Brief Anouncement:
Tight Bounds for Repeated Balls-into-Bins

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Balanced allocations setting

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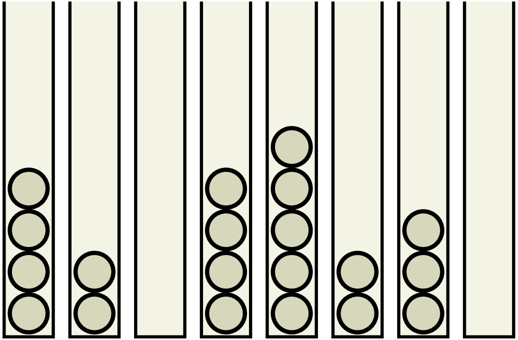

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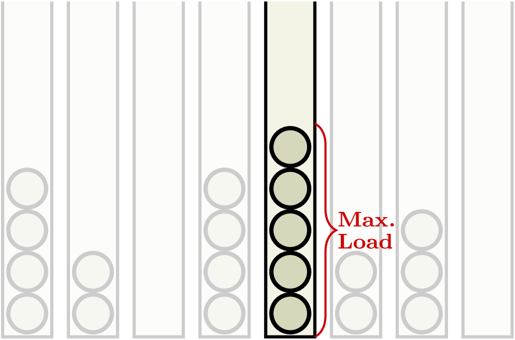

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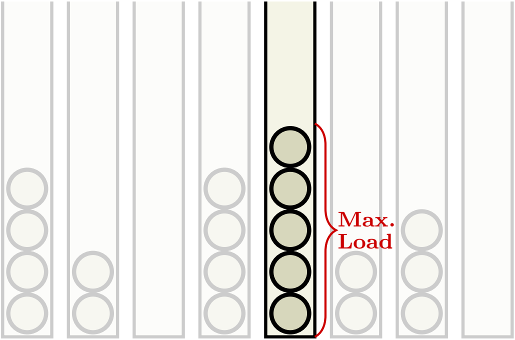

- (ONE-CHOICE) Allocating each ball uniformly at random for $m = \Omega(n \log n)$ gives w.h.p. a maximum load of: $\frac{m}{n} + \Theta(\sqrt{\frac{m}{n} \cdot \log n})$.

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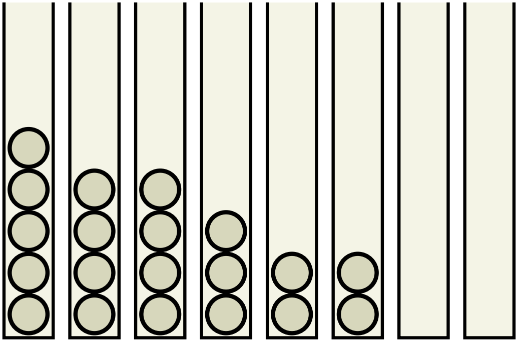

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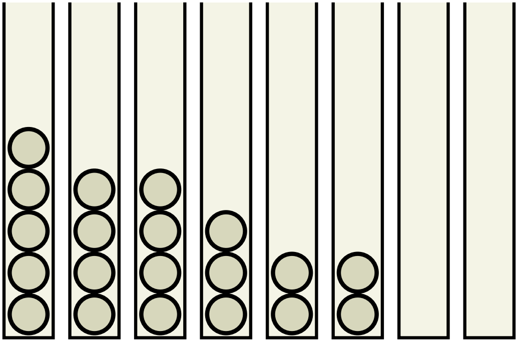

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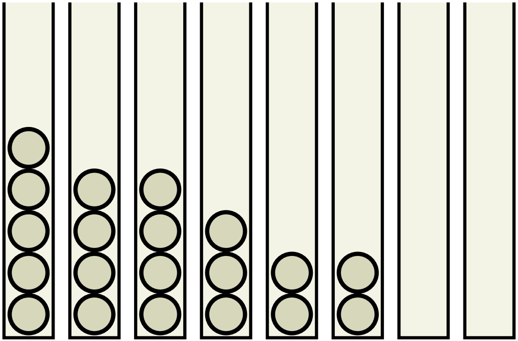

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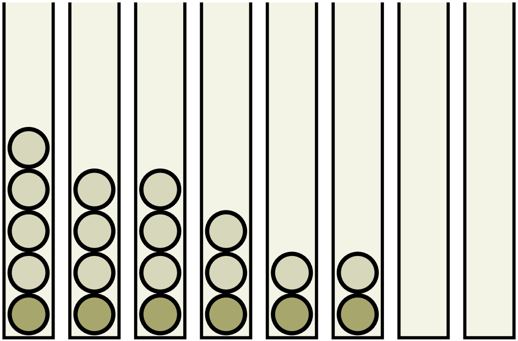

