



Let's tackle each part of the question in a step-by-step manner:

让我们逐步解决问题的每个部分：

Part (a): Real Estate Investment Decisions for Mr. Chen

(a)部分： 陈先生的房地产投资决策

Mr. Chen has the option to invest in four types of properties (Industrial, Office, Shop, and Condominium), and he wants to determine the best investment option based on different economic criteria.

陈先生可以选择投资四种类型的房产（工业、办公、商铺和公寓），他希望根据不同的经济标准来确定最佳的投资选择。

Table of Returns**回报表**

Property Type	Recession (E1) 经济衰退 (E1)	Moderate Growth (E2)	Rapid Growth (E3)
Industrial (I)	-10%	10%	20%
Office (O)	-20%	12%	25%
Shop (S)	-30%	15%	30%
Condominium (C)	-5%	10%	15%

Let's use each criterion to derive Mr. Chen's investment decision.

让我们使用每个标准来得出陈先生的投资决策。

(i) Criterion of Pessimism (Maximin Criterion)**(i) 悲观主义准则（最大最小准则）**

Under the criterion of pessimism, Mr. Chen would choose the investment with the highest worst-case return. This means he would look at the minimum return for each property type and choose the one with the highest value.

在悲观的标准下，陈先生会选择最坏情况下回报最高的投资。这意味着他会考虑每种财产类型的最低回报并选择价值最高的一种。

- Industrial: Min return = -10%**工业：最小回报 = -10%**

- Office: Min return = -20%**办公室：最低回报 = -20%**

- Shop: Min return = -30%**商店：最低回报 = -30%**

- Condominium: Min return = -5%

The highest minimum return is -5%, which corresponds to **Condominium (C)**. Therefore, under the pessimism criterion, Mr. Chen should invest in **Condominium**.

最高最低回报率为-5%，对应**公寓（C）**。因此，按照悲观标准，陈先生应该投资**Condominium**。

(ii) Criterion of Optimism (Maximax Criterion)**(ii) 乐观标准（Maximax 标准）**

Under the criterion of optimism, Mr. Chen would choose the investment with the highest possible return.在乐观的标准下，陈先生会选择回报率最高的投资。

- Industrial: Max return = 20%**工业：最大回报 = 20%**

- Office: Max return = 25%**办公室：最大回报= 25%**

- Shop: Max return = 30%**商店：最大回报 = 30%**

- Condominium: Max return = 15%

The highest return is 30%, which corresponds to **Shop (S)**. Therefore, under the optimism criterion, Mr. Chen should invest in **Shop**.

最高回报为30%，对应**Shop(S)**。因此，在乐观的标准下，陈先生应该投资**商铺**。

(iii) Criterion of Regret (Minimax Regret)**(iii) 遗憾标准（最小最大遗憾）**

To apply the criterion of regret, we first construct the regret table by comparing each outcome with the best outcome for each economic state.

为了应用遗憾标准，我们首先通过将每个结果与每个经济状态的最佳结果进行比较来构建遗憾表。

- Find the best returns for each economic state:**找出每个经济状态的最佳回报：**
 - Recession (E1): Best return = -5% (Condominium)
经济衰退 (E1): 最佳回报 = -5%（公寓）
 - Moderate Growth (E2): Best return = 15% (Shop)
适度增长 (E2): 最佳回报 = 15%（商店）
 - Rapid Growth (E3): Best return = 30% (Shop)**快速增长 (E3): 最佳回报 = 30%（商店）**
- Calculate the regret for each investment type by subtracting each return from the best return in that state:**通过从该州的最佳回报中减去每个回报来计算每种投资类型的遗憾：**

Property Type	Recession (E1) 经济衰退 (E1)	Moderate Growth (E2)	Rapid Growth (E3)	Maximum Regret
Industrial (I)	-5 - (-10) = 5	15 - 10 = 5	30 - 20 = 10	10
Office (O)	-5 - (-20) = 15	15 - 12 = 3	30 - 25 = 5	15
Shop (S)	-5 - (-30) = 25	15 - 15 = 0	30 - 30 = 0	25
Condominium (C)	-5 - (-5) = 0	15 - 10 = 5	30 - 15 = 15	15

- Determine the minimum of the maximum regrets:**确定最大遗憾中的最小遗憾：**

- Industrial: Max regret = 10
- Office: Max regret = 15**办公室：最大遗憾 = 15**

- Shop: Max regret = 25**商店：最大后悔= 25**

- Condominium: Max regret = 15

The smallest maximum regret is 10, which corresponds to **Industrial (I)**. Therefore, under the regret criterion, Mr. Chen should invest in **Industrial**.

