作业4：推理和语言模型

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1 贝叶斯网络

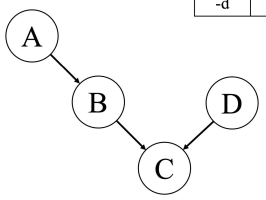
考虑以下含有4 个变量A,B,C,D 的贝叶斯网络。相应的条件概率表如下。

$P(A)$	
+a	0.4
-a	0.6

$P(D)$	
+d	0.3
-d	0.7

$P(C\|B,D)$			
+b	+d	+c	0.9
+b	+d	-c	0.1
+b	-d	+c	0.7
+b	-d	-c	0.3
-b	+d	+c	0.4
-b	+d	-c	0.6
-b	-d	+c	0.1
-b	-d	-c	0.9

$P(B\|A)$		
+a	+b	0.7
+a	-b	0.3
-a	+b	0.8
-a	-b	0.2



(a) 计算$p(-a,-b,-c,+d)$**。**

由链式规则，有：

$$p(-a,-b,-c,+d) = p(D=+d)\times p(A=-a)\times p(B=-b\mid A=-a)\times p(C=-c\mid B=-b,D=+d)$$

其中：

$$p(D=+d)=0.3$$
$$p(A=-a)=0.6$$
$$p(B=-b\mid A=-a)=0.2$$
$$p(C=-c\mid B=-b,D=+d)=0.6$$

故

$$p(-a,-b,-c,+d)=0.3\times 0.6\times 0.2\times 0.6=0.0216$$

(b) 计算$p(+b)$**。**

$$\begin{aligned} p(B=+b) &= \textstyle\sum_a p(B=+b\mid A=a)\times p(A=a) \\ &= p(B=+b\mid A=+a)\times p(A=+a)+p(B=+b\mid A=-a)\times p(A=-a) \\ &= 0.7\times 0.4+0.8\times 0.6=0.76 \end{aligned}$$

(c) 计算$p(-a\mid +b)$**。**

$$\begin{aligned} p(-a\mid +b) &= \frac{p(-a,+b)}{p(+b)} \\ &= \frac{p(+b\mid -a)\times p(-a)}{p(+b)} \\ &= \frac{0.8\times 0.6}{0.76} \\ &= 0.6316 \end{aligned}$$

(d) 计算并比较$p(+b)$ **和**$p(+b\mid -d)$ **两者的值是否相等，并从随机变量独立的角度进行解释。**

$$p(+b\mid -d)=\sum_{a,c} p(+b,a,c\mid -d)$$

通过边际化知：

$$p(+b\mid -d)=\sum_{a,c} p(a)\times p(+b\mid a)\times p(c\mid +b,-d)\times p(-d)=0.76$$

由已知得变量B和D条件独立，故题设两概率相等，B与D独立。

(e) 计算并比较$p(-a \mid +c)$ 和$p(-a \mid +c,-d)$ 两者的值是否相等，并从随机变量条件独立的角度进行解释。

由贝叶斯公式，有：

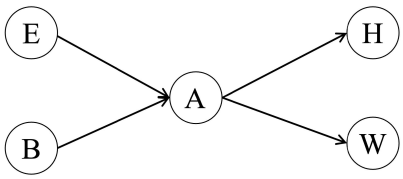
$$
\begin{aligned}
p(-a \mid +c) &= \frac{p(-a,+c)}{p(+c)} \\
&= \frac{\sum_{b,d} p(-a,b,d,+c)}{p(+c)} \\
&= \frac{\sum_{b,d} p(d)p(-a)p(b \mid -a)p(+c \mid b,d)}{p(+c)} \\
&\approx 0.6217
\end{aligned}
$$

$$
\begin{aligned}
p(-a \mid +c,-d) &= \frac{p(-a,+c,-d)}{p(+c,-d)} \\
&= \frac{p(-d)p(-a)p(b \mid -a)p(+c \mid b,-d)}{p(-d)\sum_{a,b} p(a)p(b \mid a)p(+c \mid b,-d)} \\
&\approx 0.6257
\end{aligned}
$$

二者不相等，从条件独立性的角度来看， C给定 D才使得A、B条件独立于D。

2. 变量消除法

在如下图所示的贝叶斯网络中，我们希望通过变量消除法计算$P(B=b|W=w)$。初始因子为$P(e), P(b), P(a|b,e), P(h|a), P(w|a)$。