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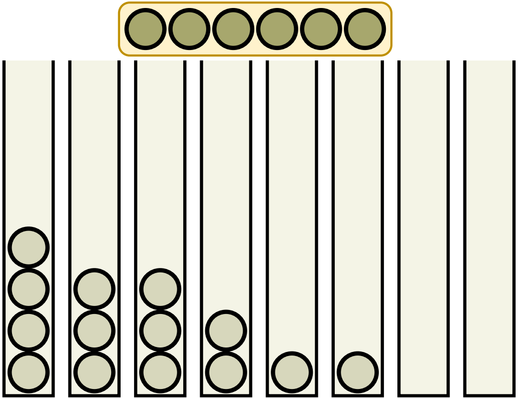

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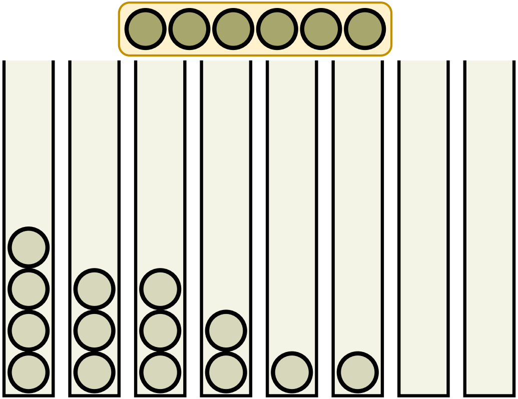

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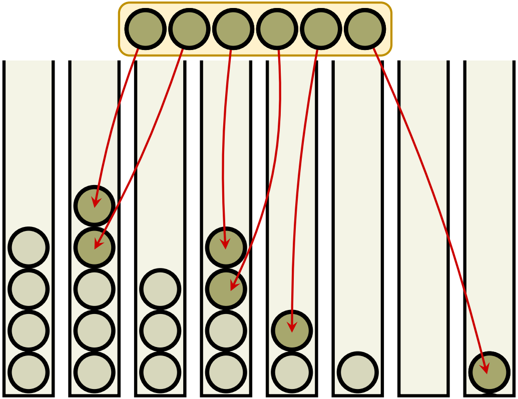

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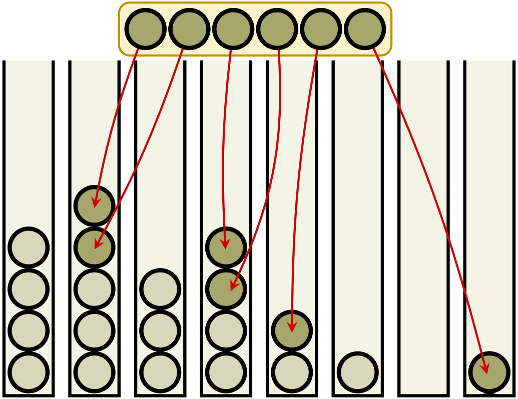

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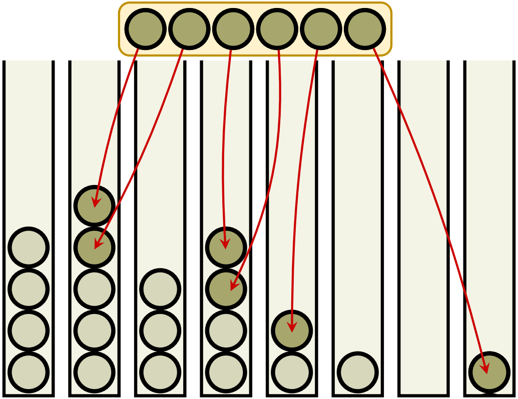

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Open in Visualiser.

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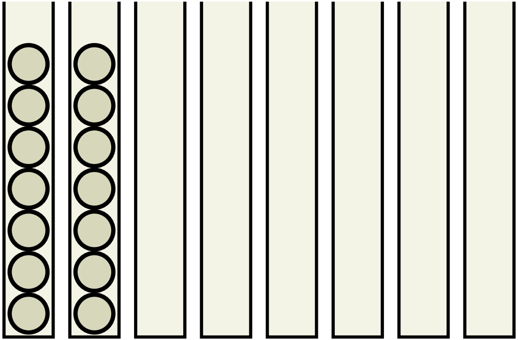

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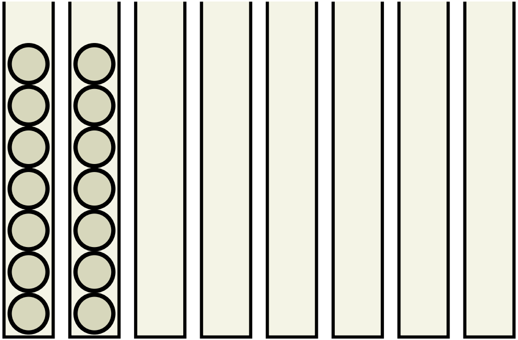
- Starting with an unbalanced configuration, the process eventually stabilises in a balanced configuration.



