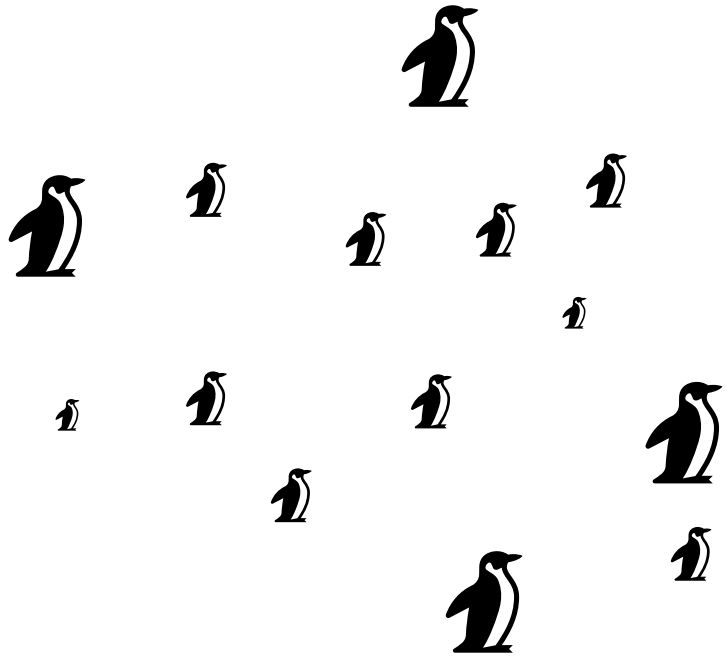
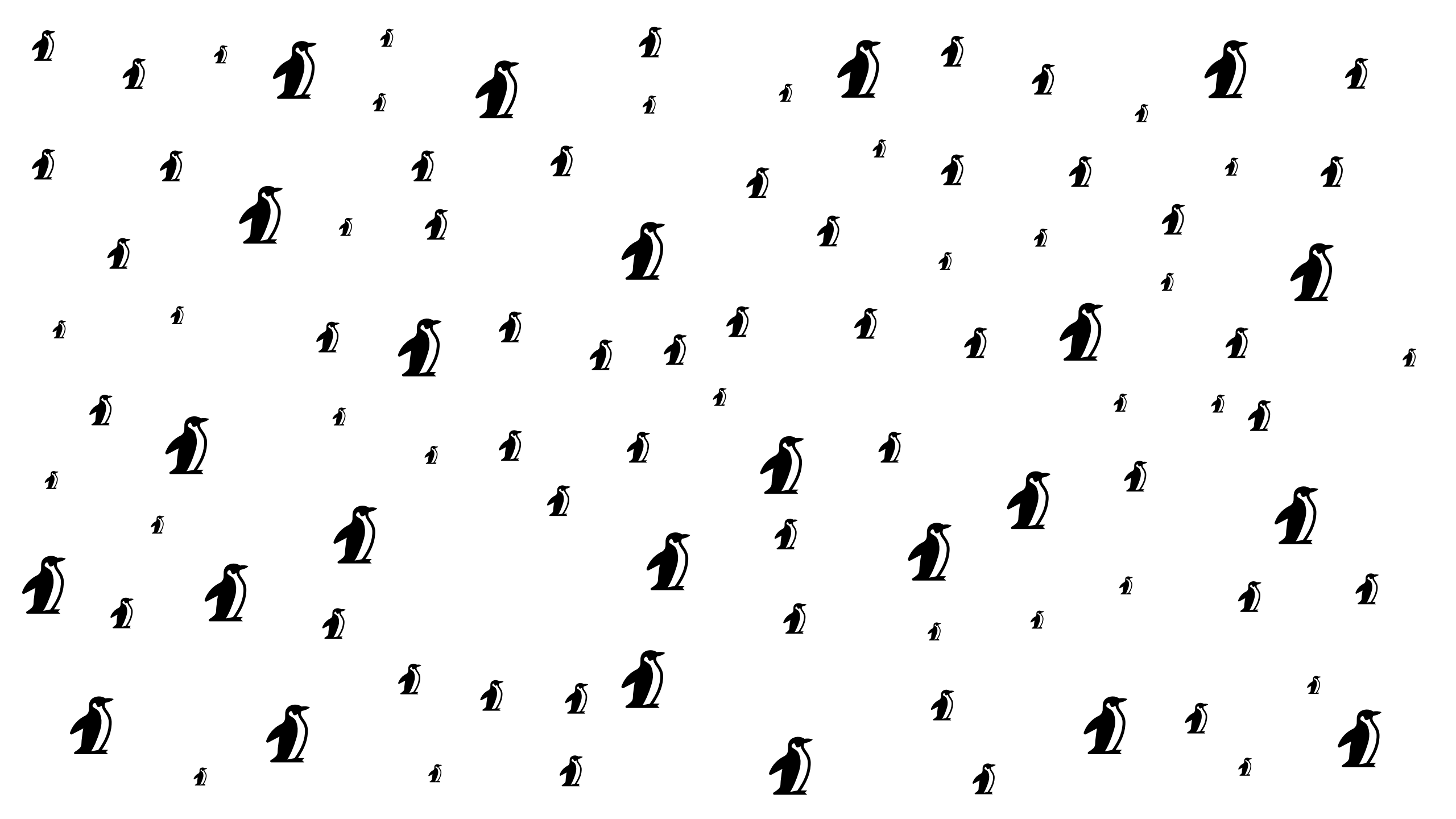
