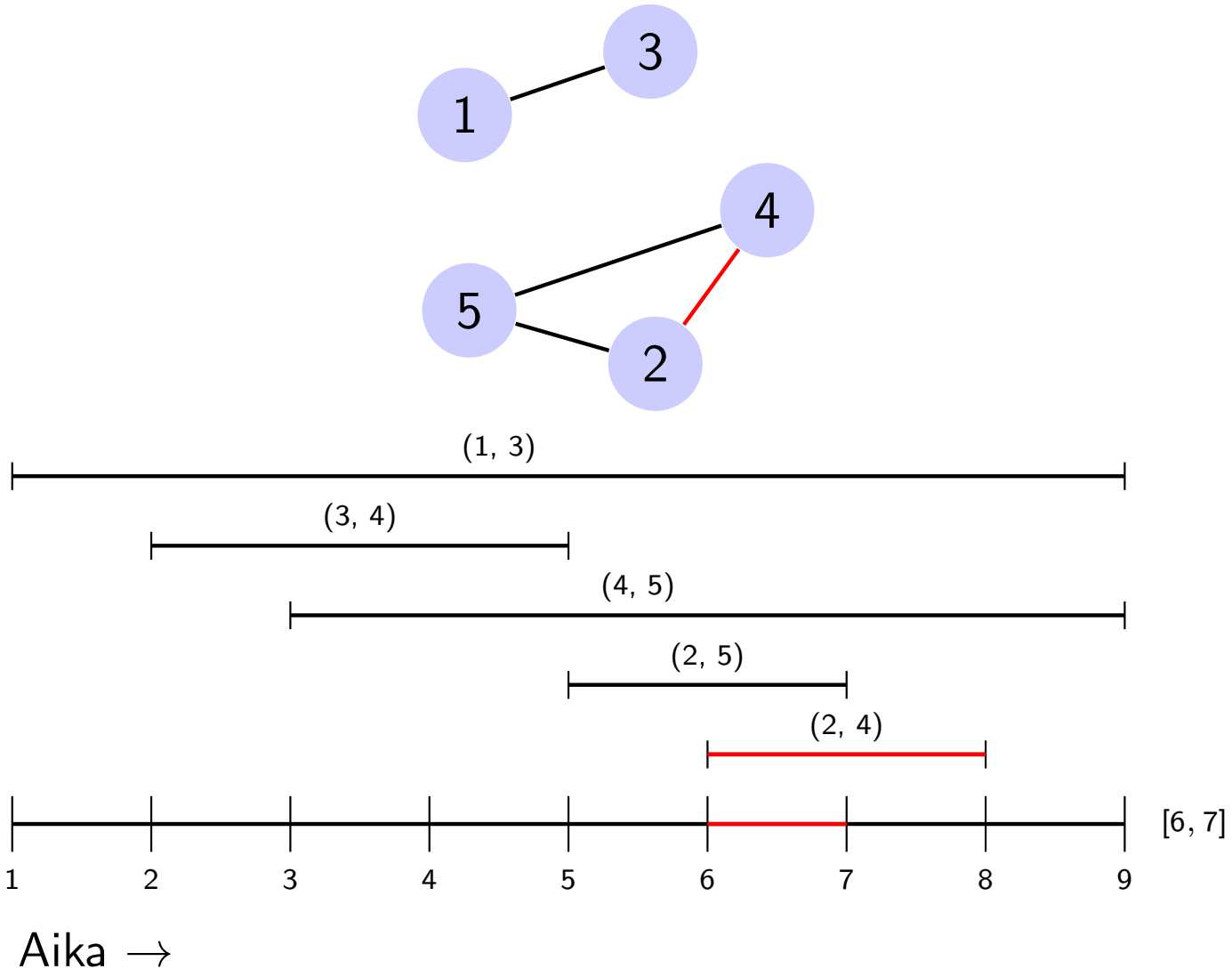

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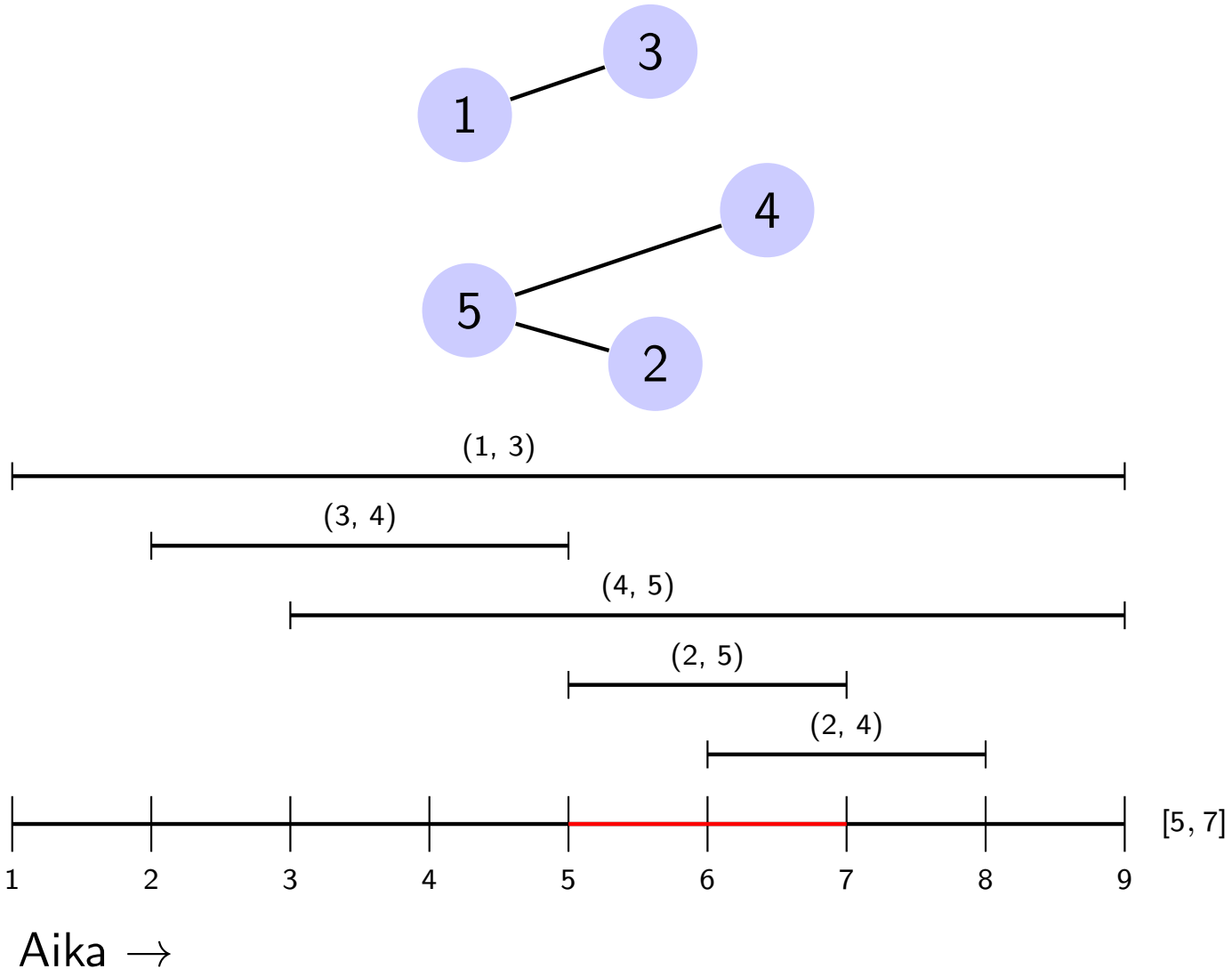

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