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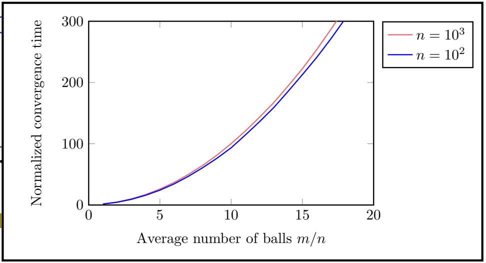

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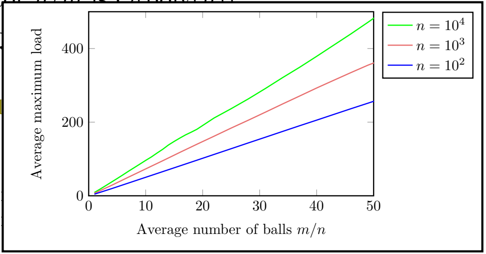

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- *What is the maximum load once stabilized (for* $\mathrm{poly}(n)$ *rounds)?*
  - For $m = n$, w.h.p. the maximum load is $\mathcal{O}(\log n)$ [BCN+19].
    - Conjectured for $m = n$, the maximum load is $\omega(\log n / \log \log n)$. ✓
    - Conjectured for $m = n \log n$, the maximum load is $\mathcal{O}(\log n)$. ✗
  - We show that:
    - For any $m = \mathrm{poly}(n)$, w.h.p. the maximum load is $\mathcal{O}(\frac{m}{n} \cdot \log n)$.
    - For any $m = \mathrm{poly}(n)$, w.h.p. the maximum load is w.h.p. $\Omega(\frac{m}{n} \cdot \log n)$.
      - $\rightsquigarrow$ On average, $\Omega(n/m)$ fraction of empty bins (quadratic and exponential potentials)
      - $\rightsquigarrow$ Coupling with One-Choice
- *How many rounds for all balls to traverse all bins?*
  - For $m = n$, w.h.p. traversal time is $\Omega(n \log n)$ and $\mathcal{O}(n \log^2 n)$ [BCN+19].

Questions of interest and Results

- *Does the process stabilize?*
  - For $m = n$, w.h.p. it stabilizes in $\mathcal{O}(n)$ rounds [BCN+19].
  - For any $m = \text{poly}(n)$, w.h.p. it stabilizes in $\mathcal{O}(m^2/n)$ rounds.
    - $\rightsquigarrow$ On average, $\Omega(n/m)$ fraction of empty bins (using random walks),
    - $\rightsquigarrow$ Exponential potential with smoothing factor n/m is $\mathcal{O}(\text{poly}(n))$.
- *What is the maximum load once stabilized (for* poly(n) *rounds)?*
  - For $m = n$, w.h.p. the maximum load is $\mathcal{O}(\log n)$ [BCN+19].
    - Conjectured for $m = n$, the maximum load is $\omega(\log n / \log \log n)$. ✓
    - Conjectured for $m = n \log n$, the maximum load is $\mathcal{O}(\log n)$. ✗
  - We show that:
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      - $\rightsquigarrow$ On average, $\Omega(n/m)$ fraction of empty bins (quadratic and exponential potentials)
      - $\rightsquigarrow$ Coupling with One-Choice
- *How many rounds for all balls to traverse all bins?*
  - For $m = n$, w.h.p. traversal time is $\Omega(n \log n)$ and $\mathcal{O}(n \log^2 n)$ [BCN+19].
  - For $m = \text{poly}(n)$, w.h.p. traversal time is $\Theta(m \log n)$.

Future work

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- Explore the process in the graphical setting.

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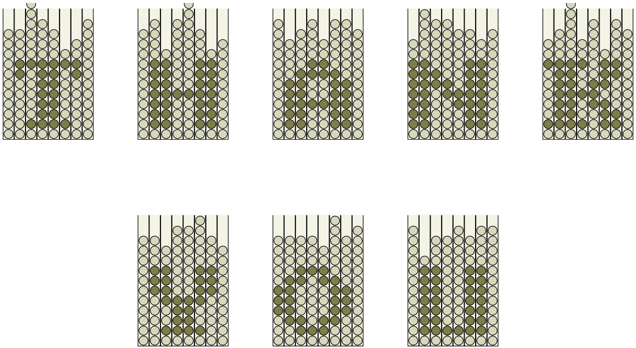
- Explore the process in the graphical setting.
- Explore versions of the process with continuous loads.

Questions?



More visualisations: `dimitrioslos.com/spaa22ba`

Bibliography I

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- ______, *Self-stabilizing repeated balls-into-bins*, Distributed Comput. **32** (2019), no. 1, 59–68.