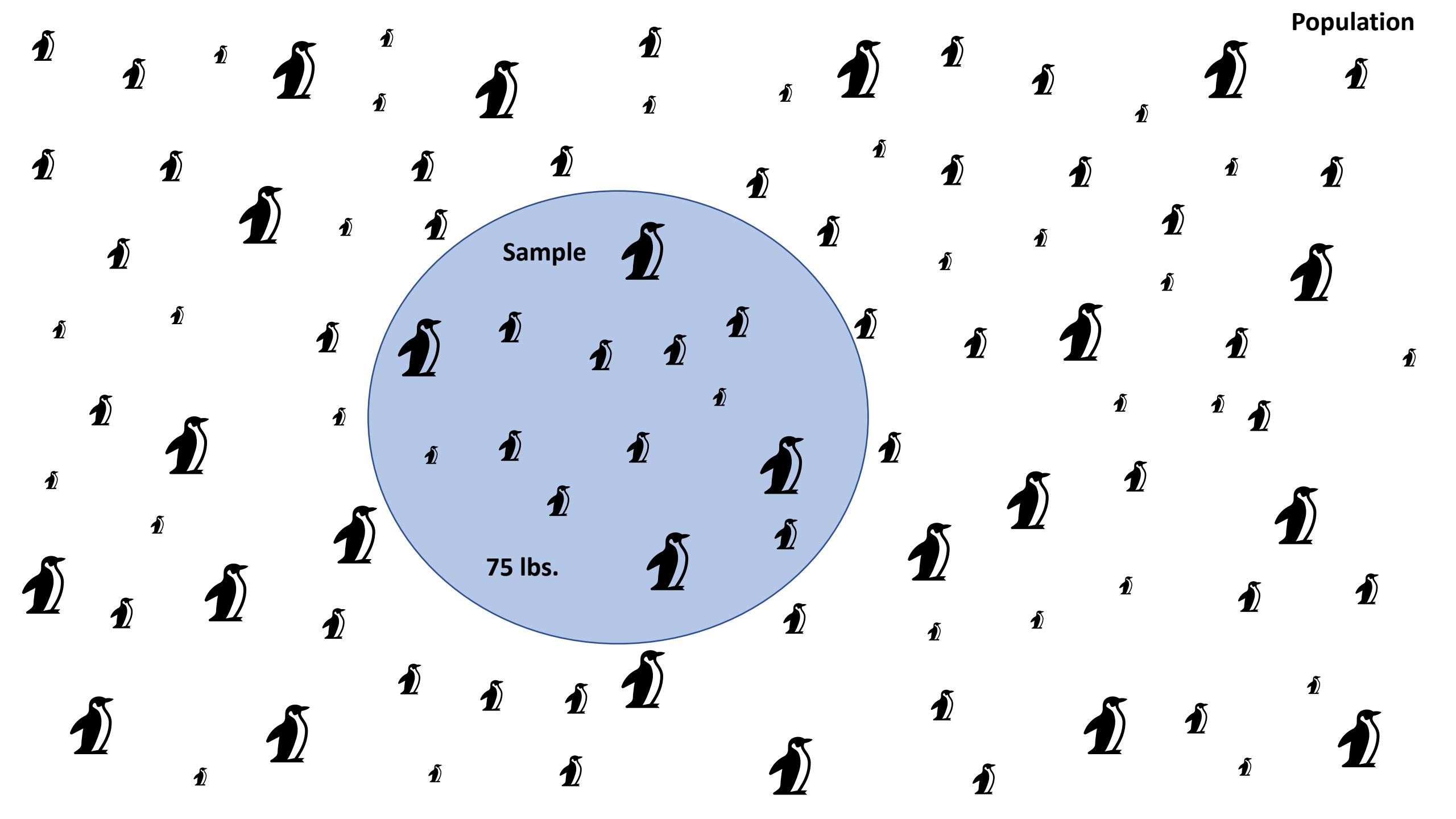
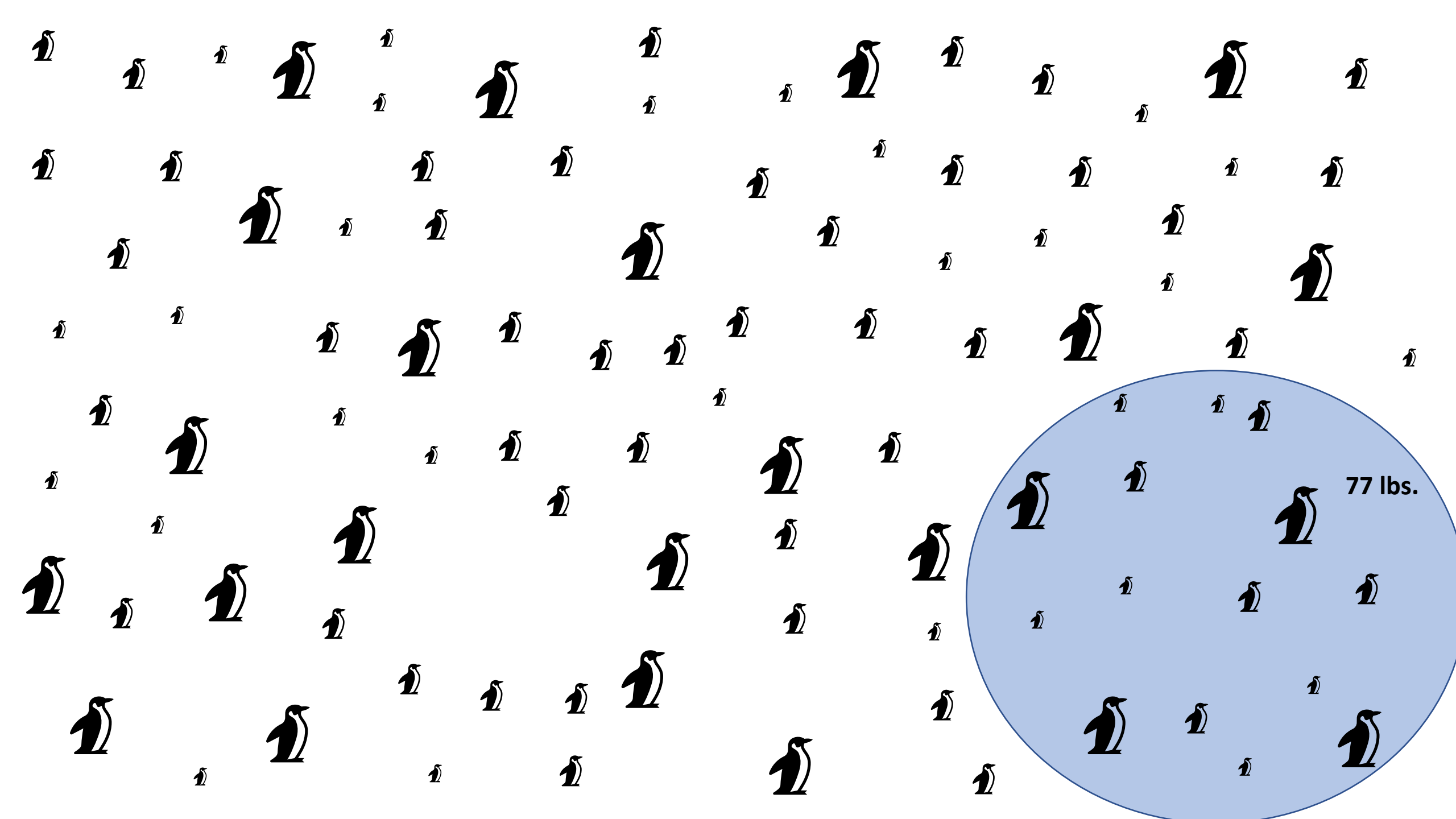
