

RRR for UUU:

Exact Analysis of Pee Queue Systems
with Perfect Urinal Etiquette

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Urinals

Fuel and Fuddle, Pittsburgh, PA

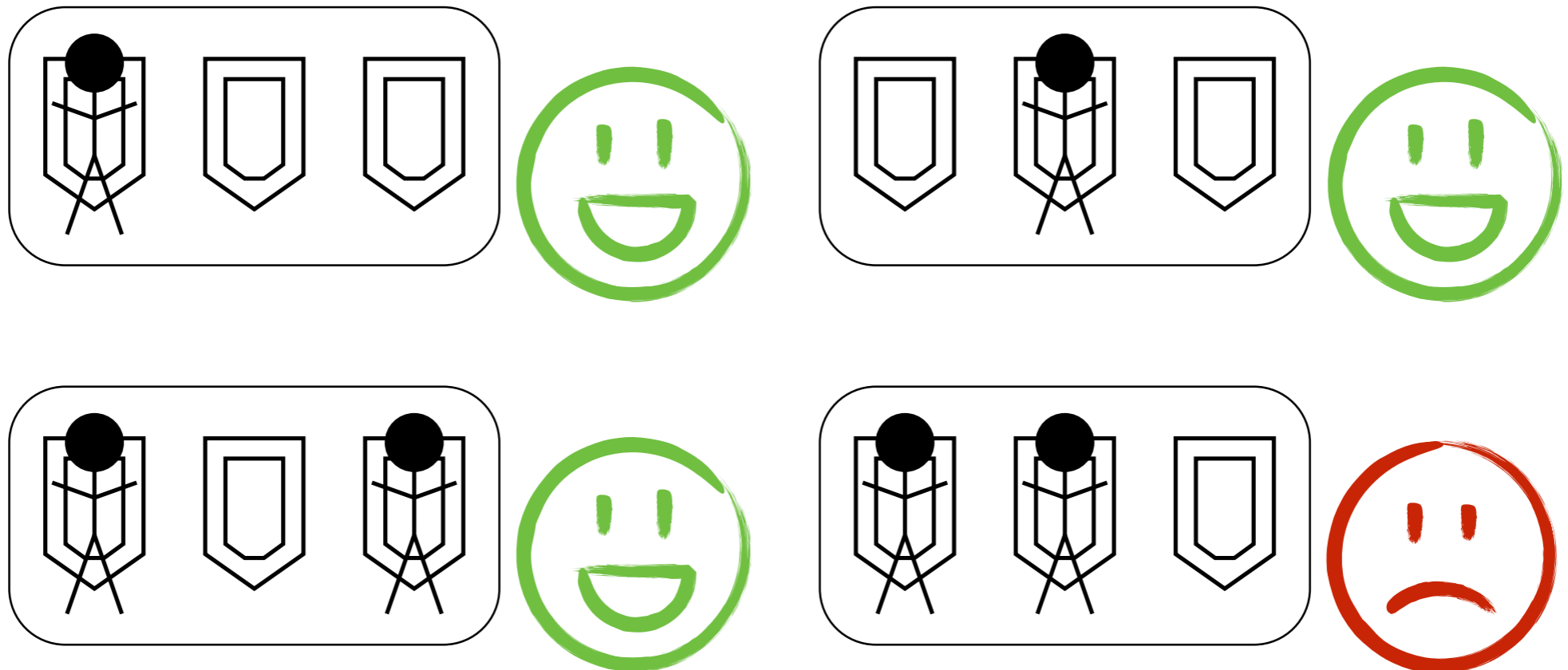


Problem:

