ESE 303: MATLAB tutorial

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https://alliance.seas.upenn.edu/~ese303/wiki/index.php

Whirlwind tour of MATLAB

```
%% Some column vectors
x = (1:2:99)';
y = zeros(50,1);
y(10) = 1;

%% Some matrices
A = [1 2 3 ; 4 5 6 ; 7 8 9];
I = eye(5);

%% Inner product: m = x^T y
m = x'*y;

%% Counting/logical indexing
count = sum(q <= 0.3 & q >= 0.1);
```

The drunkard monks

- Monks copy manuscripts
- Monks get drunk

The drunkard monks

- Monks copy manuscripts
  - Manuscripts are long
  - # manuscripts/day $\sim$ Poisson
- Monks get drunk

The drunkard monks

- Monks copy manuscripts
  - Manuscripts are long
  - # manuscripts/day $\sim$ Poisson
- Monks get drunk
  - Drunk monks don't copy manuscripts

The drunkard monks: hidden Markov chain

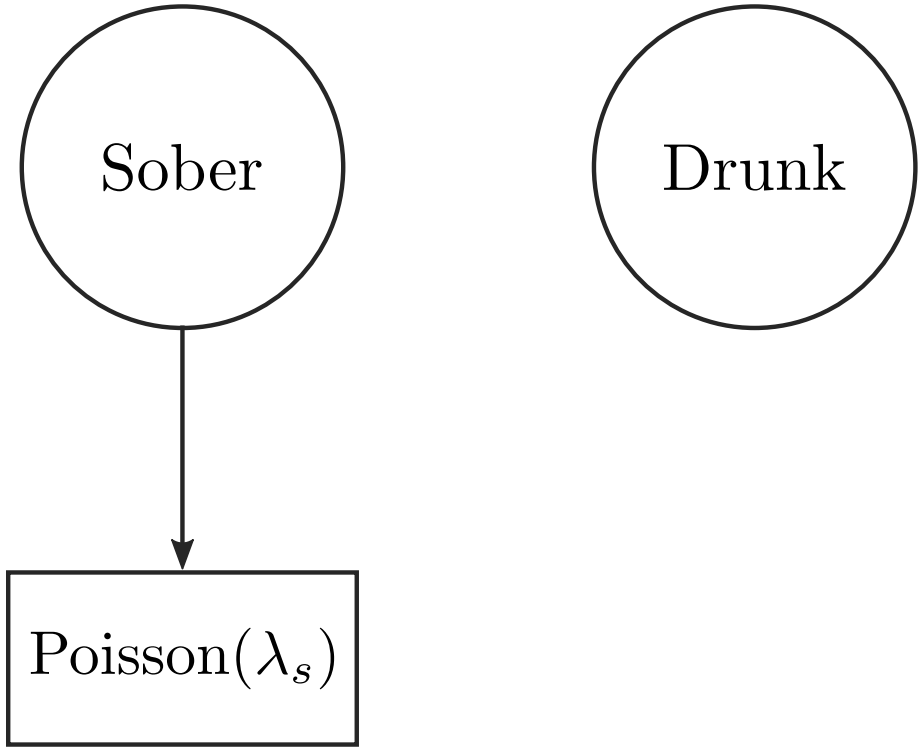
State-of-mind

Manuscript
output

The drunkard monks: hidden Markov chain