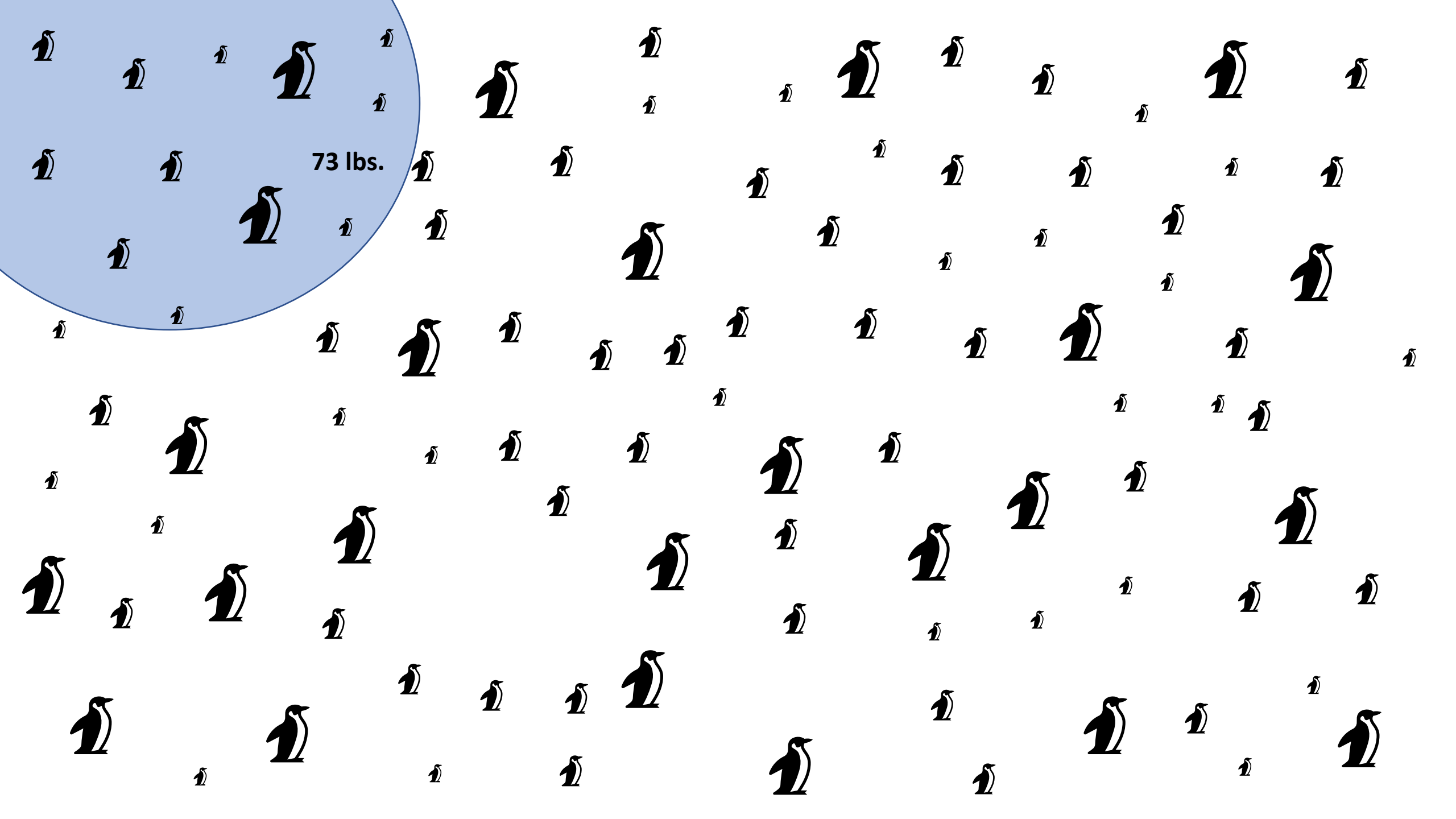
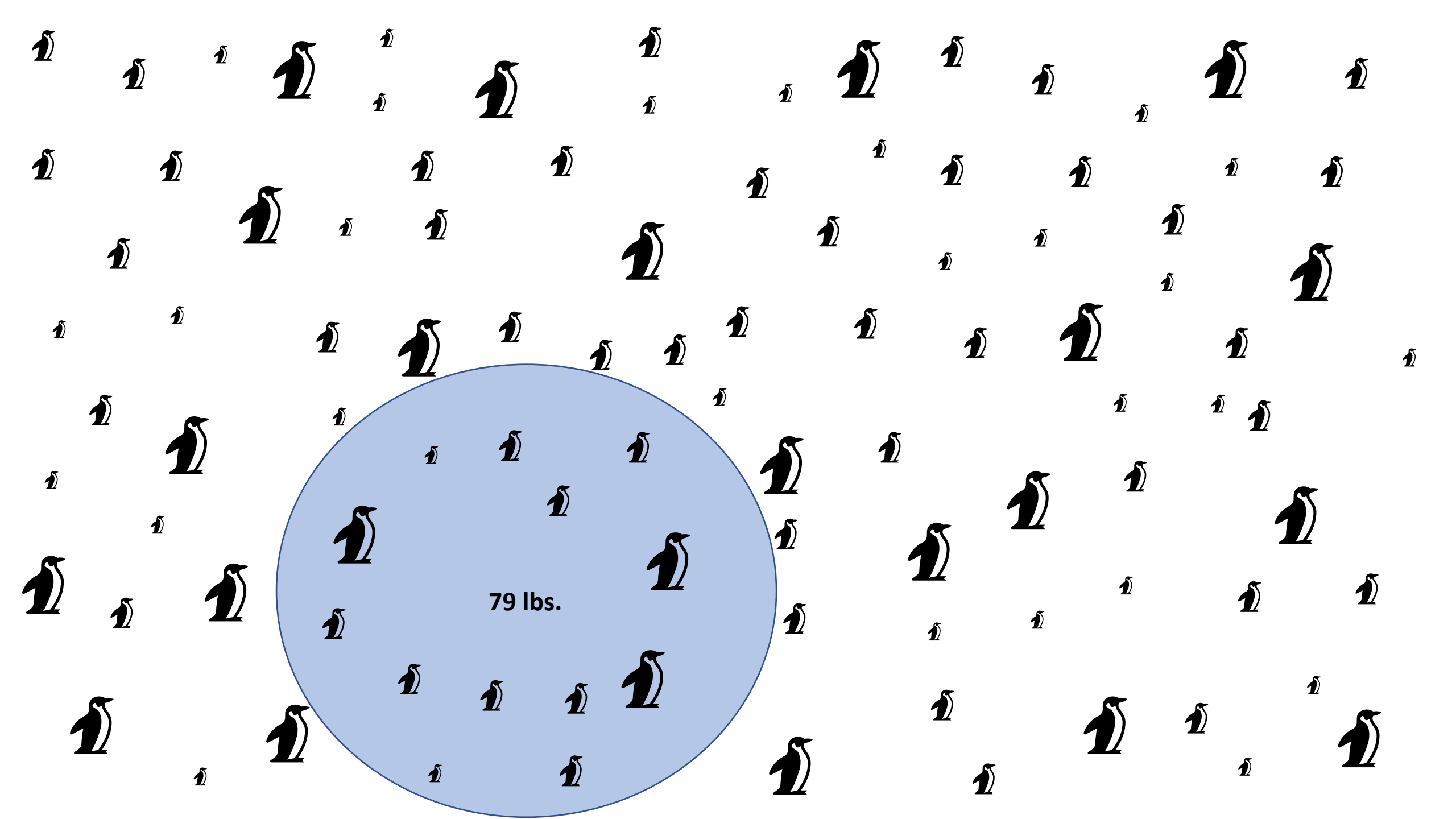