traditional queueing theory assumes
all servers can be used simultaneously

Our Solution

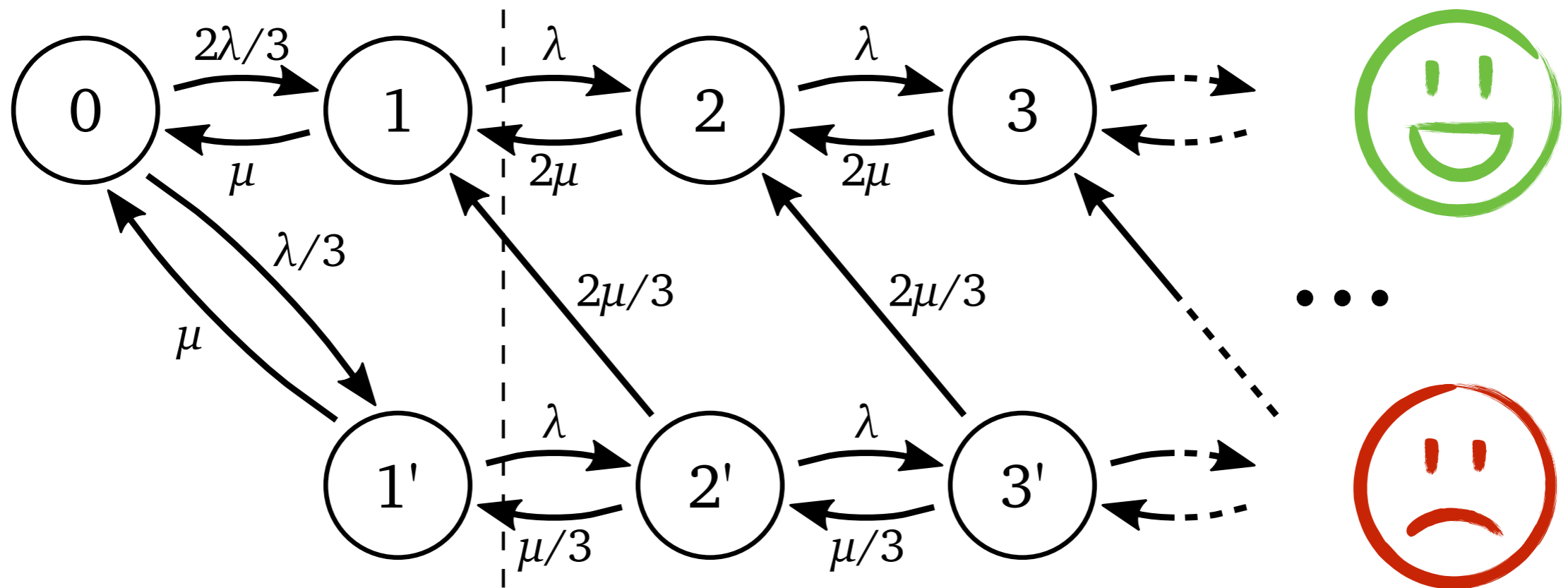
Context-2 Unease Processing Network (C2UPN)





M/M/3/C2UPN
(UUU)

M/M/3/C2UPN Markov Chain



Recursive Renewal Reward (RRR)

$$\begin{aligned}
 L &= \frac{1}{\lambda} + \frac{2}{3}L_1 + \frac{1}{3}L'_1 & L_2 &= \frac{1}{2\mu + \lambda} + \frac{\lambda}{2\mu + \lambda}(2L_2) \\
 L_1 &= \frac{1}{\mu + \lambda} + \frac{\lambda}{\mu + \lambda}(L_2 + L_1) & L'_2 &= \frac{1}{\mu + \lambda} + \frac{\lambda}{\mu + \lambda}((1 + q')L'_2 + (1 - q')L_2) \\
 L'_1 &= \frac{1}{\mu + \lambda} + \frac{\lambda}{\mu + \lambda}(L'_2 + qL_1 + q'L'_1)
 \end{aligned}$$