(a) 假设消除顺序为$E \to H \to A$。请写出每一步产生的新因子的表达式并列出剩余的因子。

消除E：$f_1(A,B) = \sum_E p(E)p(A \mid B,E)$

消除H：$f_2(A) = \sum_H p(H \mid A)$

消除A：$f_3(B,W) = \sum_A f_1(A,B)f_2(A)p(W \mid A)$

完成以上过程后，还剩下的因子为：$f_3(B,W), P(B)$

(b) 请说明如何使用剩余的因子计算$P(B=b|W=w)$。

$$
p(B=b \mid W=w) = \frac{f_3(B=b,W=w)p(B=b)}{\sum_B f_3(B,W=w)p(B)}
$$

(c) 因子大小是变量消除法计算复杂度的关键因素。例如，假设所有的变量都是二元变量，则因子$P(H|A)$ 的大小是2，它有2^2 种取值需要维护；由于W 已经被观测，因子$P(W|A)$ 的大小是1，它只有2^1种取值需要维护。在以上变量消除的过程中，最大的因子是哪个，它有多少种取值需要维护？简要说明若改用顺序$E \to A \to H$，最大中间因子的维度是否会更小、相同或更大，并说明理由。

分析每一个因子：

$p(E)$的大小为1；

$p(B)$的大小为1；

$p(A \mid B,E)$的大小为3；

$p(H \mid A)$的大小为2；

$p(W \mid A)$的大小为1（由于$W=w$已被观测）；

在消除顺序为E、H、A时：

消除E：$f_1(A,B)$的大小为2；

消除H：$f_2(A)$的大小为1；

消除A：$f_3(B,W)$的大小为1（由于$W=w$已被观测）；

该过程中最大的因子为$p(A \mid B,E)$，其大小为3，故有2^3种取值需要维护；

在消除顺序为E、A、H时：

消除E：$f_1(A,B)$的大小为2；
消除A：$f_2(B,H)$和$f_3(B,W)$的大小为2、1；
消除H：无新因子
因此无论哪种顺序，最大的因子均为$p(A \mid B,E)$

3. 朴素贝叶斯

一位心理学家做了一个关于“幸福”的调查。每个受访者提供一个向量，其元素1 或0 分别对应于他们对某一问题回答“是”或“否”。该向量的属性为x = (rich, married, healthy).
例如，回答(1, 0, 1) 表示受访者“富有”、“未婚”、“健康”。此外，每个受访者如果对自己的生活感到“满意”，就给出一个y = 1 的数值；如果“不满意”，就给出y = 0。
心理学家一共收到了9 份问卷，声称对自己的生活感到“满意”的人给出的问卷结果为：(1, 1, 1), (0, 0, 1), (1, 1, 0), (1, 0, 1)；而对于“不满意”的人，则是：(0, 0, 0), (1, 0, 0), (0, 0, 1), (0, 1, 0), (0, 0, 0)。
基于以上数据，使用朴素贝叶斯分类器（不带Laplacian smoothing），
(a) 一个“不富有”、“已婚”、“健康”的人感到“满意”的概率是多少?
(b) 一个“不富有”、“已婚”的人感到“满足”的概率是多少？（也就是说，我们不知道他们是否“健康”）

已知，朴素贝叶斯公式为：

$$p(y \mid x) = \frac{p(x \mid y)p(y)}{p(x)}$$

由于题设特征之间是条件独立的，有：

$$p(x \mid y) = p(x_1 \mid y)p(x_2 \mid y)p(x_3 \mid y)$$

其中x_1, x_2, x_3是对应于富有、已婚、健康的三个特征。

(a)

给定的特征向量为$x = (0,1,1)$
有：

$$p(y=1 \mid x) = \frac{p(x \mid y=1)p(y=1)}{p(x)}$$

由已知得：

$$p(y=1) = \frac{4}{9}$$

$$p(x \mid y=1) = p(x_1=0 \mid y=1)p(x_2=1 \mid y=1)p(x_3=1 \mid y=1) = 0.1875$$

同理有：

$$p(x \mid y=0) = 0.064$$

故：

$$p(y=1 \mid x) = \frac{0.1875 \times \frac{4}{9}}{0.1875 \times \frac{4}{9} + 0.064 \times \frac{5}{9}} \approx 0.701$$

(b)

给定的特征向量为$x = (0,1,?)$
类似a中步骤，有：

$$p(x_1=0, x_2=1 \mid y=1) = 0.375$$

$$p(x_1=0, x_2=1 \mid y=0) = 0.16$$

则：

$$p(y=1 \mid x_1=0, x_2=1) = \frac{p(x_1=0, x_2=1 \mid y=1)p(y=1)}{p(x_1=0, x_2=1 \mid y=1)p(y=1) + p(x_1=0, x_2=1 \mid y=0)p(y=0)}$$

$$\approx 0.651$$

4 编程题：语言模型

在本题中，你将基于简化版本的GPT语言模型框架，深入理解语言模型的关键结构模块的实现原理和设计理念。我们已经完成了基础的模型定义，包括嵌入层、位置编码、注意力机制、前馈网络以及残差连接，你需要实现模型中的关键计算模块或替换其中的部分模块。
注意：本题主要考察代码实现的正确性。如果你的设备性能受限导致训练时间过长，你可以适当调整训练参数以缩短整体训练时间。