Population
Sample
75 lbs.


77 lbs.


73 lbs.


79 lbs.

We collected four samples from the population and calculated the mean penguin weight in each

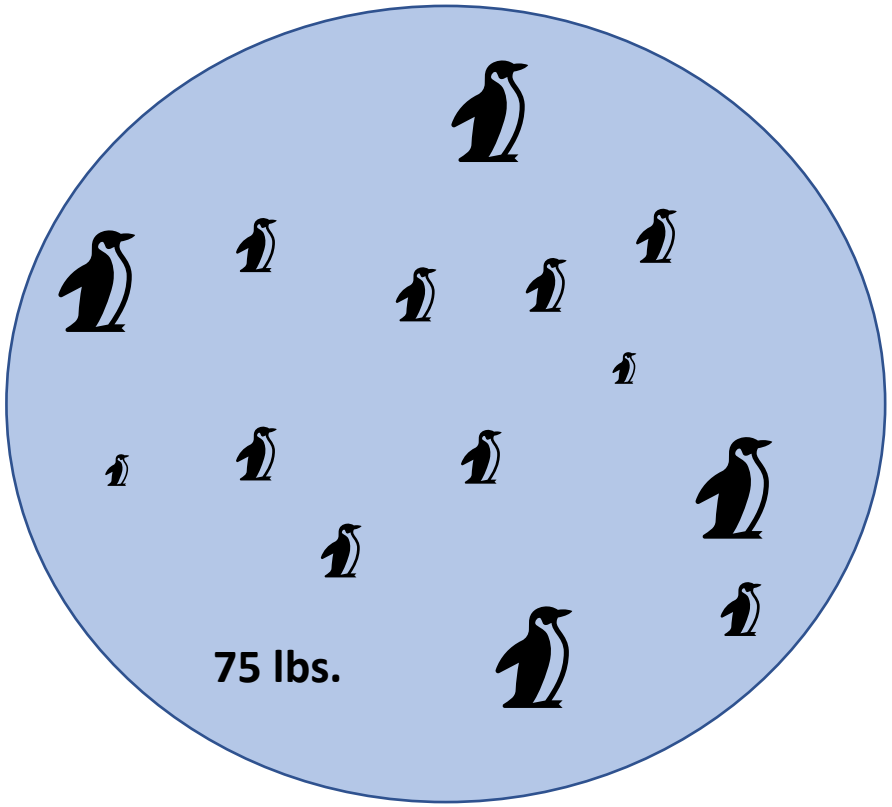
- $\bar{w}_1 = 75$ lbs.
- $\bar{w}_2 = 77$ lbs.
- $\bar{w}_3 = 73$ lbs.
- $\bar{w}_4 = 79$ lbs.

- Average of the sample means is $\bar{w} = \frac{1}{4}\sum_i \bar{w}_i = 76$ lbs.
- Sample standard deviation is $\hat{\sigma} = \sqrt{(\frac{1}{4-1}\sum_i (\bar{w}_i - \bar{w})^2)} = 2.58$
- Standard error of the mean is $\frac{\hat{\sigma}}{\sqrt{4}} = \frac{2.58}{2} = 1.29$

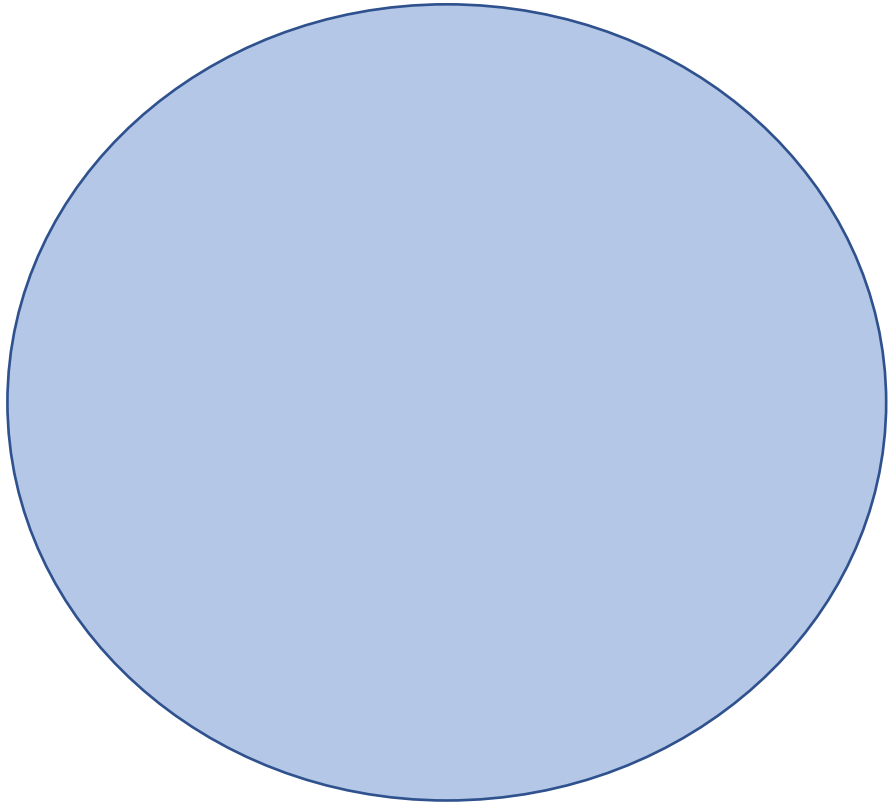
But what if we had no way to sample more penguins from the population?

- Then we can bootstrap sample
- Pretend as if our sample is the population and sample with replacement from it