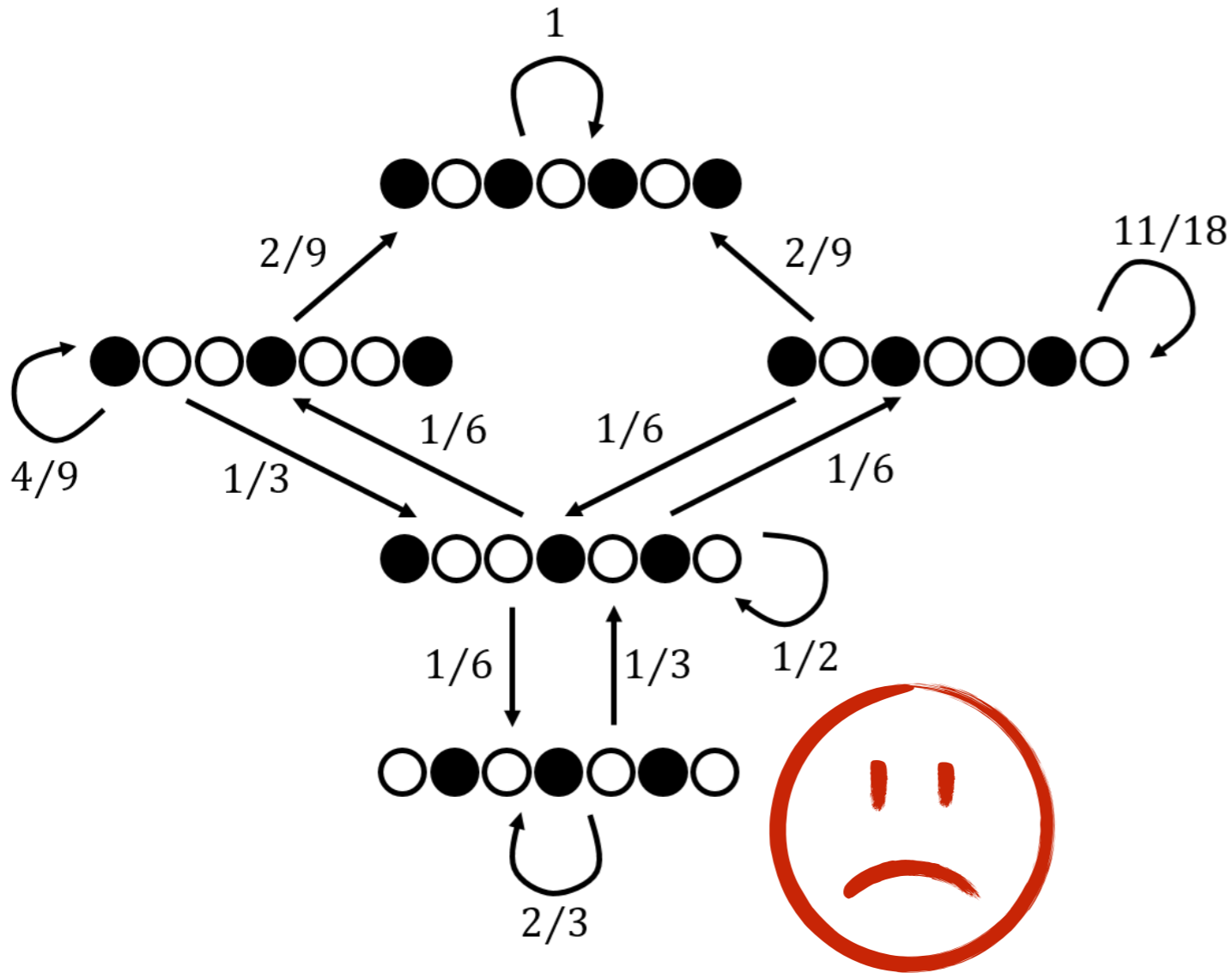
$$\hat{N}(z) = \frac{(\rho - 2)(-3\rho + X + 3)(\rho(z - 1) - 1)(\rho^2(X(z - 1) + 4z - 7) + \rho(X(z - 2) + 3z - 8) - 2(X + 3) + 3\rho^3(z - 1))}{(3\rho^2 + 5\rho + (\rho + 2)X + 6)(\rho z - 2)(X + \rho(3 - 6z) + 3)}$$

$$\text{where } X = \sqrt{9\rho^2 + 6\rho + 9}$$

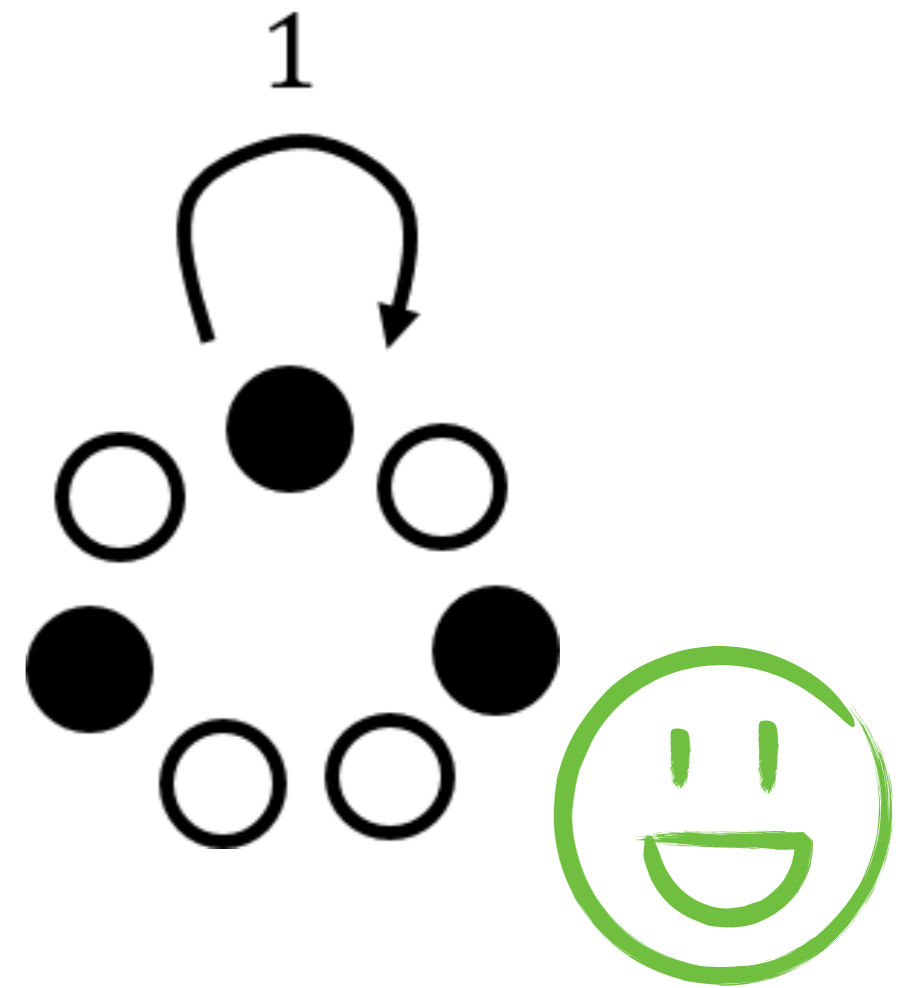


Circular Urinal Positioning (CUP)