State-of-mind

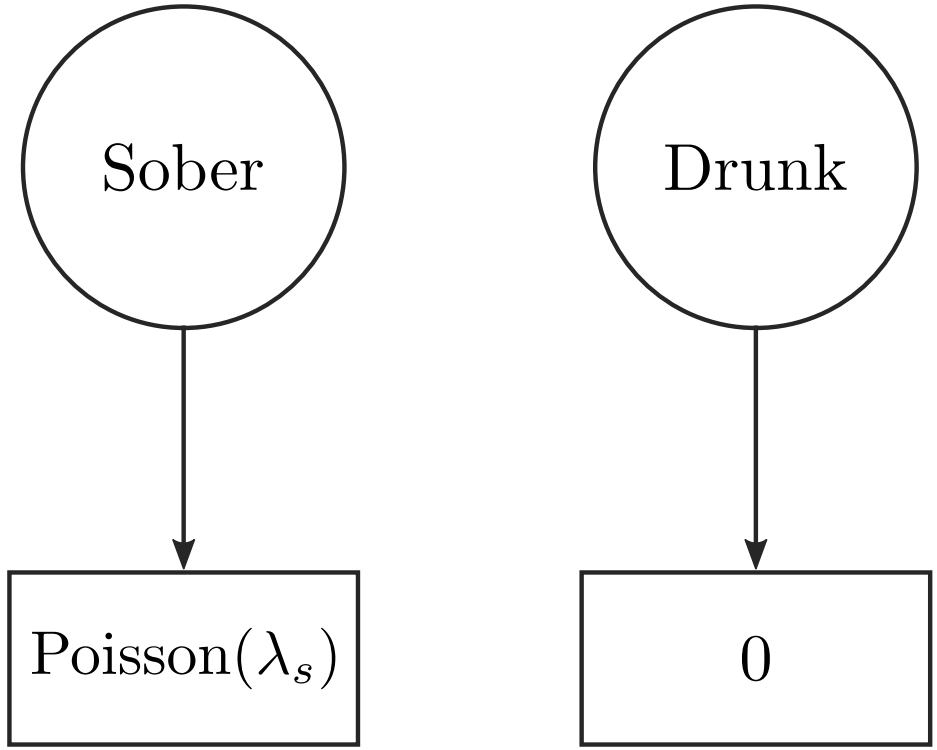
Manuscript output



The drunkard monks: hidden Markov chain

State-of-mind

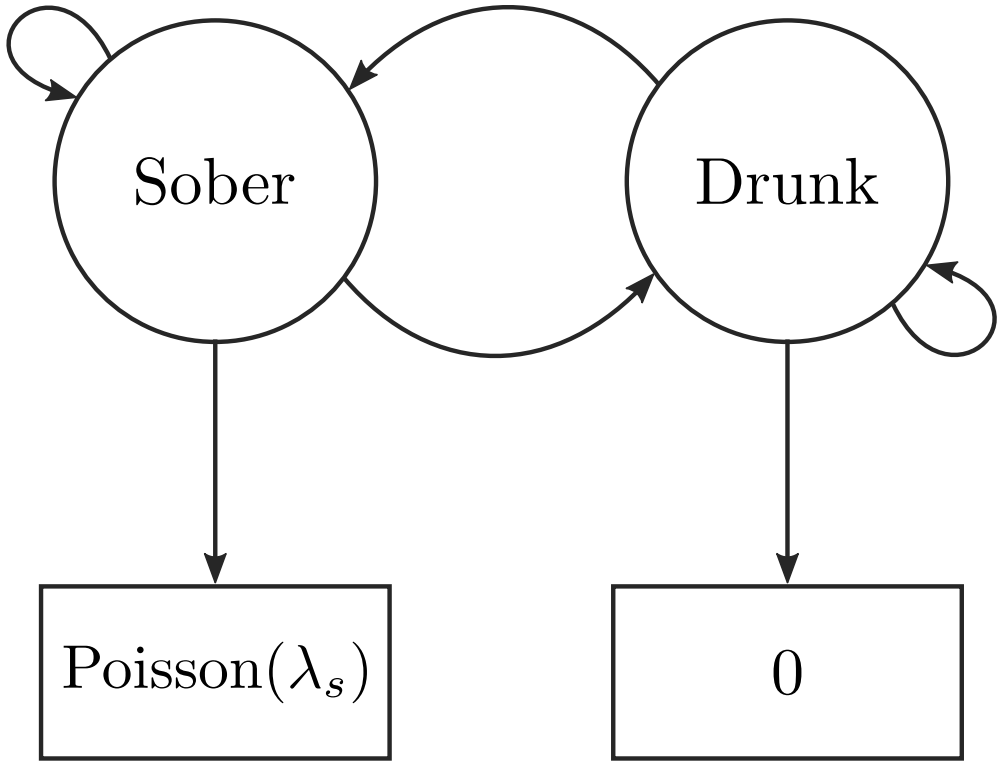
Manuscript output



The drunkard monks: hidden Markov chain

State-of-mind

Manuscript output



The drunkard monks: hidden Markov chain

State-of-mind

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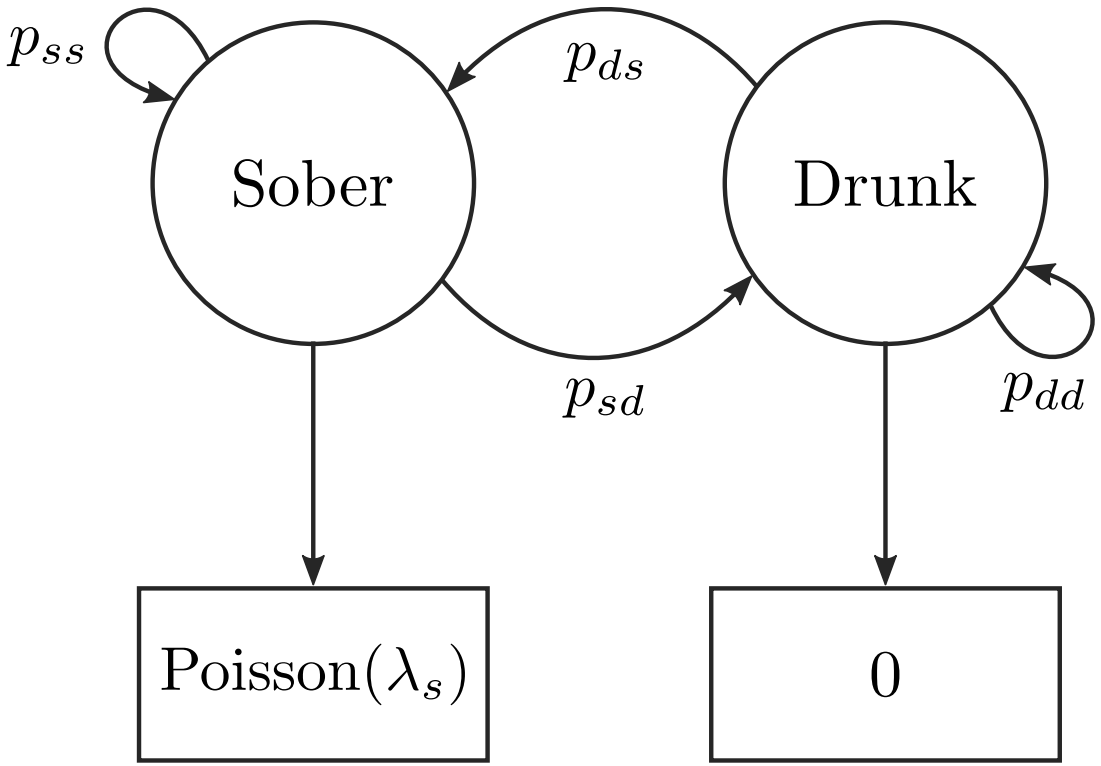


The drunkard monks: simulation

- Simulate 1 years (365 days)
- $\lambda_s = 1$ manuscript/day
- Initial state: sober
- Transition matrix

	Sober	Drunk
Sober	0.6	0.4
Drunk	0.3	0.7

The drunkard monks: simulation

```
clear all

%% Setup
REAL = 365;             % # of days
lambda_s = 1;           % Avg # of manuscripts/day

% Transition matrix
P = [0.6 0.4 ; 0.3 0.7];

%% Simulation
state = zeros(REAL,1);  % Sober (1) or drunk (2)
books = zeros(REAL,1);  % # of manuscripts/day
state(1) = 1;           % Initial state: sober (1)
```

The drunkard monks: simulation

```
for i = 1:REAL-1
    % Monks manuscript output

    % Monk state transition

end
```

The drunkard monks: simulation

```
% Monks manuscript output
if state(i) == 1
    books(i) = poissrnd(lambda_s);
elseif state(i) == 2
    books(i) = 0;
end
```

The drunkard monks: simulation

```
% Monk state transition
if state(i) == 1
    % Monks are currently sober
    p = rand(1);

    if p <= P(1,1)
        state(i+1) = 1;    % Monks stay sober
    else
        state(i+1) = 2;    % Monks decide to drink
    end
elseif state(i) == 2
    % Monks are currently drunk
    ...
end
```

The drunkard monks: simulation

- Sanity check: has any state not been updated?
- How many manuscripts in a year? How many manuscripts per day on average?
- Probability of being drunk?

