# Defining the limits of forensic DNA profile interpretation:

## An assessment of the information content inherent in complex mixtures

Clare Marsden, Norah Rudin, Keith Inman, Kirk Lohmueller

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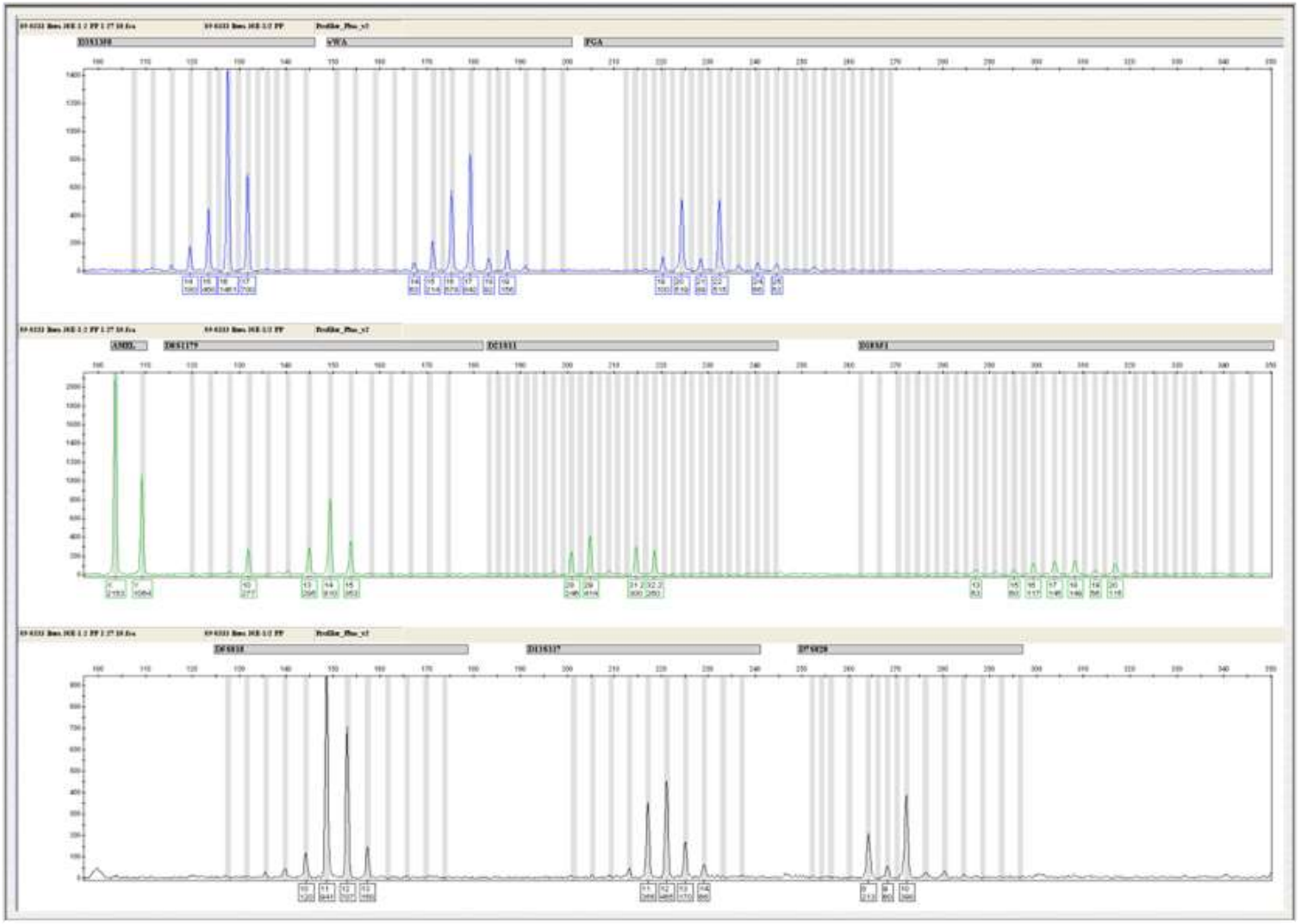
# What is the risk of error when interpreting complex DNA profiles?

