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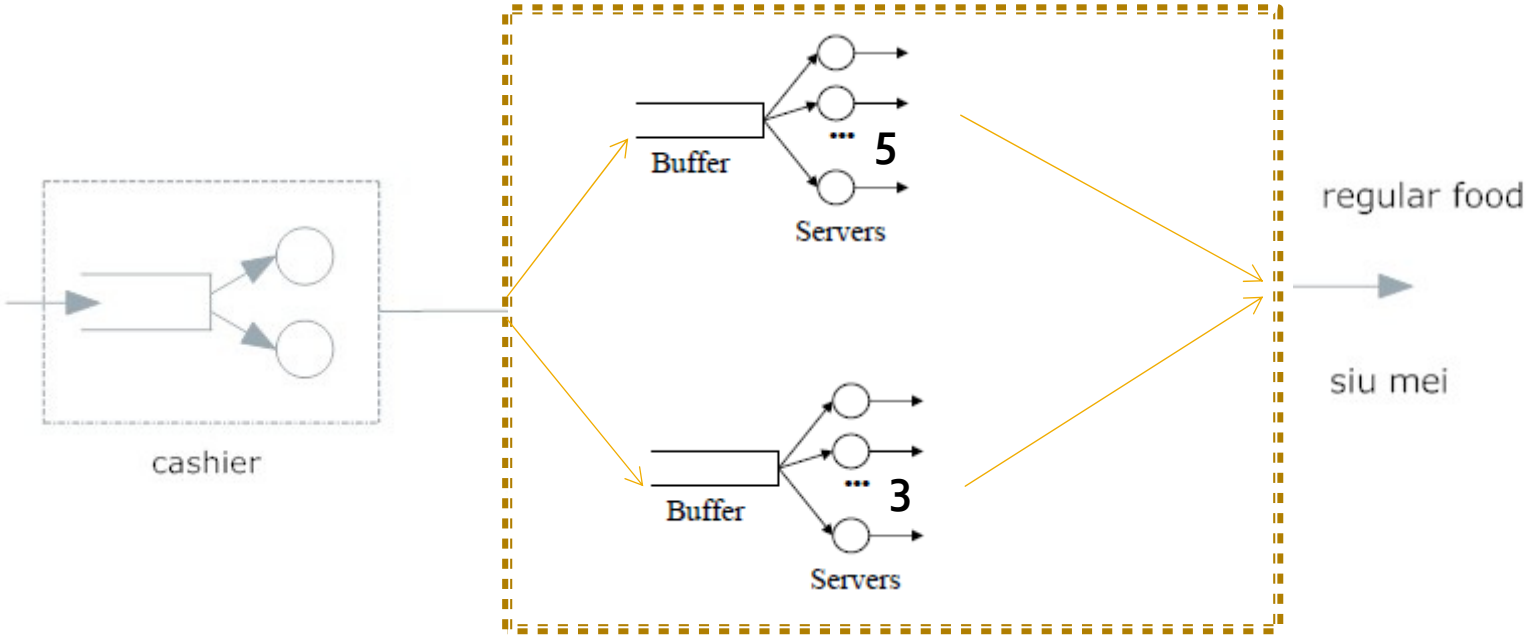
Queuing of Café de Coral during weekday lunch hour