CUP Analysis



Traditional C2UPN

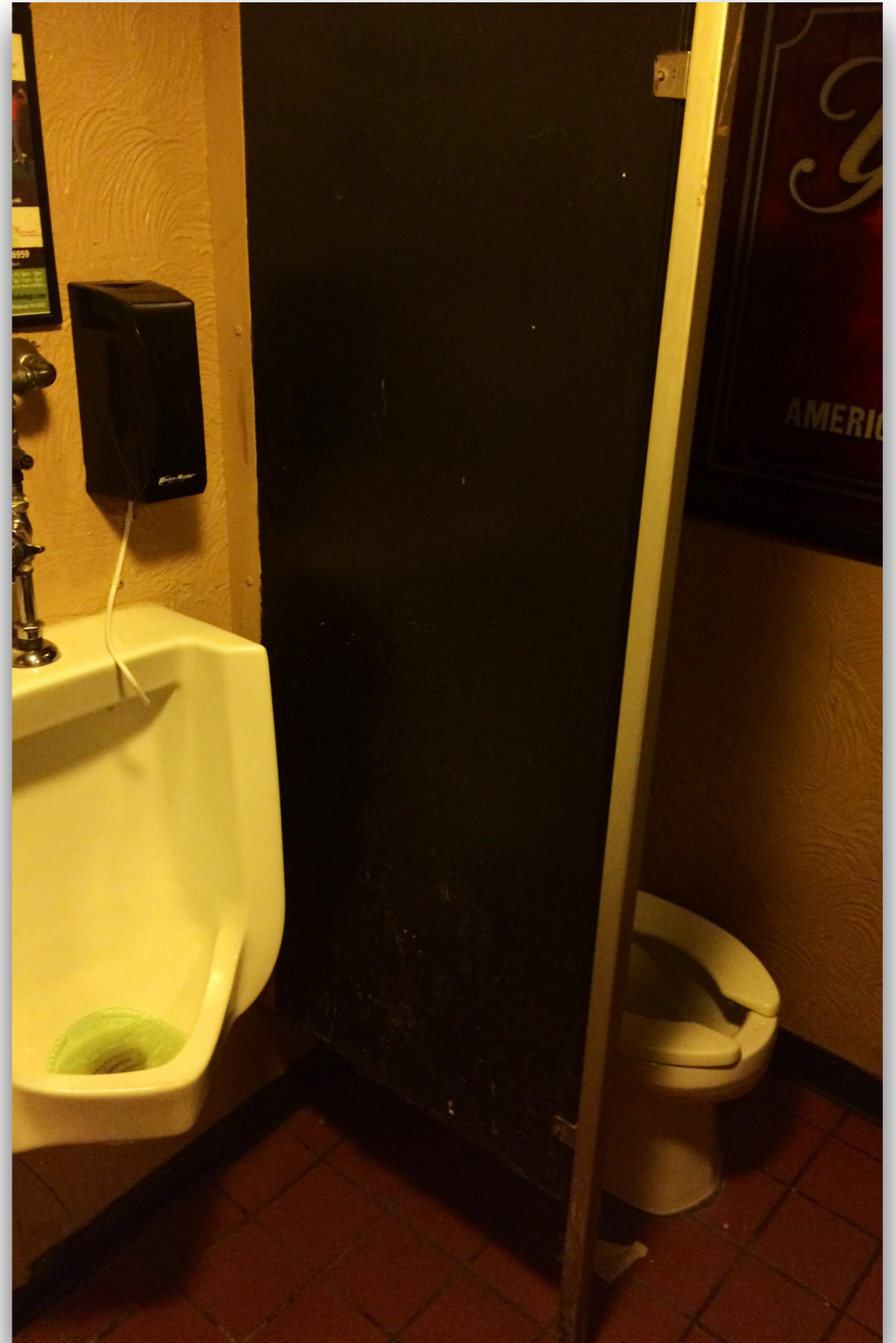


CUP C2UPN

Future Work

Multiclass Queues

“Class 1” and “Class 2”





CNUPN Systems

Unease graphs with degree $N > 2$

Continuous generalization