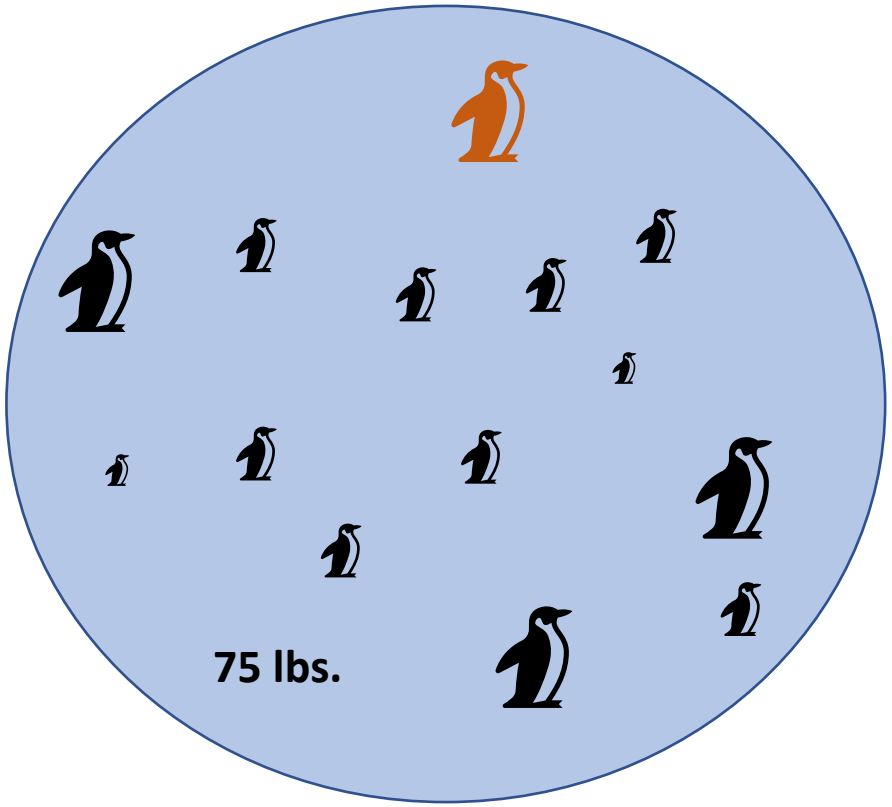
Original sample



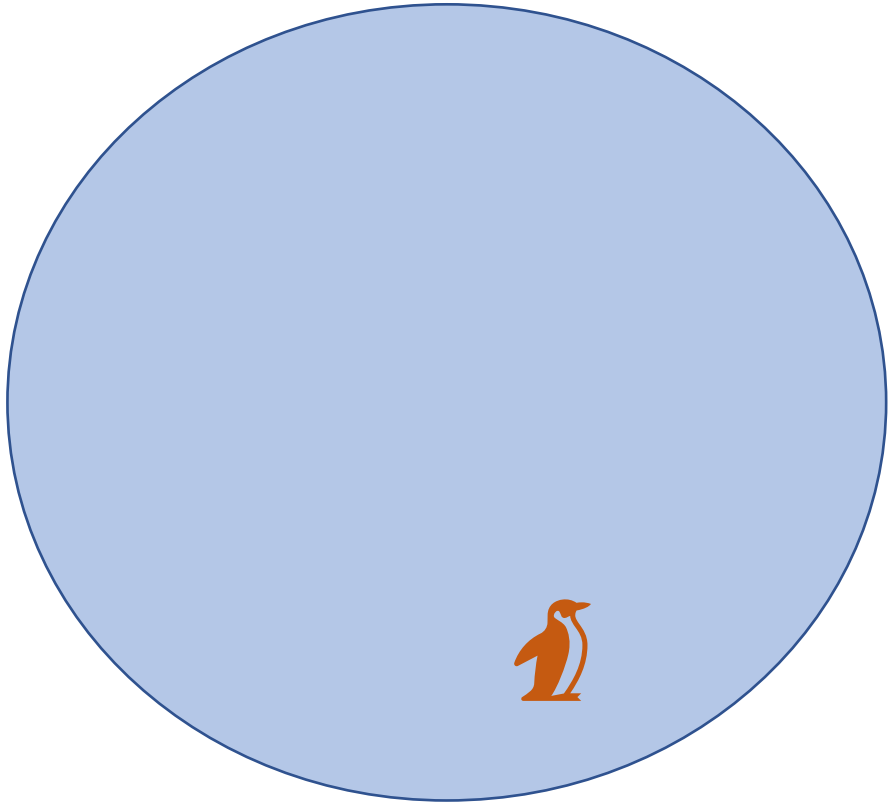
Bootstrap sample 1



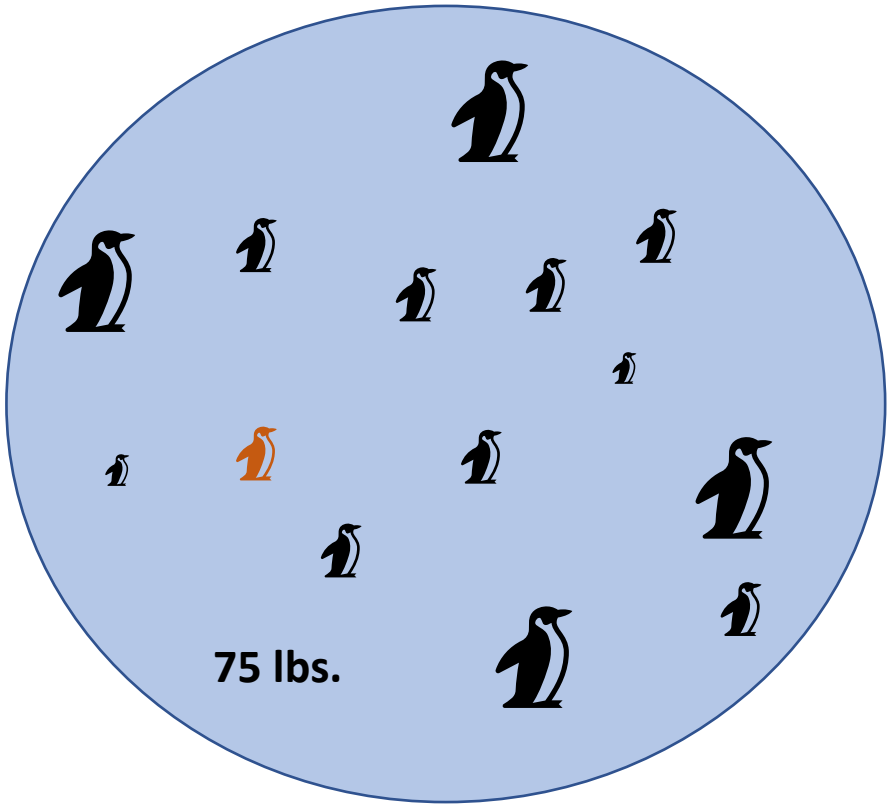
Original sample



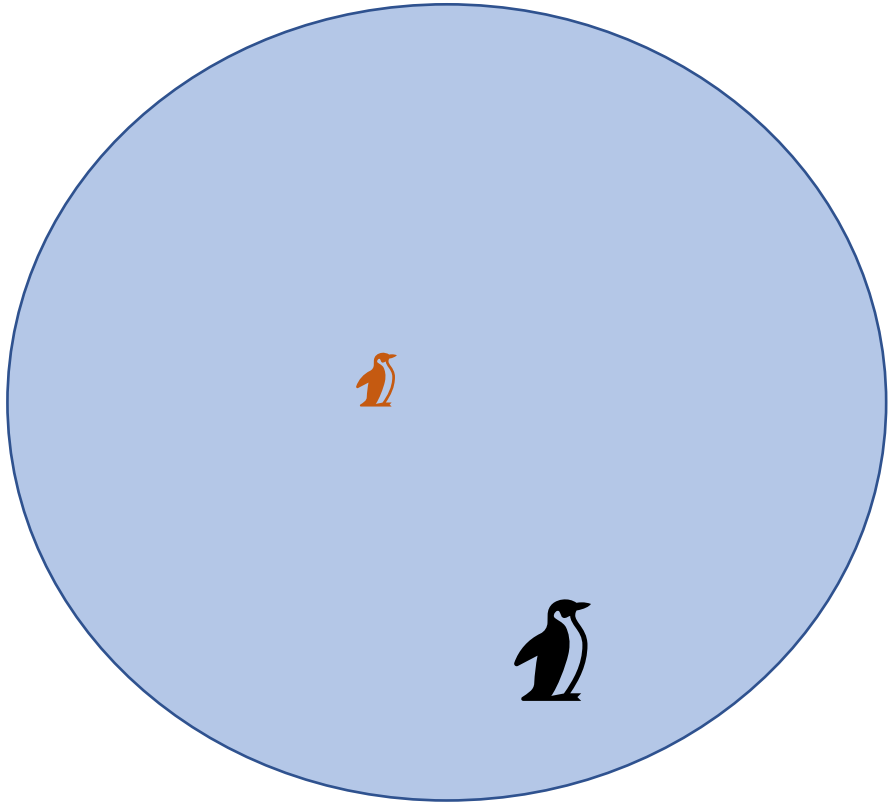
Bootstrap sample 1



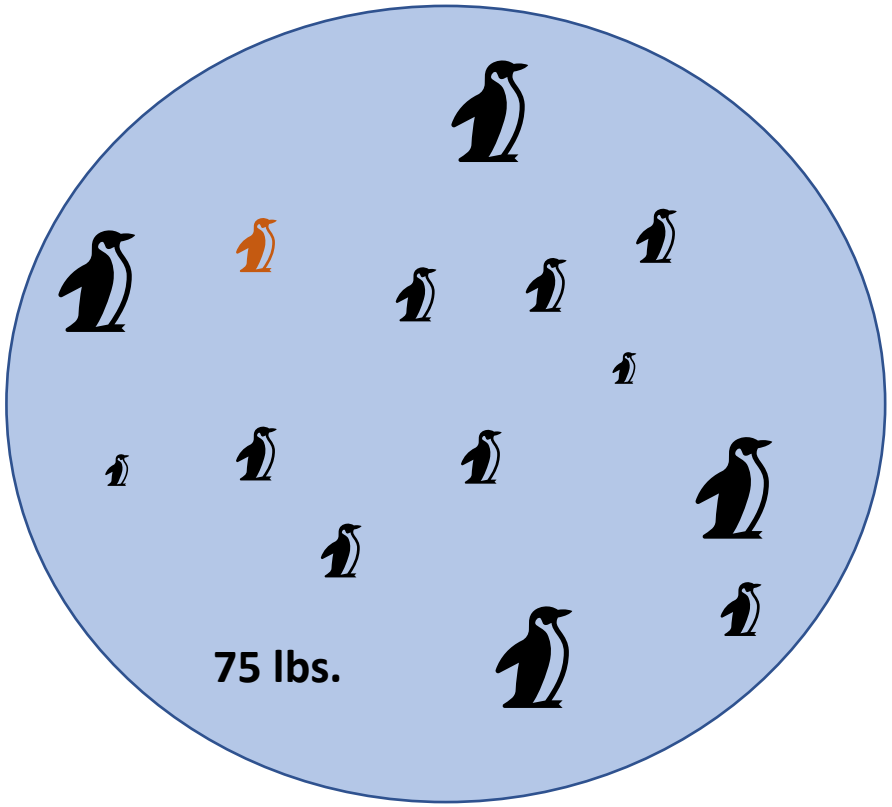
Original sample



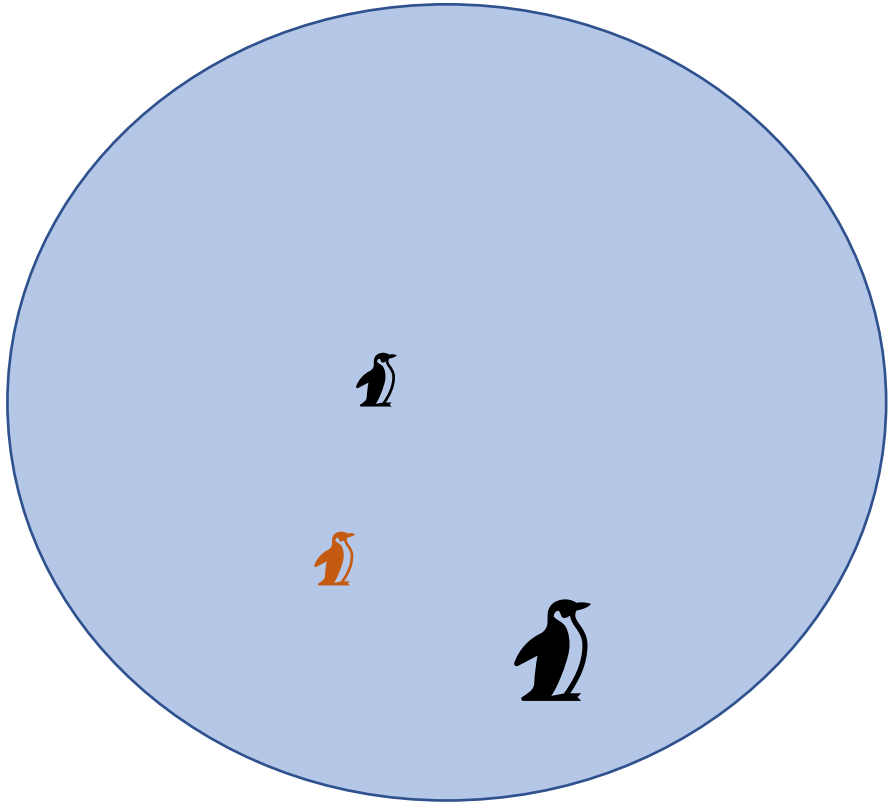
Bootstrap sample 1