Café de Coral

- Tai Po Market MTR branch
- 01:00pm – 02:00pm

Simplified Queuing System

- Separation of regular food and "siu mei"
- No. of food tray is always changing



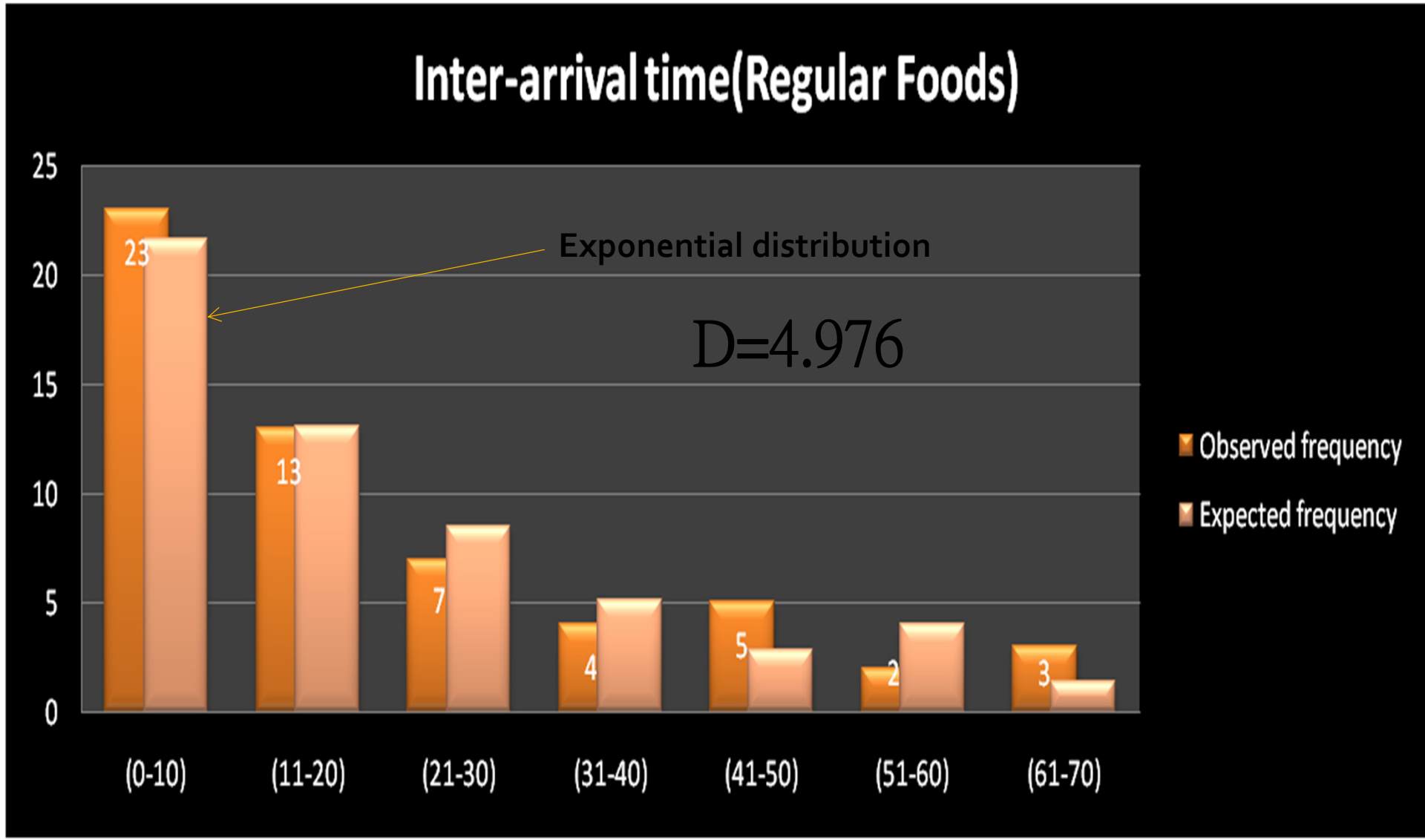
Selecting Input Distribution