The drunkard monks: simulation

- Sanity check: has any state not been updated?

```
sanity_check = sum(state == 0);
fprintf('Errors: %d\n', sanity_check);
```

The drunkard monks: simulation

- How many manuscripts in a year? How many manuscripts per day on average?

```
books_in_year = sum(books);
books_per_day = mean(books);

fprintf('Total manuscripts: %d\n', ...
    books_in_year);
fprintf('Average manuscripts/day: %.2f\n', ...
    books_per_day);
```

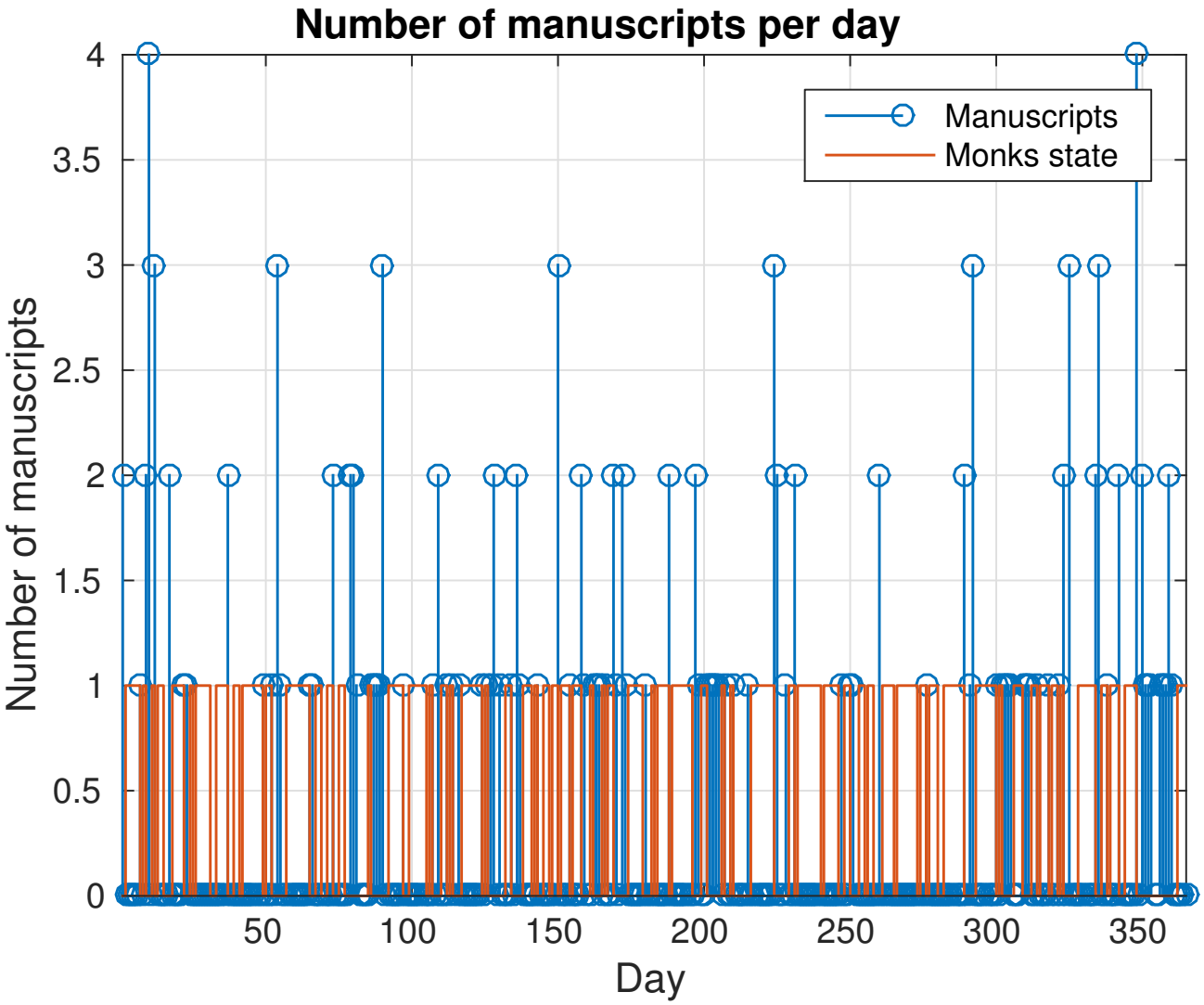
The drunkard monks: simulation

- Probability of being drunk?