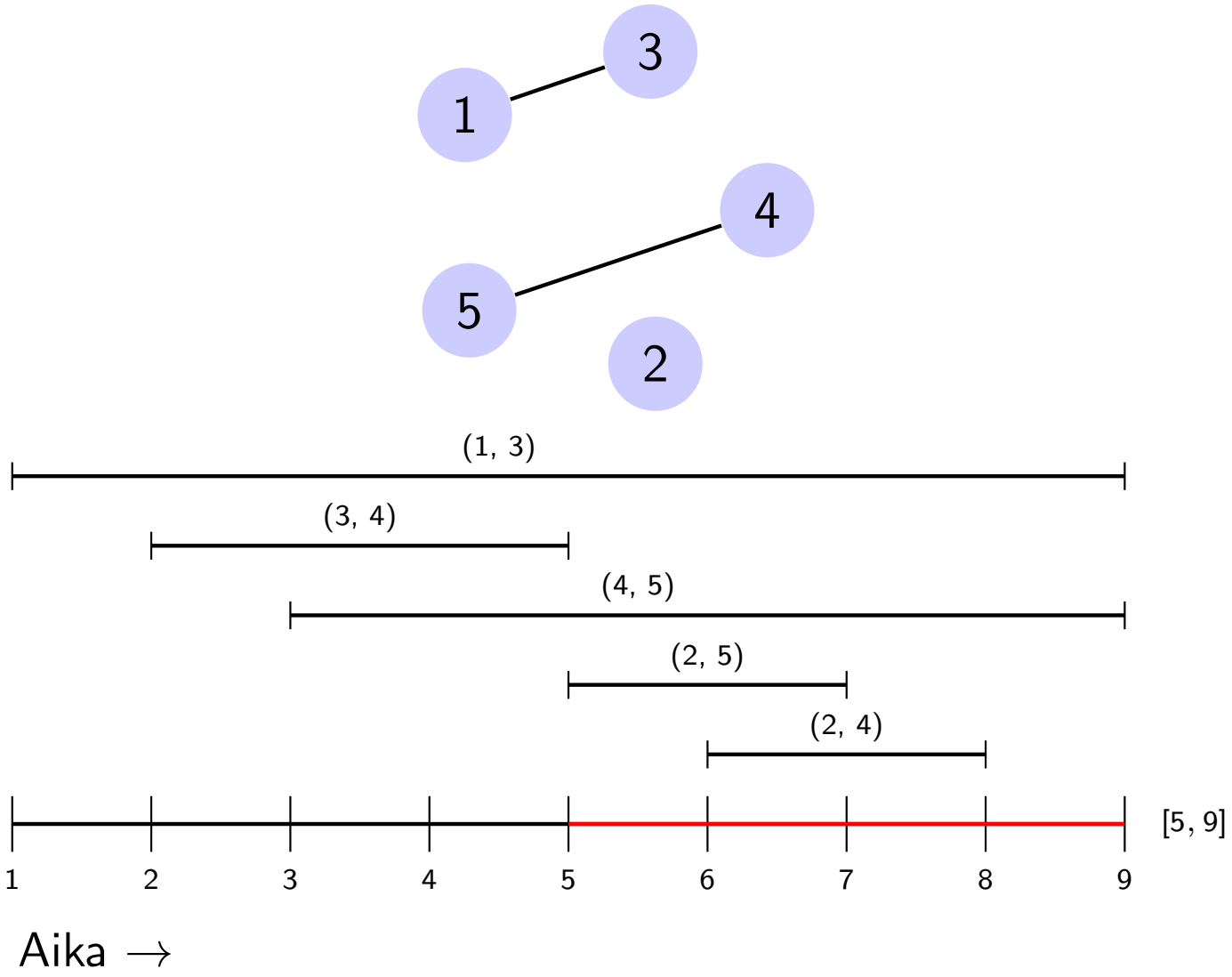

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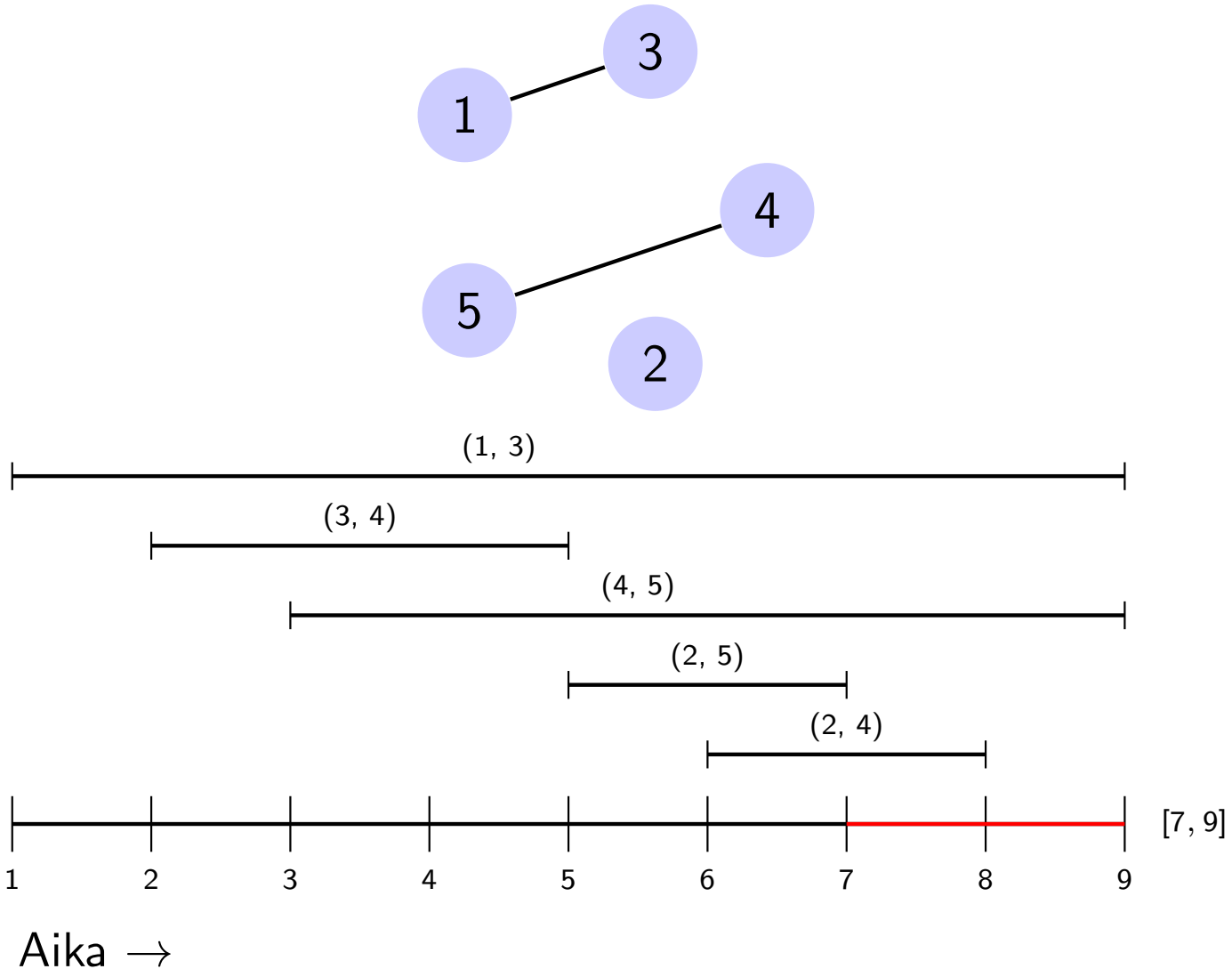

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