- We used ground truth samples to establish the foundational limits when interpreting complex DNA profiles
- Error defined as drawing an incorrect inference with regard to whether a specific individual has contributed DNA to a profile

# Complex mixtures



# Complex mixtures

$$LR = \frac{\Pr(\text{Evidence} \mid \text{Suspect is contributor})}{\Pr(\text{Evidence} \mid \text{Suspect is not the contributor})}$$

LR values expectation:

LR > 1 if suspect in the mixture.

LR < 1 if suspect not in the mixture.

Does this hold for complex mixtures?

# Questions

- To what extent can LR reliably distinguish true-contributors (TC) and known non-contributors (KNC)?
  - Do true contributors always yield LR > 1 in complex mixtures?
  - Do known non-contributors give LR < 1 in complex mixtures?

# Simulations

Generating mixture set:

*True Contributor - in all mixtures*

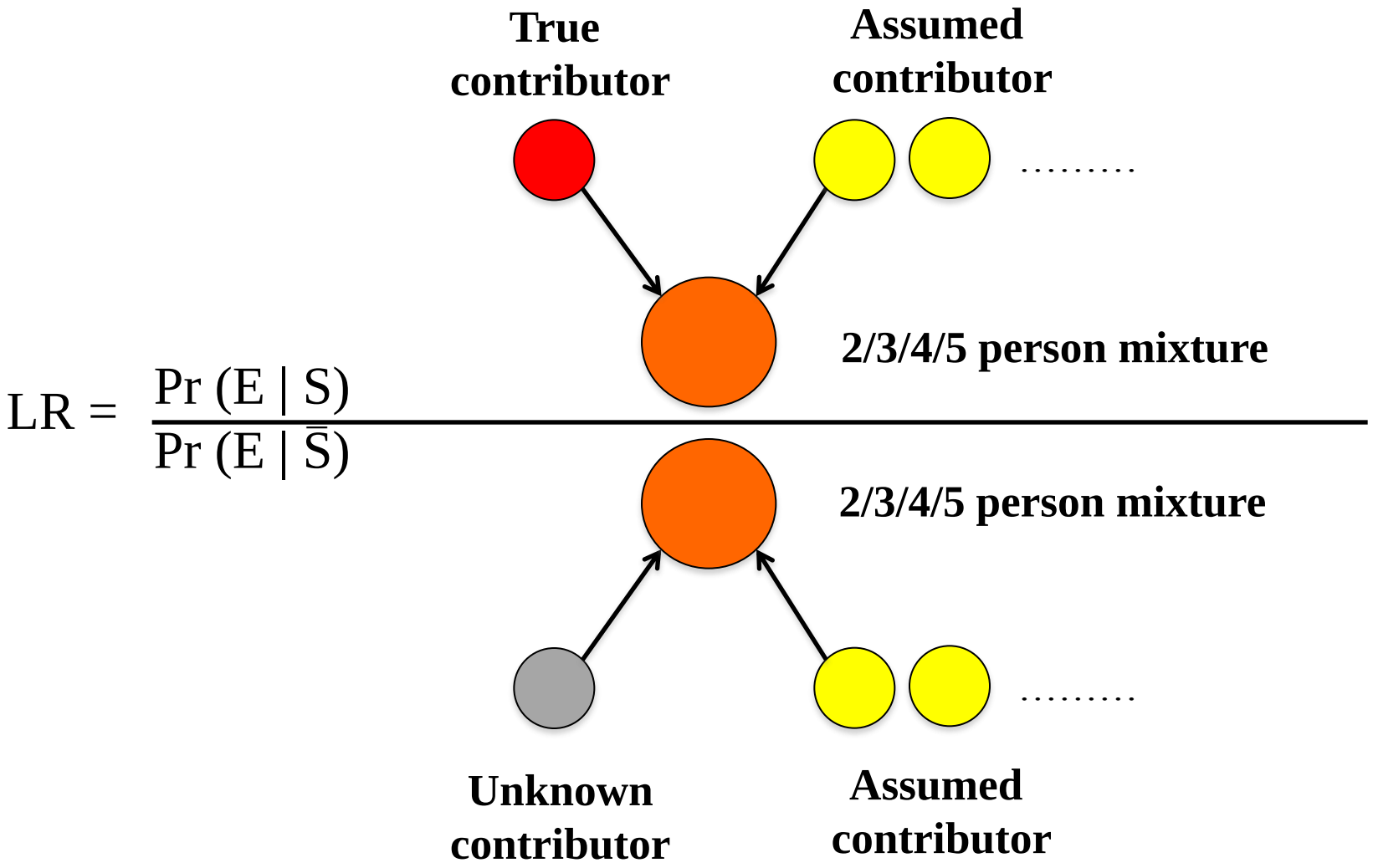
- C1
- C2
- C3
- C4
- C5
- KNC

2 person mixture: C1 + C2

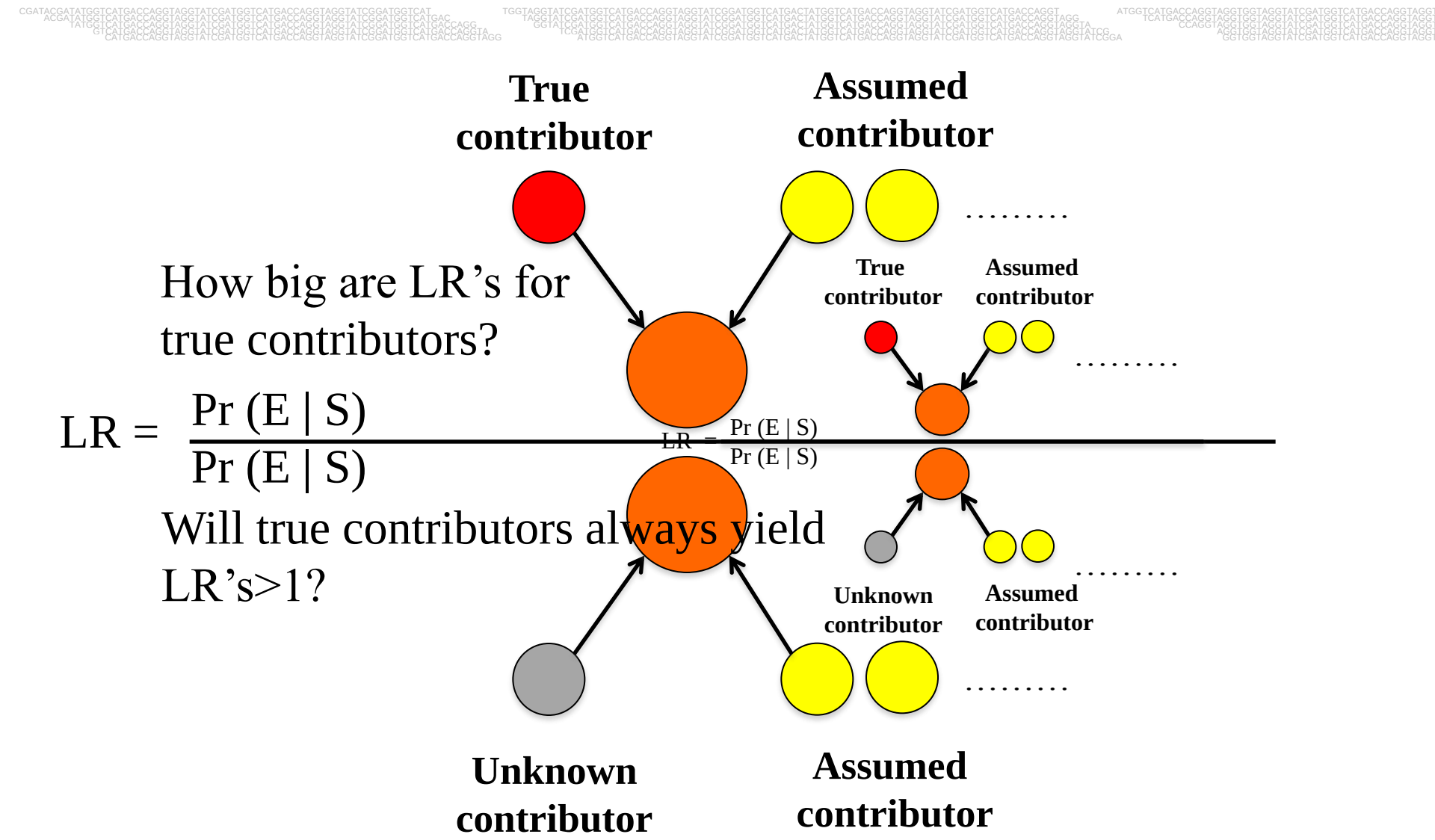
3 person mixture: C1 + C2 + C3

10,000 mixture sets created

# Calculating the LR



# Calculating the LR

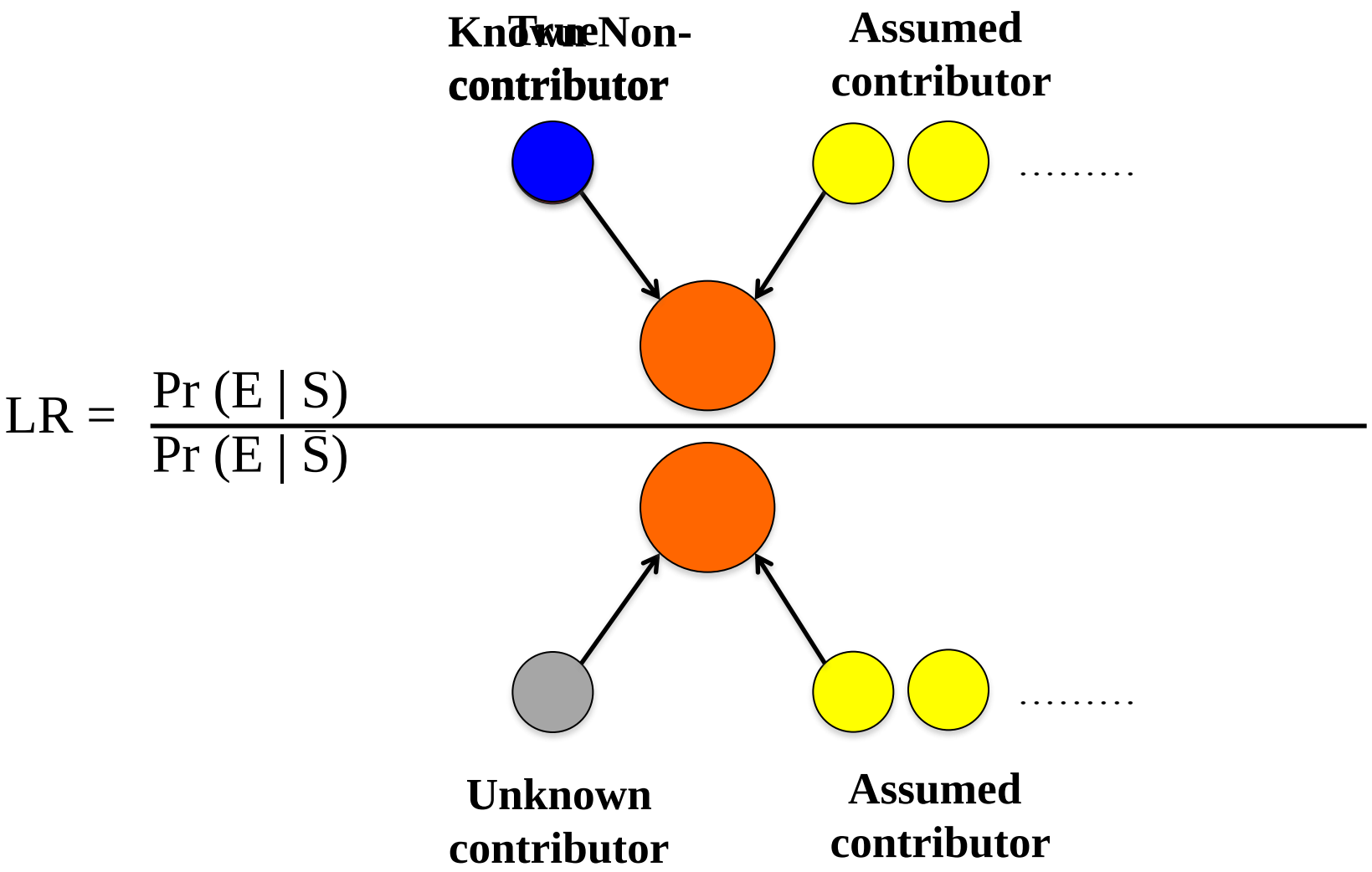



How big are LR's for true contributors?

$$LR = \frac{Pr\,(E \mid S)}{Pr\,(E \mid S)}$$

Will true contributors always yield LR's>1?

