Good morning, Distinguished professors.

It is a great pleasure and honor to have you attending my preliminary exam. Thank you for your participation.

The title is seat planning and seat assignment with social distancing.

The content is divided into the following 6 parts. In the introduction, since the outbreak of the pandemic, social distancing as a valid physical measure to restrict the spread of the virus has been used in many places.

For instance, in the dining hall and office, the social distancing tapes are pasted on the floor to remind people to keep social distancing. In the restaurant, plastic boards have been used to separate the adjacent groups. In the park, the square line is drawn to confine the scope of group activity. Social distancing has also been used in seating areas, such as in amusement parks, shopping malls, restaurants and theaters or music concert.

Then we will discuss the requirements for social distancing, which will introduce the seat planning and seat assignment we are going to talk about. The policy regarding social distance usually requires a limit on the size of each group, with people in the same group sitting together and different groups maintaining distance.

We clarify the two terms, seat planning and seat assignment used in the following part.

Seat planning refers to planning the seats for the incoming groups. Blue squares represent the social distancing. Here are two types of seat planning for one row.

The seat assignment refers to the process of assigning the seats to the incoming group. For example, here is a group of 2, we assign 3 seats to it, then three seats will be occupied and will not be used in the future.

This thesis basically includes two parts, seat planning and seat assignment. In the seat planning part, we consider to obtain the seat planning with the deterministic demand, known specific demand. We also consider the stochastic demand, that is, we know demand distribution before the realization of demand.

For the seat assignment part, we consider to assign seats under the seat planning. We mainly focus on the real-time seat assignment, and the late assignment and assignment under the flexible seat planning are also discussed.

Regarding the contribution of the seat planning, we propose a new model and develop the corresponding technique for the stochastic demand situation. This model can provide the seat planning as a guidance or basis for seat assignment.

In the seat assignment part, we propose the new model for this problem and provide practical policies and insights.

Regarding the literature review, there have been many works about seat planning with social distancing, including seat planning on airplanes, in classrooms, trains. There are a few literatures about the group-based seat planning that can be applied in airplanes and theaters. However, they mainly concentrate on the static model and know the specific groups.

In terms of the dynamic seat assignment, we model the problem as a dynamic multiple knapsack problem. This is related to the well-studied multiple knapsack problem and dynamic knapsack problem. However, the dynamic multiple knapsack problem itself has not been extensively researched in the literature.

This problem is also related to the area of group-based network revenue management. However, revenue management typically focuses on the decision of whether to accept or reject a group, without considering the actual seat assignment. In contrast, our problem has the additional feature of assigning groups to specific seats. In a word, our work considers the group-based seat assignment.

Now, we incorporate social distancing into the seat planning problem by introducing several key concepts.

There are M types of groups, type i group contains i people. The seat layout contains N rows, row j has Lj0 seats. Set delta seats as the social distancing. We do the following conversions, i.e., for each i, let n\_i equal i plus delta. The value, ni, indicates the number of seats occupied by type i group. For each row, let Lj equal the number of physical seats plus delta.

We use the following picture to illustrate the conversion. In the top row, the blue squares represent the social distancing, here it is one seat. There are 10 physical seats. In the bottom row, the gray square is the added virtual seat. For the first group, And we use a size of 3 seats to represent the group of 2 with one seat as the social distancing. Then we don't need to consider the social distancing seperately after the conversion. In the following part, we only consider the new size of type i and row.

To better understand this problem, I introduce the concept of pattern. Pattern represents the seat planning for one row, denoted by h, where hi is the number of type i groups. A feasible pattern should satisfy this constraint. And the number of people can be accommodated is the size of h, the summation of this term.

Still use the above example to explain, here L = 11. This pattern contains two type 2 groups, one type 1. The size of h is 7, i.e., the number of people accommodated is 7.

Then we define some patterns.

h is a largest pattern if the size h is no less than the size of any feasible pattern.

h is a full pattern if the total size of all groups equals the size of the row.

Since the largest and full pattern can utilize as many seats as possible,

For the type i less than i tilde, we don't plan seats for these groups; for the type larger than i tilde, we plan seats for the groups; then the remaining seats are planned for type i tilde.

We have the following programming to help generate the full or largest patterns.

Regarding the first set of constraints, we present the specific form as follows: The number of type M groups in the new seat planning must be greater than or equal to the number in the original seat planning.

The same constraint applies to the summation of the number of type M and M-1. The same constraint applies to the summation of all group types.

In this way, each group type in the original seat planning is fulfilled by the new seat planning.

P29 the expected value difference between acceptance and rejection

Now we move on to the numerical results, first we describe some common parameters.

Then we investigate the impact of social distancing.

We set an even probability distribution. There are two figures, in the left one, x axis is the period, y-axis is the percentage of accepted individuals relative to total seats. In the right one, x-axis is the percentage of expected demand relative to total seats.

Introduce the gap point to refer to the first period when there is difference between accepted individuals with social distancing and without social distancing.

Here, the gap point is 58, the corresponding occupancy rate is 71.3%.

P40 For the managerial insight of the DSA policy, we examine the impact of implementing social distancing. We know that when the demand is small, we will accept all groups with social distancing constraints. As the demand increases, there will be a difference between the number of people accepted with social distancing and without social distancing. What interests us is when the difference starts to be larger than 0.

Let gamma be the expected number of people at each period.

The gap point represents the first period when we have the difference.

The gap points of different probabilities with the same gamma has little difference, which can be seen by the estimation of gap point.

Here we have a figure including the gap points under DSA with 200 probabilities, the blue points represent the period and red points represent the corresponding occupancy rate.

And these points can be fitted very well.

I will not go into details here.

Here we can get the conclusion that

1. we address dynamic assignment

2. we develop the efficient policy .

3. the occupancy rate can be estimated by gamma.

Our work makes the first attempt to implement dynamic seat assignments

We assume that the surplus supply for group type i can be occupied by smaller group type

The objective function is to maximize the expected number of people that can be assigned across multiple demand scenarios.

we could reformulate ssp in a vector form as problem 2, here for each scenario, problem 3 has the same form, if we can solve it efficiently which is helpful to solve problem 2. Fortunately, it is easy to solve problem 3 by the dual problem.

The solution to SSP can be obtained by solving the master problem iteratively. We develop other approach to obtain the seat planning composed of full or largest pattern.

Now we see how to do the dynamic seat assignment. It contains two parts, seat planning can be seen as the supply for each group type, when the supply is enough, we will accept the corresponding request, if there is no supply for small group, we should decide whether to use a larger group type supply to cover the smaller one. Let dij represent the expected difference between the acceptance and rejection of group type i on the supply of group type j.

For each j larger than i, we find the largest one, denoted as j star. It is a necessary condition based on the current planning, we also use the value of stochastic programming to make the final decision.

The optimal policy is to make the decision when we have complete knowledge of all future requests in advance.

That concludes my presentation."

And that wraps up my presentation."

And that brings me to the end of my presentation."

And that's all for my presentation."

I would be delighted to address any questions, comments, or suggestions you may have. Please feel free to share your thoughts, and I will do my best to provide thorough responses. I value your insights and look forward to our discussion.