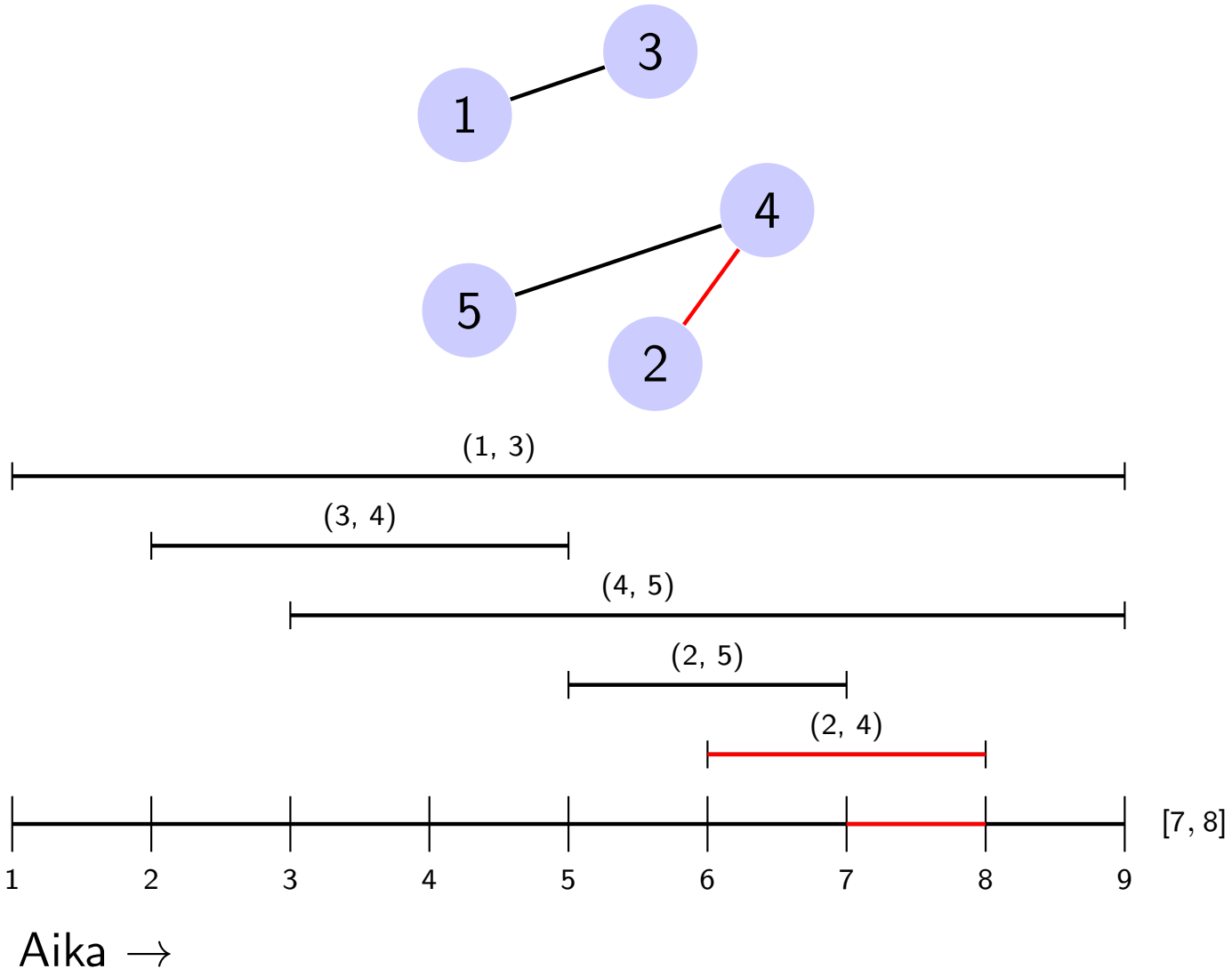

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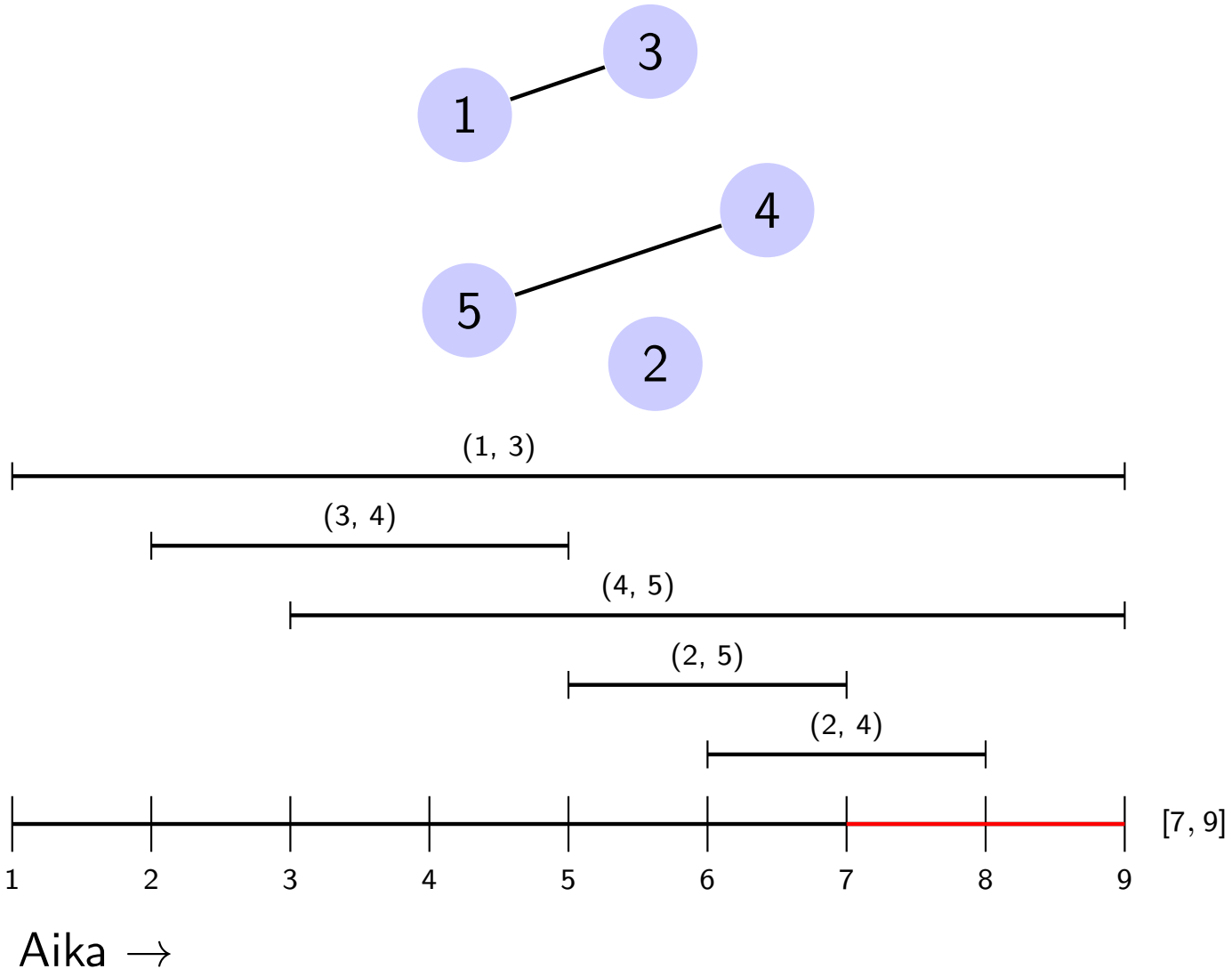

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