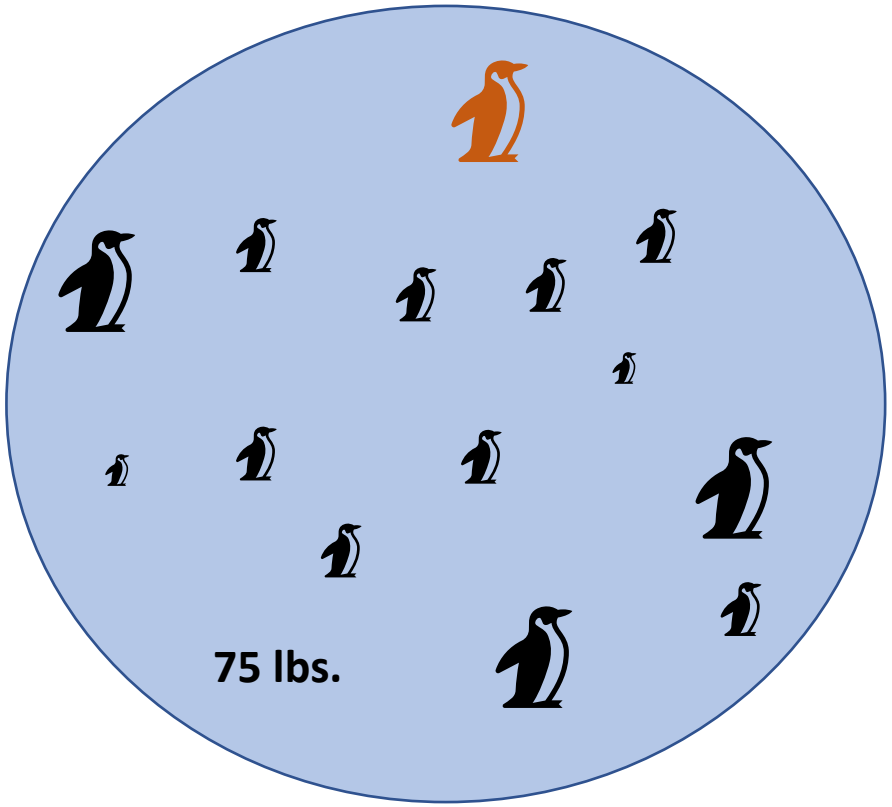
Original sample



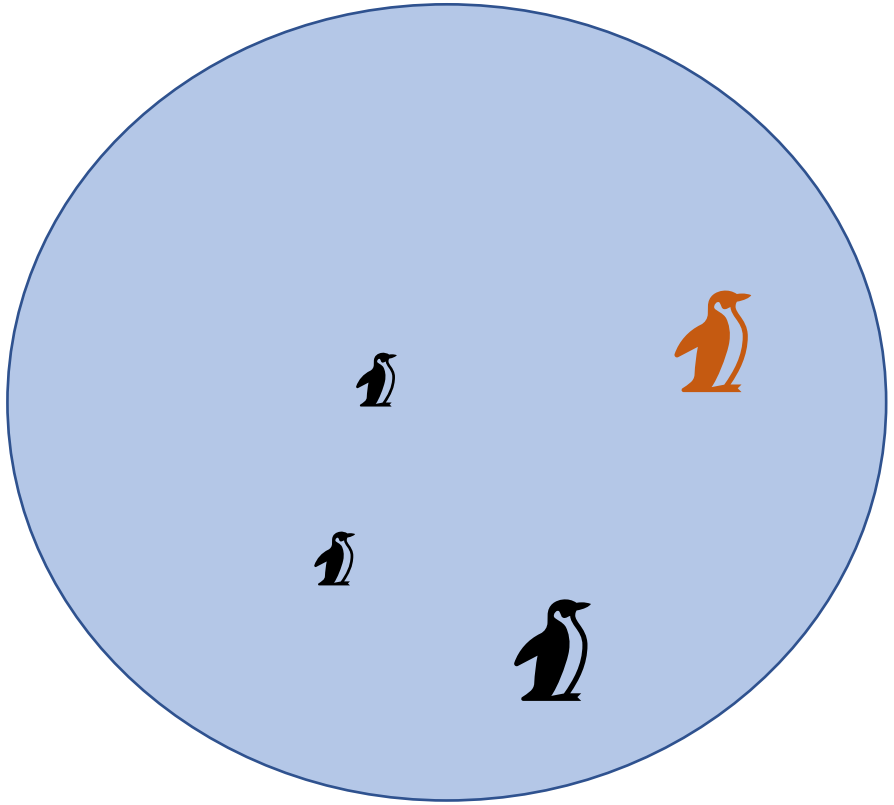
Bootstrap sample 1



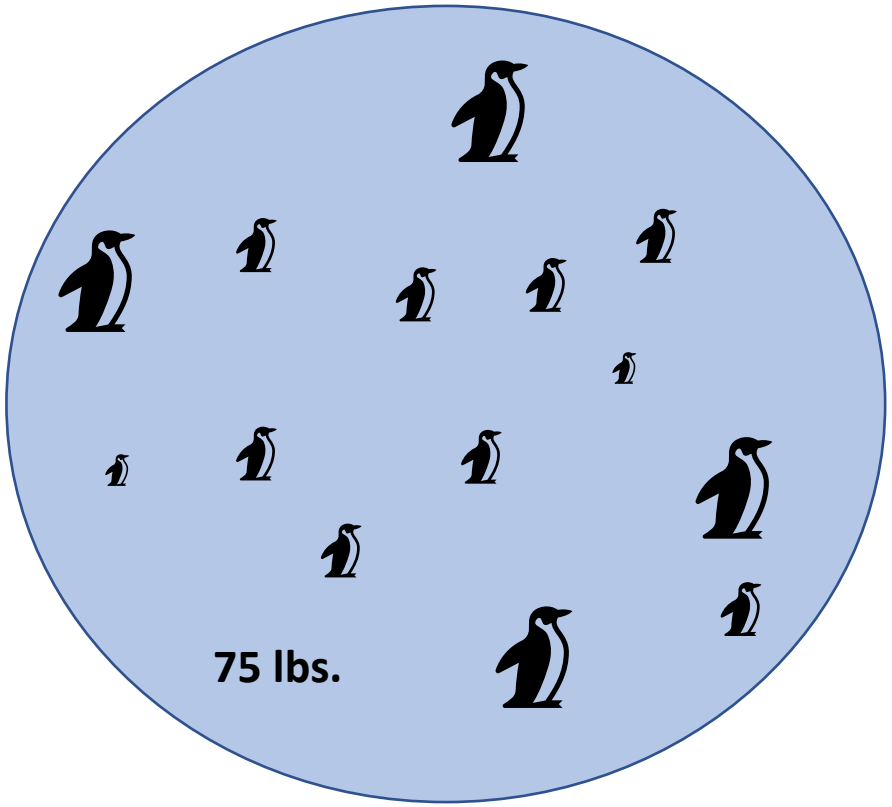
Original sample



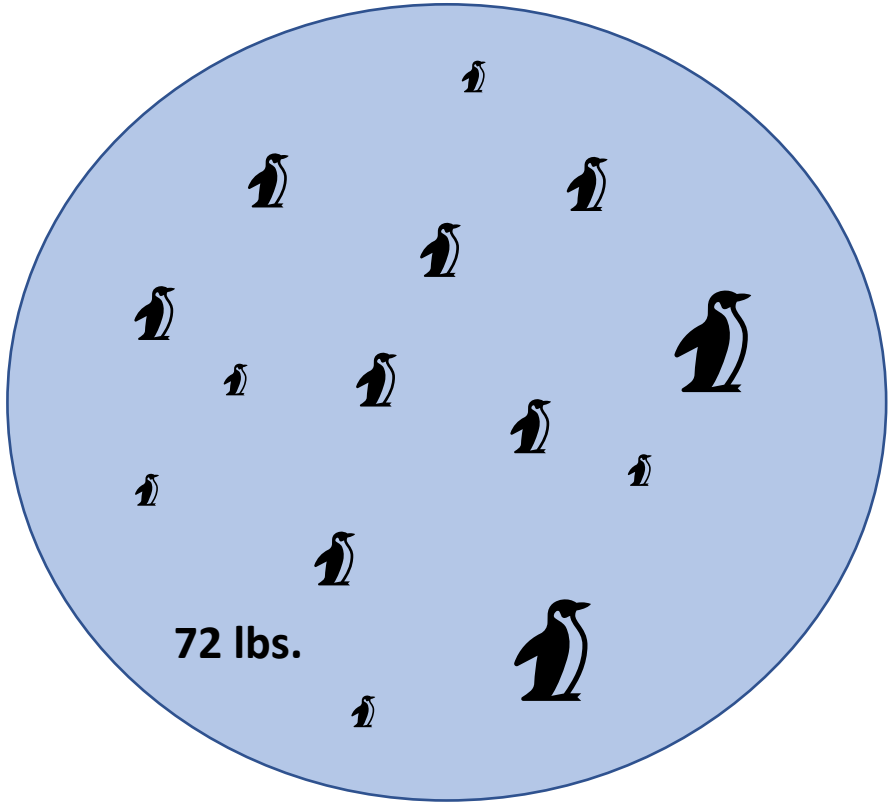
Bootstrap sample 1



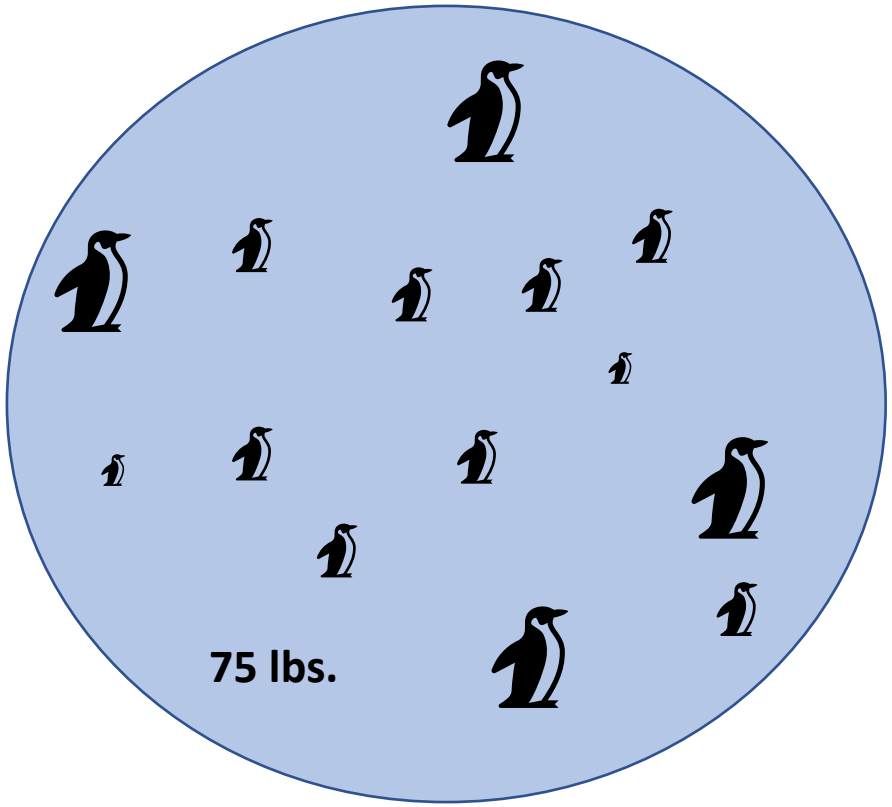
Original sample



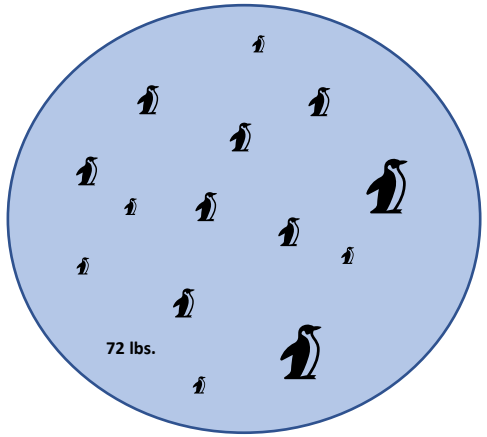