- Collecting inter-arrival and service-time data
  - Collected around 60 samples

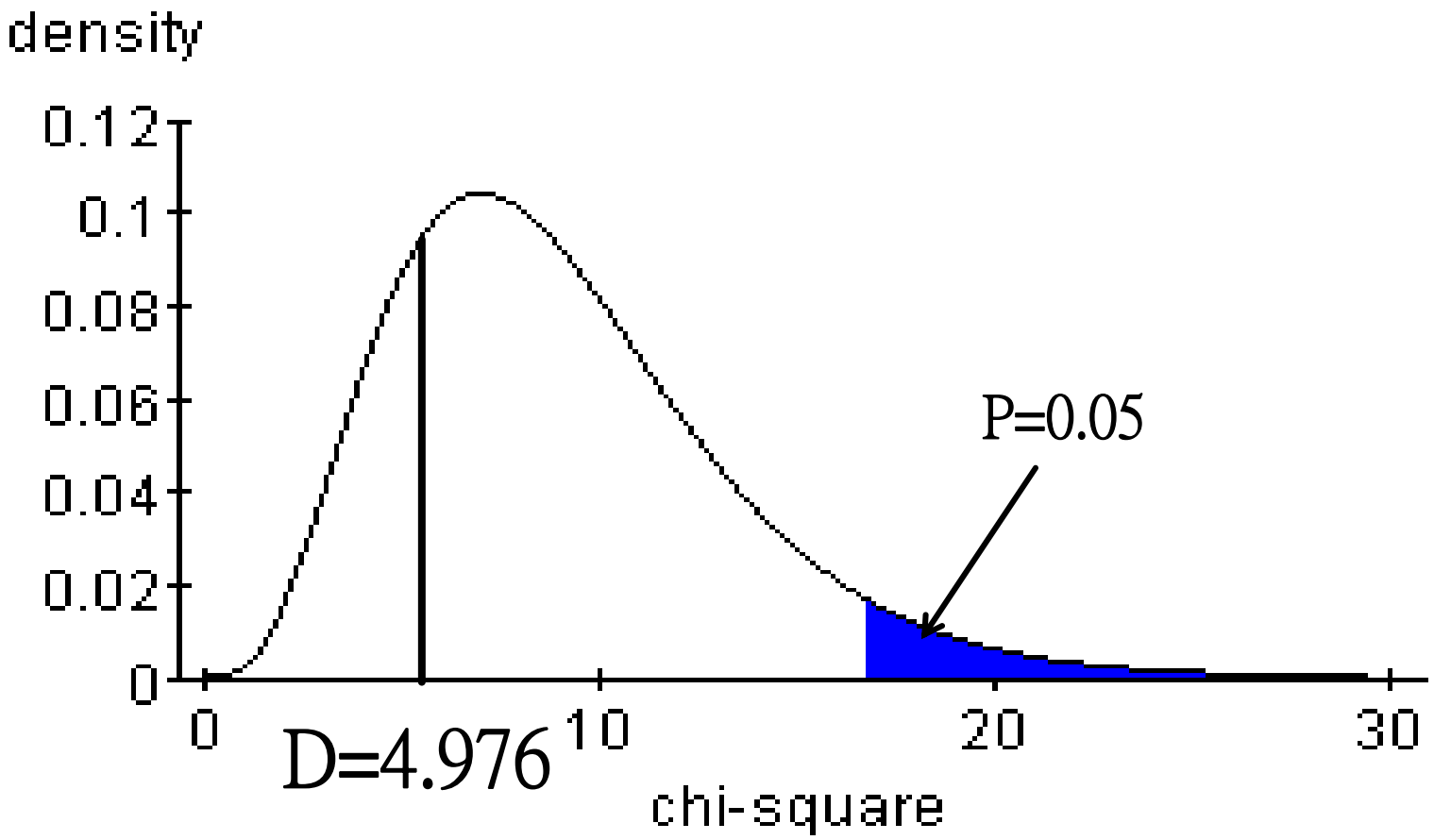
Selecting Input Distribution

- Select a theoretical distribution
  - Time is continuous
  - Time is greater than zero