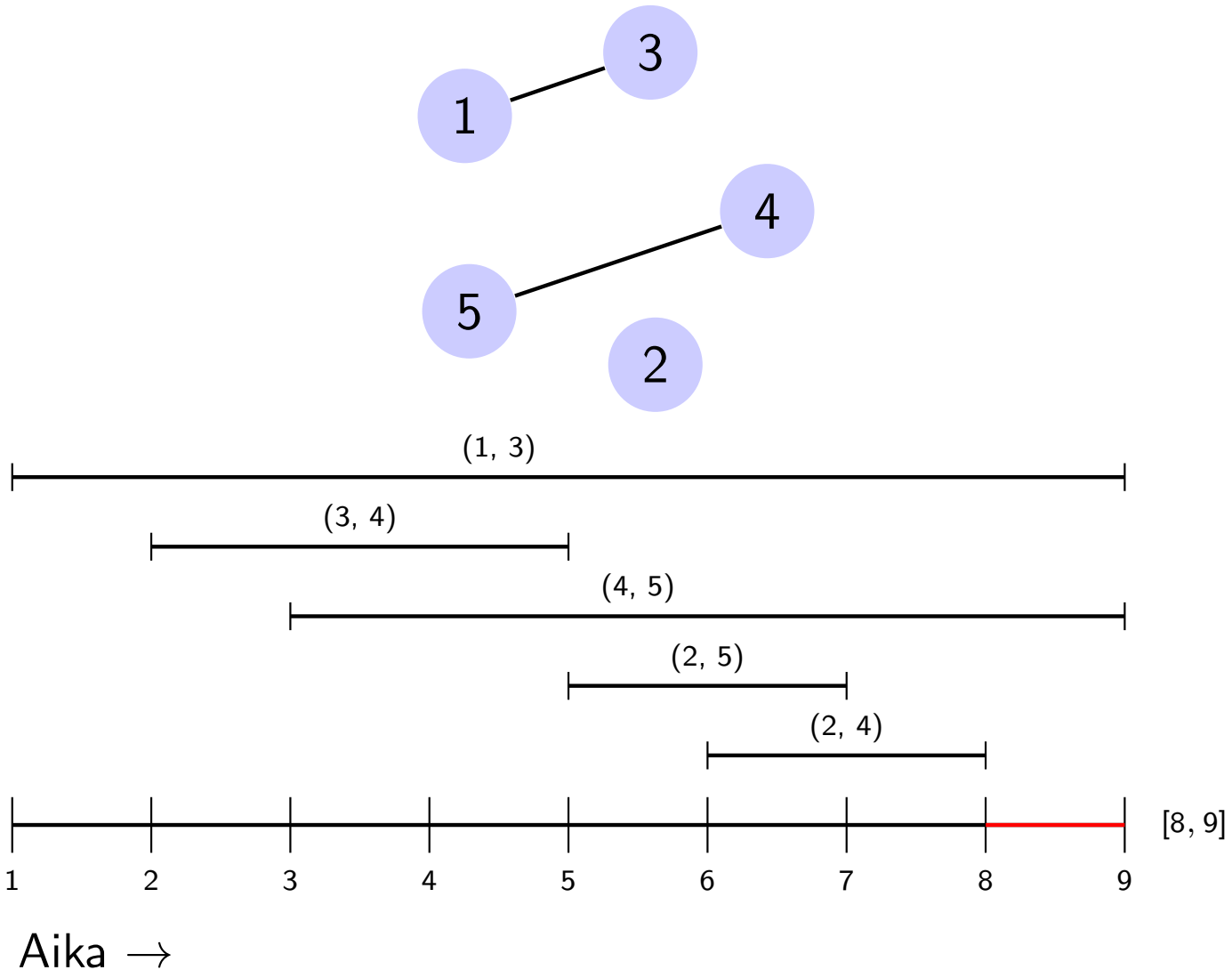

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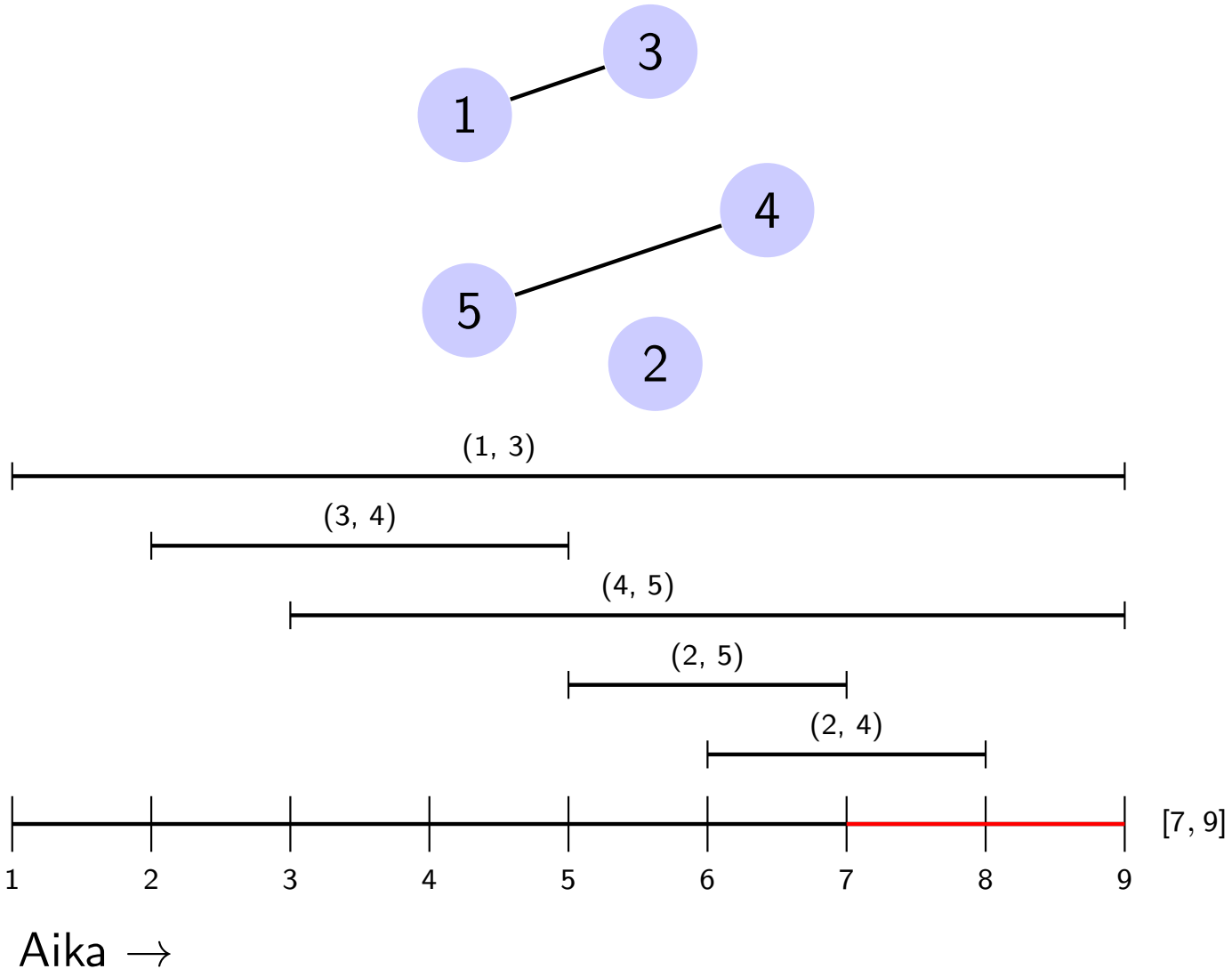