Bootstrap sample 1



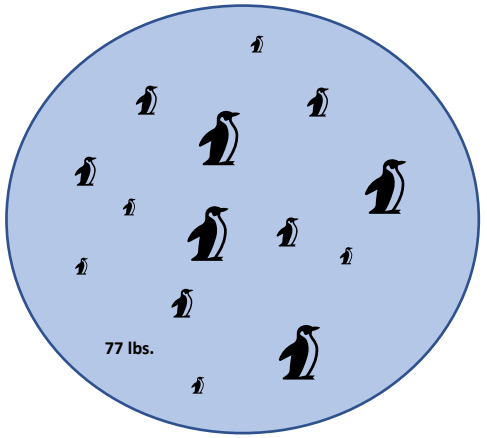
Original sample



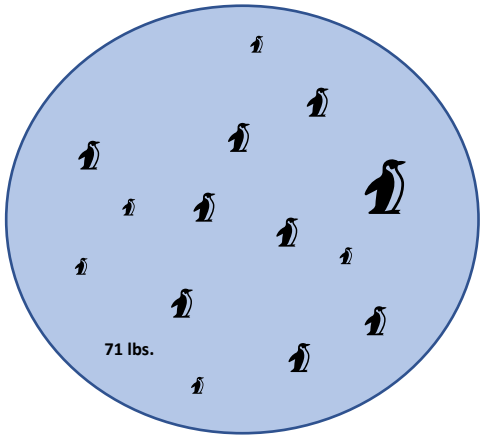
Bootstrap sample 1



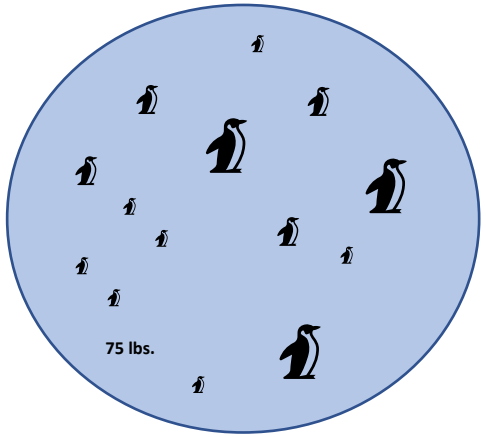
Bootstrap sample 2



Bootstrap sample 3



Bootstrap sample 4



We collected four bootstrap samples from our original sample and calculated the mean penguin weight in each

- $\bar{w}_1 = 72$ lbs.
- $\bar{w}_2 = 77$ lbs.
- $\bar{w}_3 = 71$ lbs.
- $\bar{w}_4 = 76$ lbs.

- Average of the sample means is $\bar{w} = \frac{1}{4}\sum_i \bar{w}_i = 74$ lbs.
- Sample standard deviation is $\hat{\sigma} = \sqrt{(\frac{1}{4-1}\sum_i (\bar{w}_i - \bar{w})^2)} = 2.94$
- Standard error of the mean is $\frac{\hat{\sigma}}{\sqrt{4}} = \frac{2.94}{2} = 1.47$