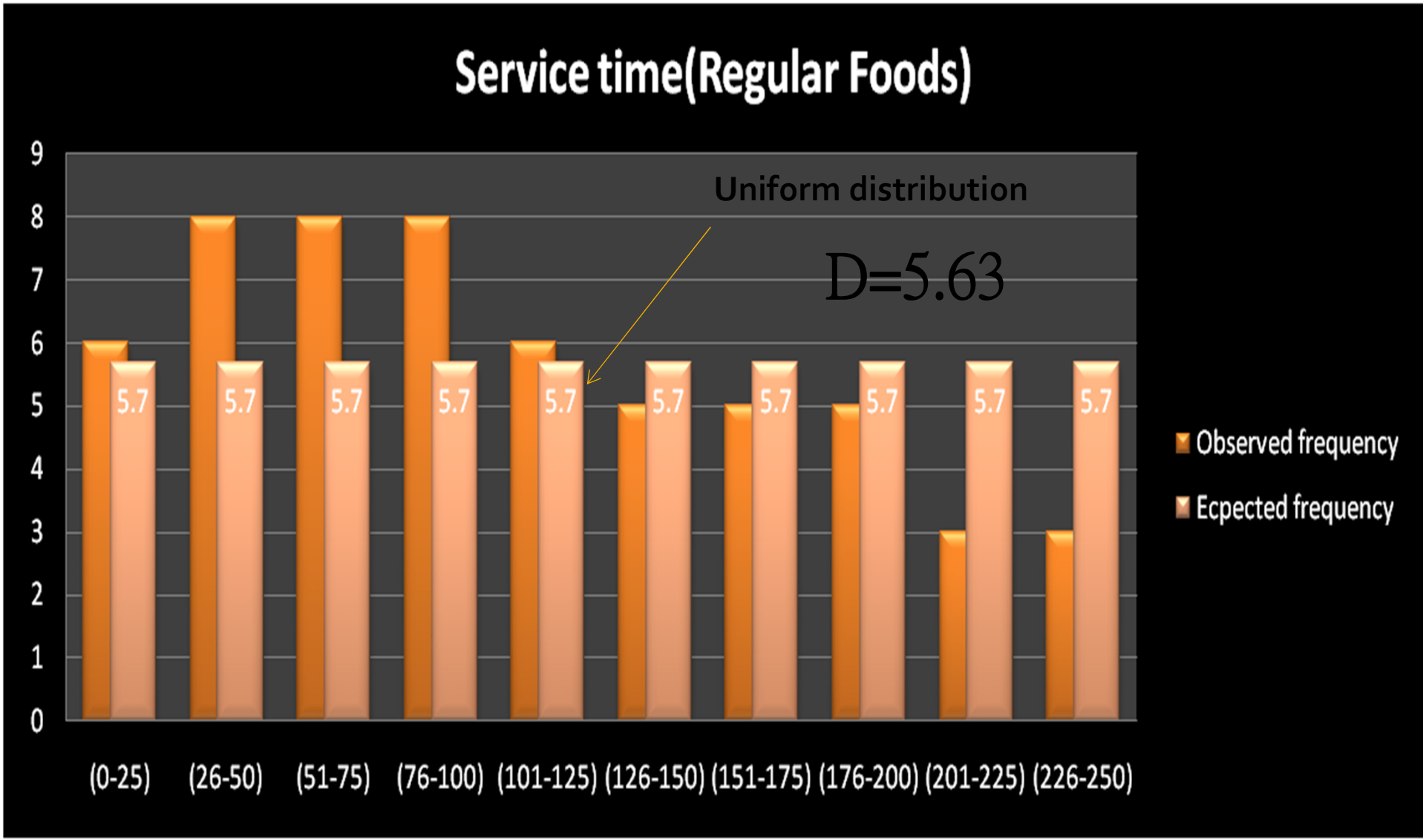
Fitting Regular foods inter arrival time