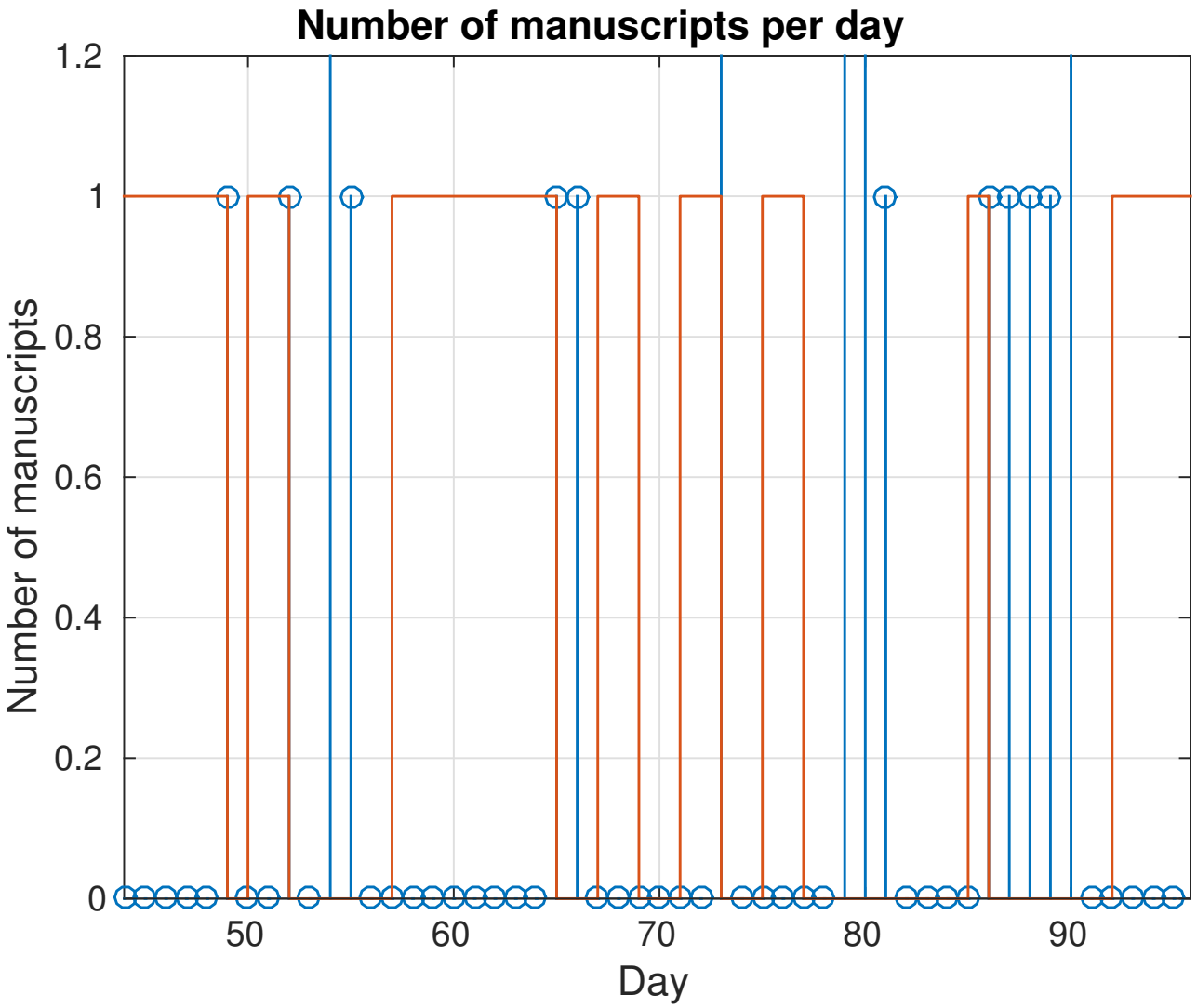
```
p_drunk = sum(state == 2);

fprintf('Pr[drunk] = %.2f\n', p_drunk);
```