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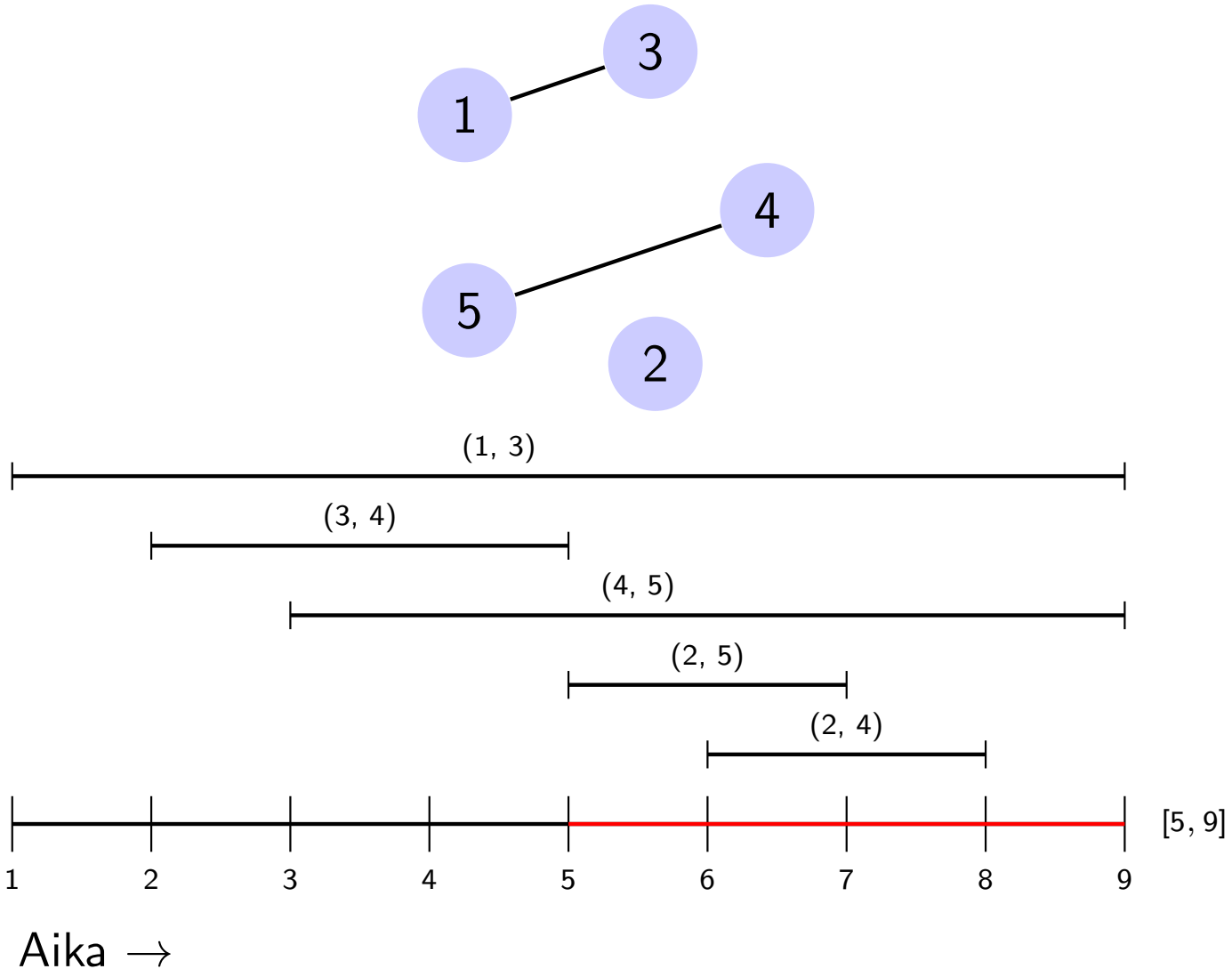

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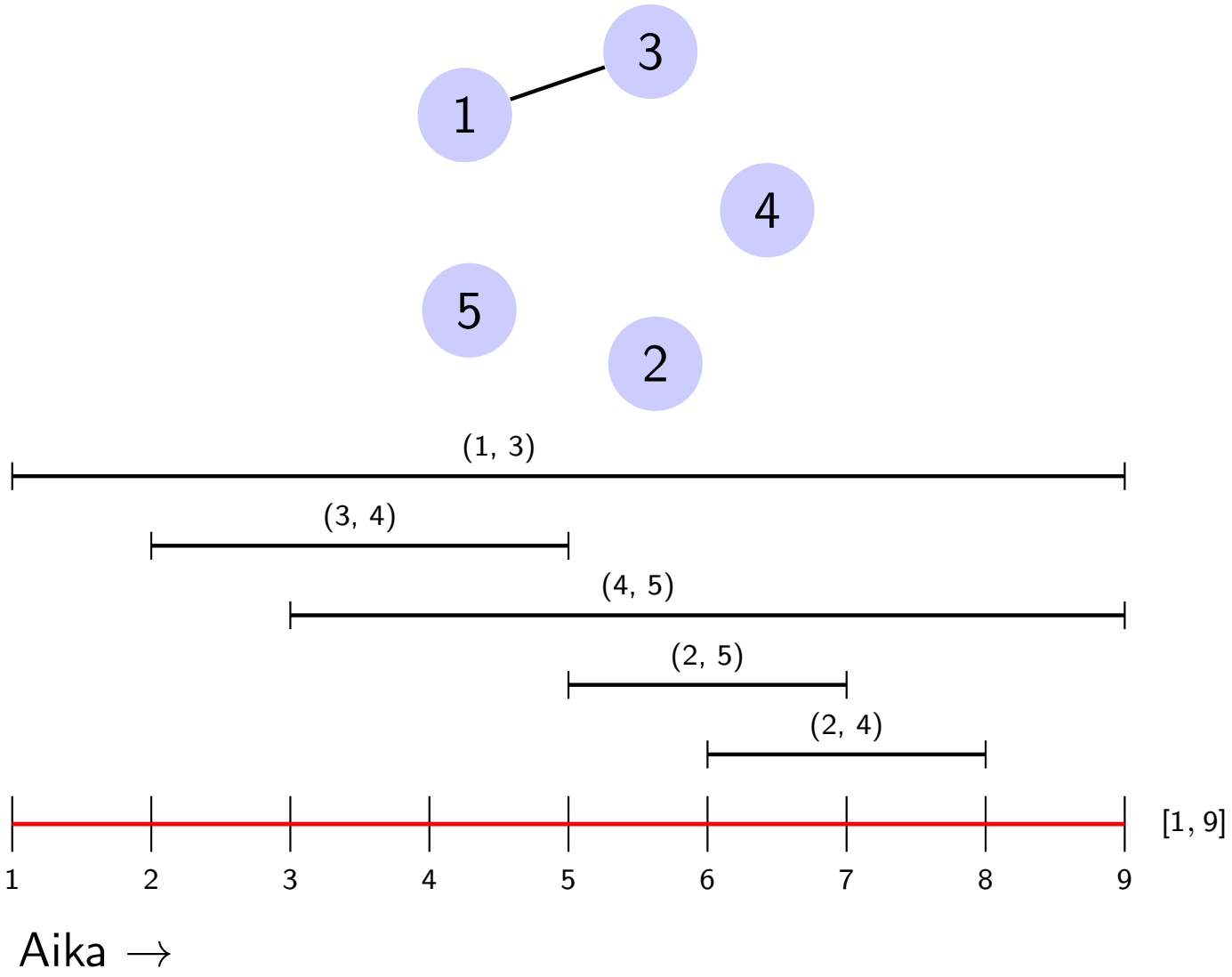

Offline algoritmi

- Jokainen kaari lisätään maksimissaan $O(\log n)$ kertaa
- Aikavaativuus on siis $O(n \log^2 n)$
- On olemassa myös toteutus joka ei käytä union-find rakennetta jolloin saadaan $O(n \log n)$ aikavaativuus

Online algoritmeja

- Jos verkko on metsä, link/cut tree-tietorakenteella voi vastata dynaamisen yhtäisyyden kyselyihin $O(\log n)$ ajassa
- Paras tunnettu tietorakenne yleiseen dynaamiseen yhtenäisyyteen vastaa kaarien lisäys/poisto kyselyihin $O(\log^2 n / \log \log n)$ ajassa ja yhtenäisyys kyselyihin $O(\log n / \log \log n)$ ajassa