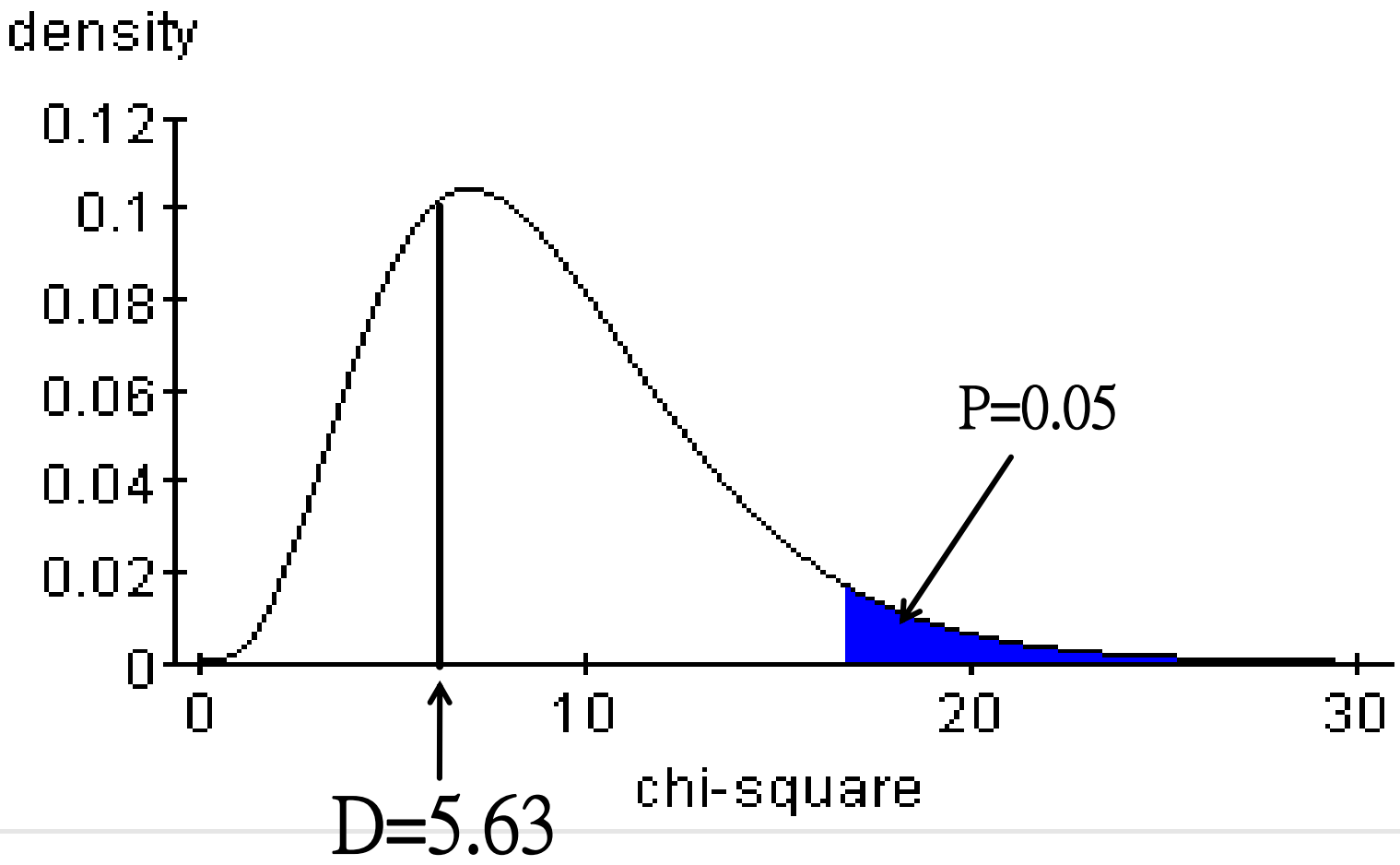
Chi Square distribution(Regular foods) Arrival time