# Calculating the LR



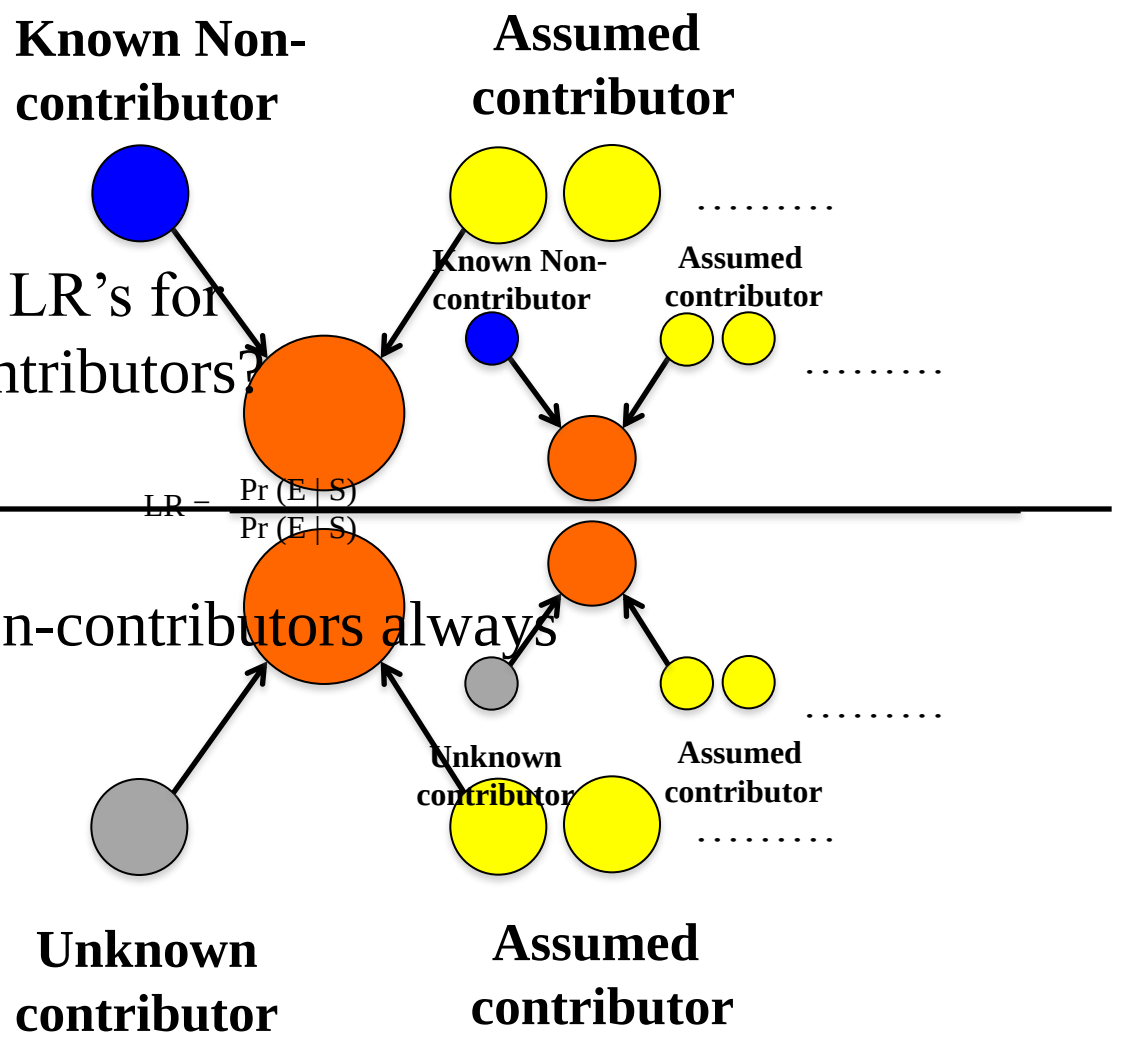

$$LR = \frac{Pr\,(E \mid S)}{Pr\,(E \mid \bar{S})}$$

# Calculating the LR

How small are LR's for known non-contributors?

$$LR = \frac{Pr(E \mid S)}{Pr(E \mid S)}$$

Will known non-contributors always yield LR's<1?