The drunkard monks: results



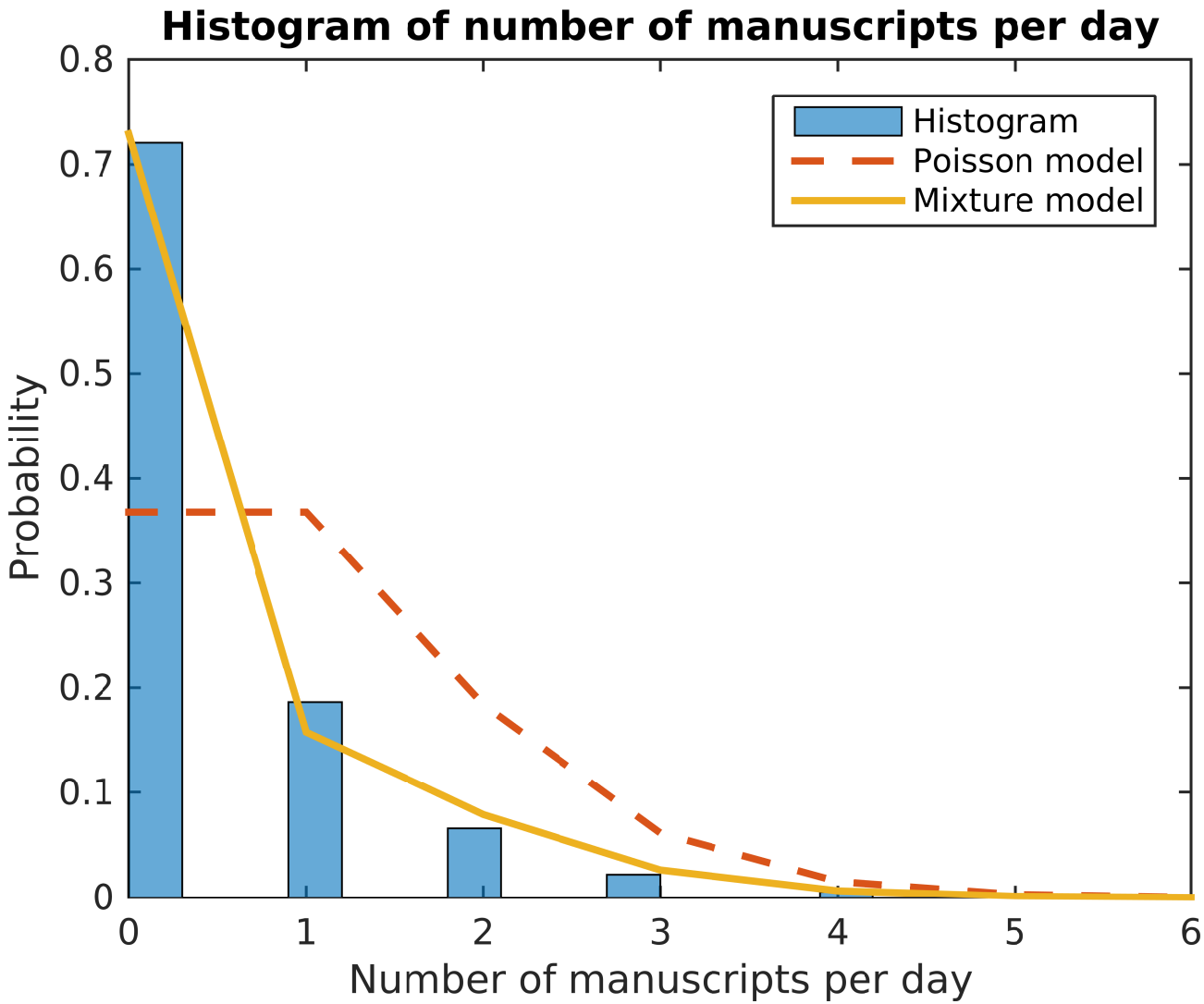
The drunkard monks: results



The drunkard monks: results

```
figure();
stem(1:REAL, books);
hold on;
stairs(1:REAL, state-1);
grid;
xlim([1 REAL]);
legend('Manuscripts', 'Monks state');
xlabel('Day');
ylabel('Number of manuscripts');
title('Number of manuscripts per day');
```

The drunkard monks: results



The drunkard monks: results

```
figure();
histogram(books, 'BinMethod', 'fd', ...
    'Normalization', 'probability');
hold on;
plot(0:6, poisson, '--', 'LineWidth', 2);
plot(0:6, poisson_mix, 'LineWidth', 2);
legend('Histogram', 'Poisson model', ...
   'Mixture model');
xlabel('Number of manuscripts per day');
ylabel('Probability');
title('Histogram of manuscripts per day');
```

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