Fitting Regular foods service time

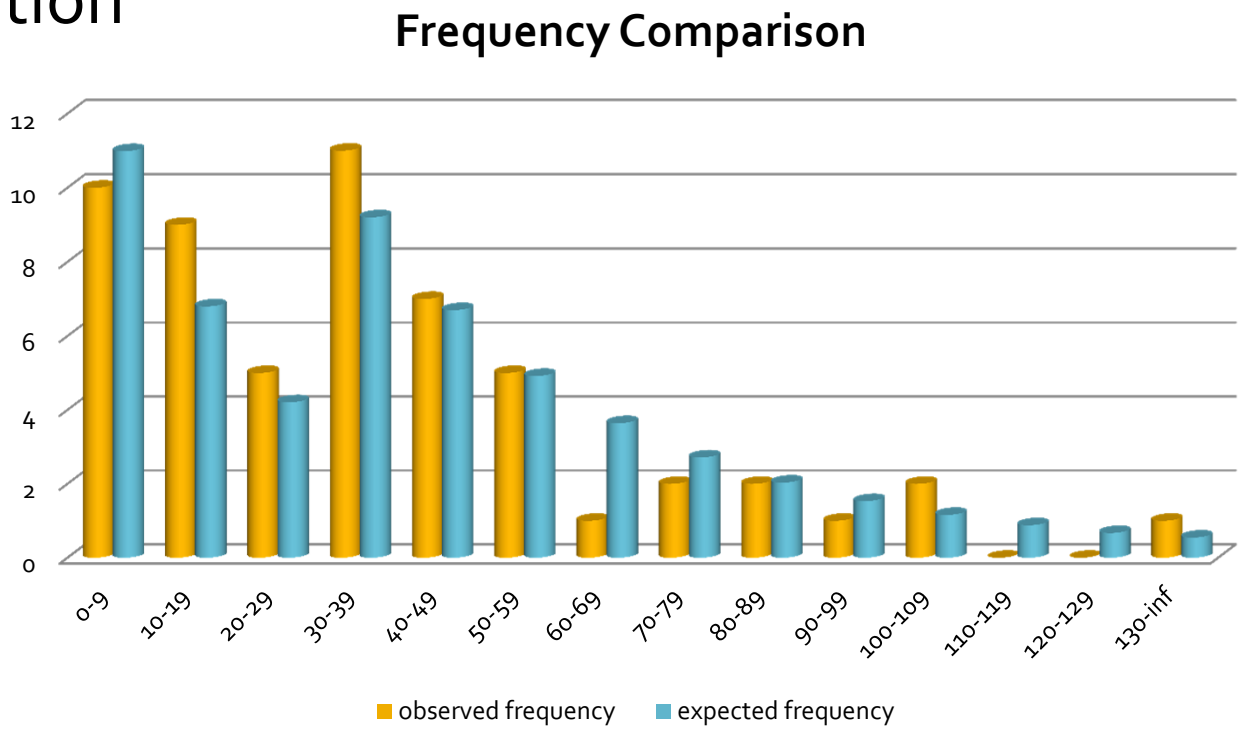


Chi Square distribution(Regular foods) Service time



Fitting Siu Mei inter-arrival times

- Heuristic method: Frequency Comparison
  - Hypothesis: superimposition of two exponential function

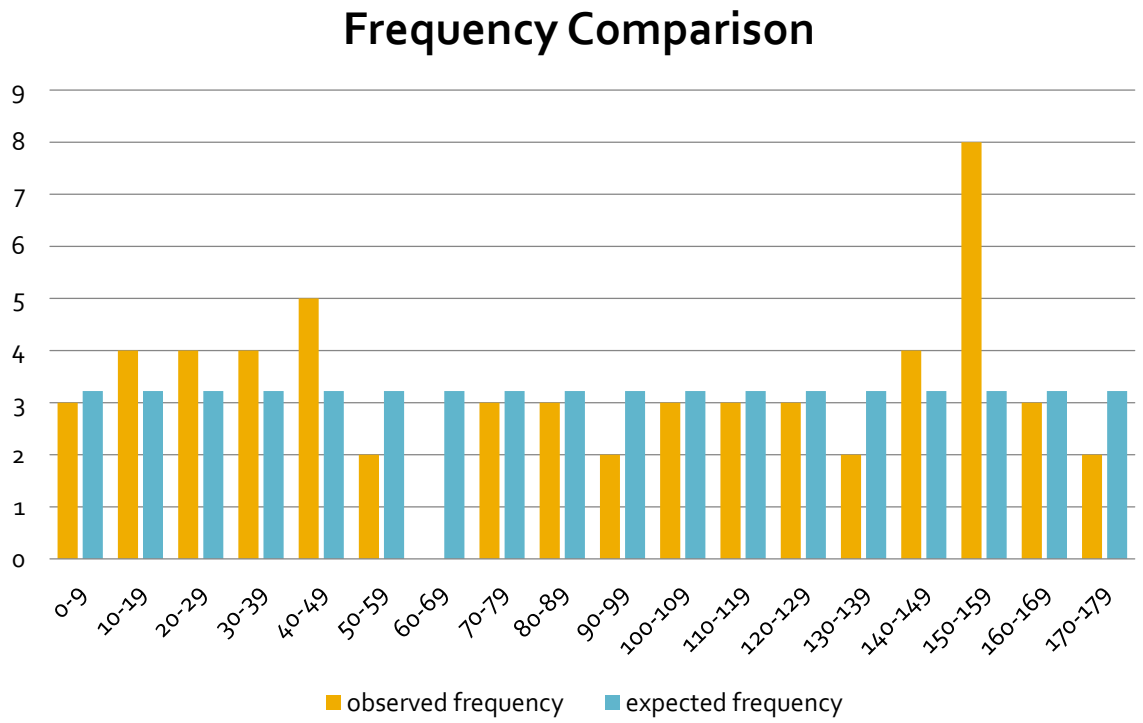


Fitting Siu Mei inter-arrival times

- Actual p.d.f.: $p(x) = c\,(0.048e^{-0.048x} + 0.026e^{-0.026(x-30)})$
  - Constant c = 0.51473924…
- Chi-square Goodness-of-fit Test
  - Test statistic D = 6.1426
  - Level of significance = 5%, $\chi 2$ = 22.36
  - D < $\chi 2$, null hypothesis is not rejected