# Number of LR's

| # contributors to mixture | Numerator Hypothesis | Denominator Hypothesis |
|---|---|---|
| 2 mixture | C1 + C2 | C2 + 1 unk |
| 2 mixture | C1 + 1 unk | 2 unk |
| 3 mixture | C1 + C2 + C3 | C2 + C3 + 1 unk |
| 3 mixture | C1 + C2 + 1 unk | C2 + 2 unk |
| 3 mixture | C1 + 2 unk | 3 unk |
| 4 mixture | C1 + C2 + C3 + C4 | C2 + C3 + C4 + 1 unk |
| 4 mixture | C1 + C2 + C3 + 1 unk | C2 + C3 + 2 unk |
| 4 mixture | C1 + C2 + 2 unk | C2 + 3 unk |
| 4 mixture | C1 + 3 unk | 4 unk |
| 5 mixture | C1 + C2 + C3 + C4 + C5 | C2 + C3 + C4 + C5 + 1 unk |
| 5 mixture | C1 + C2 + C3 + C4 + 1 unk | C2 + C3 + C4 + 2 unk |
| 5 mixture | C1 + C2 + C3 + 2 unk | C2 + C3 + 3 unk |
| 5 mixture | C1 + C2 + 3 unk | C2 + 4 unk |
| 5 mixture | C1 + 4 unk | 5 unk |

14 pairs (TC & KNC) of possible hypotheses

140,000 LR's total each condition

# Simulations

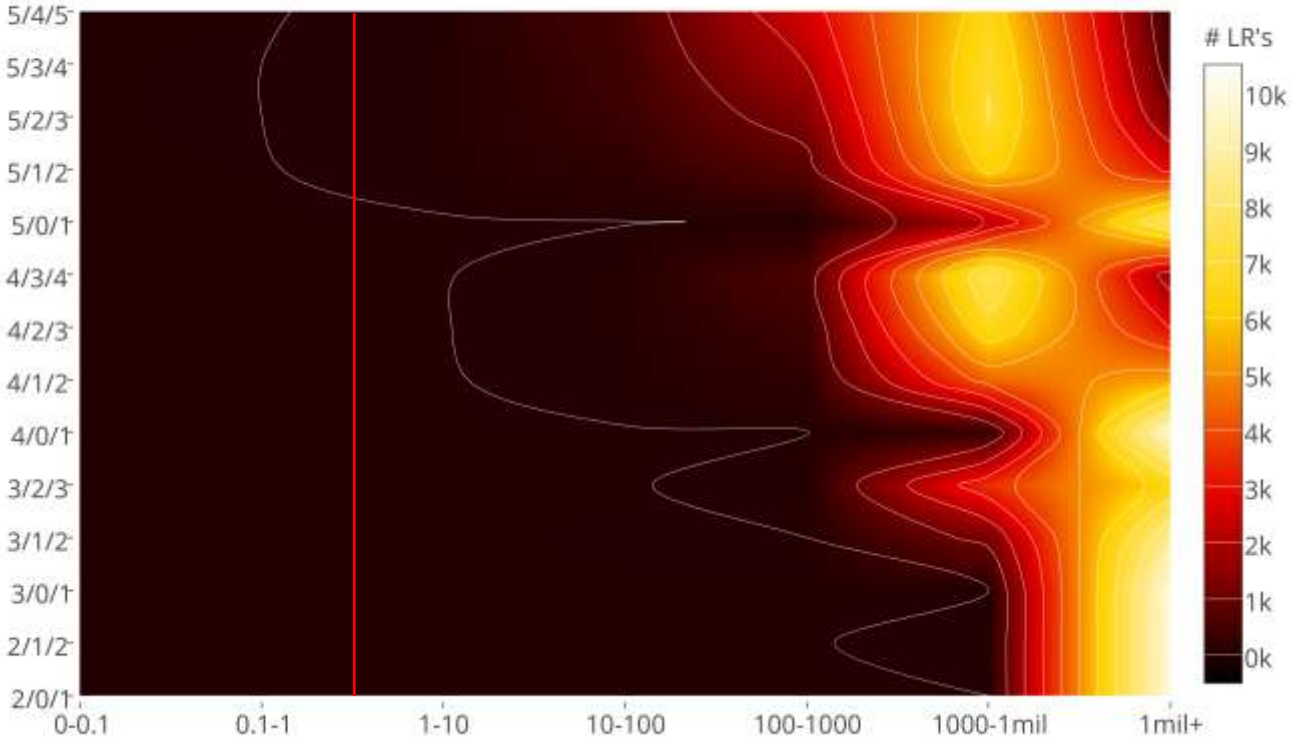
## Generating LR's:

Assumptions:

- No drop out
- No peak height information was used

# Do true contributors always yield LR > 1

## True Contributors

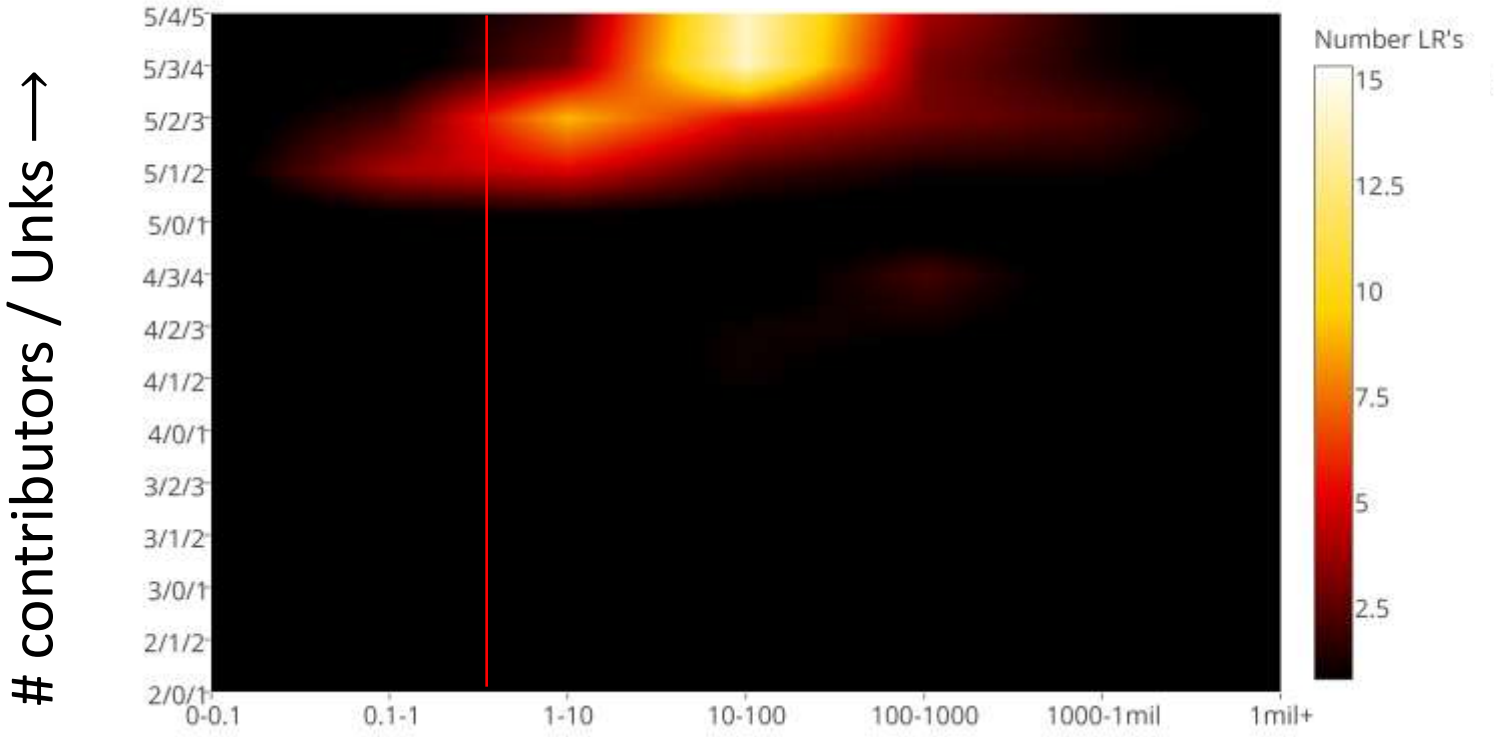



LR < 1: 7 of 140,000

5 person mixtures with 1 + unk in numerator

# Do known non-contributors always yield LR > 1

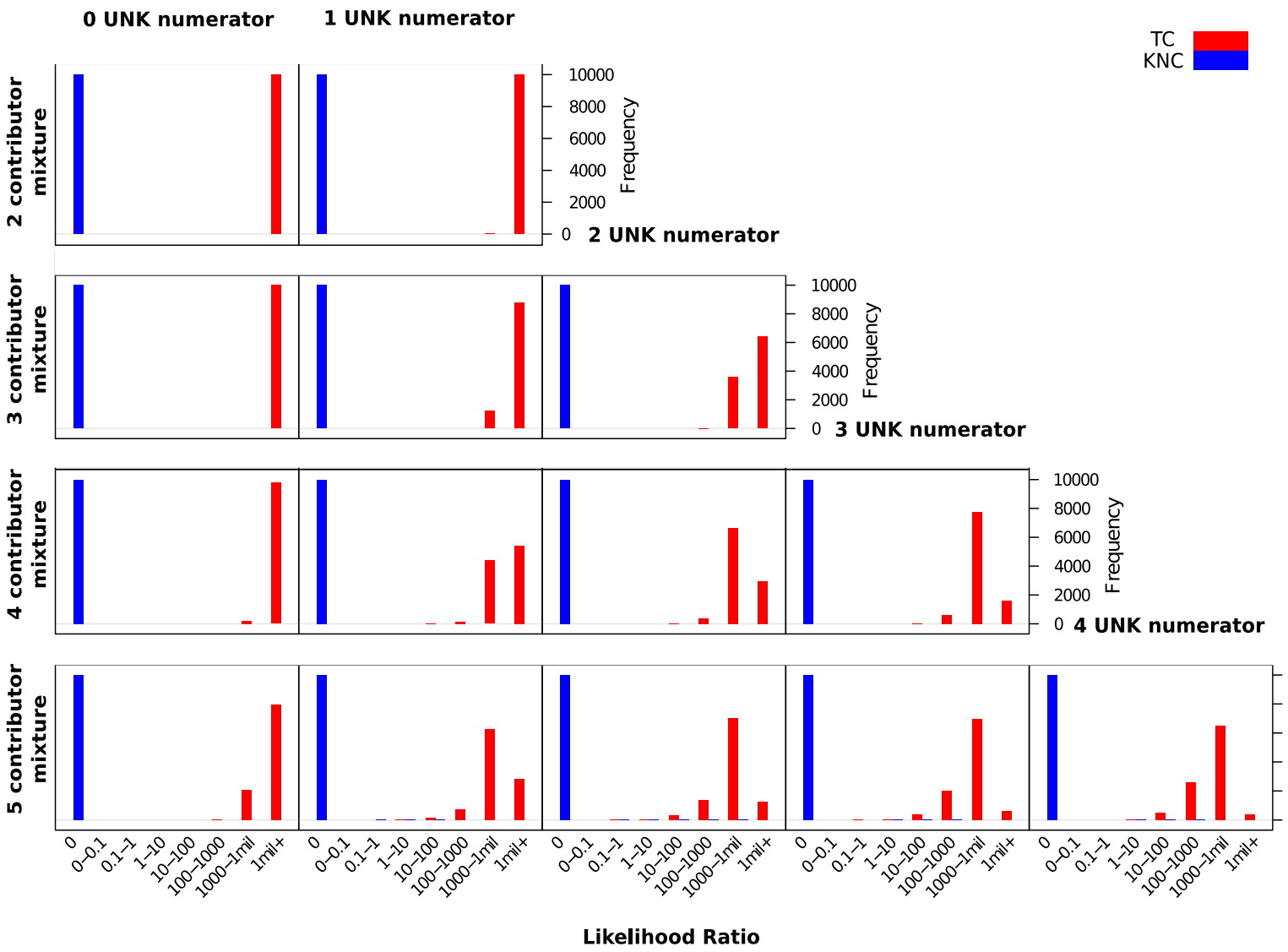
## Known non-contributors




LR > 1: 75/140,000

4-5 person mixtures with 1 + unk in numerator

# Can LR reliably distinguish true-contributors and known non-contributors ?



# Conclusions

- LR distinguish TC from KNC in mixtures containing up to 3 contributors.
- LR will distinguish most TC from KNC in mixtures of 4 or 5 individuals
  - Some low percentage of overlap
- LR generate a low false negative (TC < 1) and false positive (KNC > 1)
  - Primarily found in mixtures of 4 or 5 individuals