最小的最大遗憾是 10，对应于**Industrial (I)**。因此，根据后悔标准，陈先生应该投资**实业**。

Summary of Decisions in Part (a)**(a) 部分的决定摘要**

- Criterion of pessimism:** Condominium**悲观标准：公寓**

- Criterion of optimism:** Shop**乐观标准：商店**

- Criterion of regret:** Industrial**遗憾标准：工业**

Part (b): Location Selection for the Bakery**(b) 部分：面包店选址**

The bakery has three potential locations (HDB Town Central, Orchard Road, and Airport), with various costs, revenues, and probabilities. The net profit is calculated as revenue minus operational costs. The bakery boss's utility function for profit is given by:

该面包店有三个潜在地点（HDB 市中心、乌节路和机场），成本、收入和概率各不相同。净利润的计算方式为收入减去运营成本。面包店老板的利润效用函数由下式给出：

$$u(x) = \sqrt{\max\{x + 2, 0\}}/21$$

where x is the net profit in units of \$1,000.在哪里 x 是以 1,000 美元为单位的净利润。

(i) Calculating Expected Utility for Each Location**(i) 计算每个地点的预期效用**

Let's calculate the expected utility for each location, considering the operational costs and expected revenue.让我们考虑运营成本和预期收入，计算每个地点的预期效用。

- HDB Town Central:**
 - Operational cost: \$12K**运营成本：12K 美元**
 - Revenue outcomes: \$20K (0.4 probability) and \$25K (0.6 probability)
收入结果：20K 美元（0.4 概率）和 25K 美元（0.6 概率）
 - Net profit outcomes: $20 - 12 = 8$ K and $25 - 12 = 13$ K
 - Utilities: $u(8)$ and $u(13)$
- Orchard Road:**
 - Operational cost: \$16K**运营成本：16K 美元**
 - Revenue outcomes: \$25K (0.3 probability) and \$32K (0.7 probability)
收入结果：25,000 美元（0.3 概率）和 32,000 美元（0.7 概率）
 - Net profit outcomes: $25 - 16 = 9$ K and $32 - 16 = 16$ K
 - Utilities: $u(9)$ and $u(16)$
- Airport (with and without promotion):**机场（有或没有促销）：****
 - Operational cost: \$10K**运营成本：10K 美元**
 - With promotion:**
 - Promotion cost: \$9K (additional)**促销费用：9K 美元（额外）**
 - Total cost: $\$10\text{K} + \$9\text{K} = \$19\text{K}$
 - Revenue outcomes: \$28K (0.4 probability) and \$38K (0.6 probability)
收入结果：28K 美元（0.4 概率）和 38K 美元（0.6 概率）
 - Net profit outcomes: $28 - 19 = 9$ K and $38 - 19 = 19$ K
 - Utilities: $u(9)$ and $u(19)$
 - Without promotion:**无促销：****
 - Revenue outcomes: \$15K (0.2 probability) and \$18K (0.8 probability)
收入结果：15K 美元（0.2 概率）和 18K 美元（0.8 概率）
 - Net profit outcomes: $15 - 10 = 5$ K and $18 - 10 = 8$ K
 - Utilities: $u(5)$ and $u(8)$

Using these calculations, we can compare the expected utilities for each location and determine the location with the highest expected utility.

使用这些计算，我们可以比较每个位置的预期效用，并确定预期效用最高的位置。

(ii) Sensitivity Analysis on the Promotion Fee (y)**(ii) 促销费敏感性分析 (y)**

To determine how values of y (the promotion fee) would change the decision:

确定如何值 y （促销费）将改变决定：

- Set up an equation for the expected utility of the Airport location with the promotion fee y .**建立机场位置的预期效用与促销费的方程 y 。**
- Find the value of y that makes the expected utility equal to the next highest option from (i).**求出 的值 y 这使得预期效用等于 (i) 中的下一个最高选项。**
- This process identifies the range of y values where the bakery boss might prefer a different location based on utility outcomes.
这个过程确定了范围 y 面包店老板可能会根据公用事业结果更喜欢不同位置的值。