Fitting Siu Mei service rates

- Heuristic method: Frequency Comparison
  - Hypothesis: U~(0,180)



Fitting Siu Mei service rates

- Chi-square Goodness-of-fit Test
  - Test statistic D = 14
  - Level of significance = 5%, $\chi 2 = 27.59$
  - $D < \chi 2$, null hypothesis is not rejected

CSIM Implementation

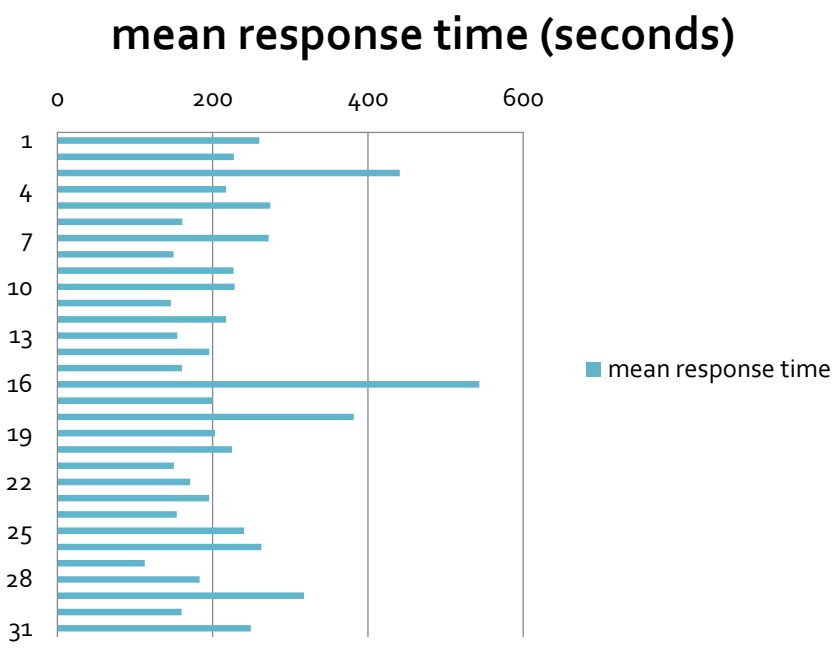
- E.g. Composition method was used

```
void sim()
{
    int i;
    init();
    for (i = 0; i < 1; i++) {
        create("sim"); /* make this a process */
        // reset_my_system();
        reset_prob(9000);
        start_time = simtime();
        while (simtime() < 7200.0)  /* 2 hours = 7200 seconds */
        {
            if (uniform(0.0, 1.6376137) < c)    {
                hold(exponential(1 / 0.048));
            } else  {
                hold(exponential(1 / 0.026));
            }
            customers();
        }

        total_time = simtime() - start_time;
        // avg_busy = AUC_busy / total_time;    /* time average =
        // proportion_busy = avg_busy / n;
        printPerformance();
    }
    // report();
}
```

Output Data Analysis

- Method of Replication
  - Made 31 replications of the whole simulation
    - Same replications Xi and Yi use the same sequence of random number



Output Data Analysis

- Vary the number of food tray
  - At 90% confidence level

number of server	response time	completed count	queue length	max. no. in system
2	(888.1, 2154.7)	(145.9, 172.0)	(20.5, 46.1)	(44.3, 87.2)
3	(78.0, 378.8)	(193.6, 230.0)	(1.9, 11.5)	(8.6, 26.7)
4	(90.6, 129,1)	(198.4, 239.0)	(2.5, 4.1)	(6.8, 14.4)

System Comparison

- Paired-t comparison with a standard
  - Standard: 3 food trays
  - Overall level of significance = 10%
  - 3 systems, individual $\alpha = 5\%$

compared against	response time	completed count	max. no. in system
2	(648.2, 1937.7)	(-76.3, -29.4)	(28.2, 68.0)
4	(-285.4, 48.2)	(-3.8, 17.7)	(-15.0, 0.9)

Some Observations

- This Café de Coral branch has an optimal configuration for the siu mei queue at lunch time
  - In respect to benefit of the restaurant
- Bench space is limited, staff allocated to regular food queue, since it is even busier
- Siu mei queue is extremely overloaded in tea time, since chef has a maximum service rate

Q &A