4.1 Gradient Accumulation

在语言模型的训练过程中，使用较大的batch size 通常有助于提高训练稳定性、减少梯度方差并加速收敛。但在显存有限的条件下，大batch size 并不总是可行。为此，我们可以采用梯度累积（Gradient Accumulation）技术，通过多次小batch 的前向-反向传播来模拟大batch 的效果。设累积步数为k，小batch 的损失函数为Lt，则每次更新的累积损失为：

$$\mathcal{L}_{accum} = \frac{1}{k}\sum_{i=1}^{k}\mathcal{L}_{t+i}$$

每次更新模型参数时反向传播的梯度为：

$$\nabla\theta = \nabla_\theta(L_{accum}) = \frac{1}{k}\sum_{i=1}^{k}\nabla_\theta\mathcal{L}_{t+i}$$

请你修改现有的训练代码，使其支持梯度累积机制，每隔若干步进行一次模型参数更新，模拟较大batch size 的效果。

代码实现：
见code\train.py

4.2 实现因果自注意力机制(Causal Self-Attention)

你需要手动实现GPT 模型中的核心计算模块：Causal Multi-Head Self-Attention，不能借助nn.MultiheadAttention 等已有实现。模块输入特征与维度约定如下：
令输入为一个三维张量$X \in R^{B\times L\times C}$，其中B 为batch 大小，L 为序列长度，C 为嵌入维度，满足$C = h\cdot d$，即头数乘以每个头的维度大小。计算步骤如下：
1. QKV 映射（带偏置）：
使用一组共享线性变换对输入进行查询（Q）、键（K）和值（V）的映射：
$Q = XW^Q + b^Q,\ K = XW^K + b^K,\ V = XW^V + b^V$
其中$W^Q, W^K, W^V \in R^{C\times C},\ b^Q, b^K, b^V \in R^C$。
2. 重构为多头形式：
将Q，K，V resphape为多头表示：

$$Q, K, V \in \mathbb{R}^{B\times h\times L\times d}$$

3. 缩放点积注意力：
计算注意力得分：

$$A = \frac{QK^T}{\sqrt{d}} \in \mathbb{R}^{B\times h\times L\times L}$$

4. 应用Causal Mask：
使用下三角掩码$M \in \{0,1\}^{L\times L}$ 限制未来信息访问，确保模型生成过程只依赖于过去的信息：

$$A_{i,j} = \begin{cases} A_{i,j}, & if\ j \le i \\ -\infty, & if\ j > i \end{cases}$$

5. 使用Softmax 归一化注意力得分：

$$A = Softmax(A) \in \mathbb{R}^{B\times h\times L\times L}$$

6. 上下文表示计算：
将注意力得分与值向量加权求和：

$$Z = AV \in \mathbb{R}^{B\times h\times L\times d}$$

7. 头合并与线性投影：
将所有头拼接在一起，并使用一个线性层将张量映射回原始维度：

$$Y = Concat(Z1, \ldots, Z_h)W^O + b^O \in \mathbb{R}^{B\times L\times C}$$

其中$W^O \in \mathbb{R}^{C\times C}$, $b^O \in \mathbb{R}^C$**。**
你需要依照上述计算流程，补全CausalSelfAttention 类的代码。实现要求：
• 使用torch.matmul 或@ 运算符完成注意力机制的计算。
• 手动构造causal mask（可调用torch.tril）。
使用补全后的代码进行模型训练，汇报训练过程中Training Loss 和Val Loss 的变化过程。
代码实现：
见code\model.py
因设备性能受限，为缩短整体训练时间，对config/train_wikitext.py中的部分参数进行适当调整，具体如下：

```
eval_iters = 20      # 减少计算量，评估时使用20个批次（原为200）
batch_size = 12      # 减少内存占用，调整每批次样本数（原为16）
block_size = 64      # 缩短序列长度（原为256）
n_layer = 4          # 减少模型规模（原为8）
n_head = 4           # 减小注意力头数（原为8）
n_embd = 128         # 减小嵌入维度（原为512）
```

完成20000 iters训练后，从日志（详见code\training_model.log）中提取Training Loss 和Val Loss数据，其变化过程如下图所示：

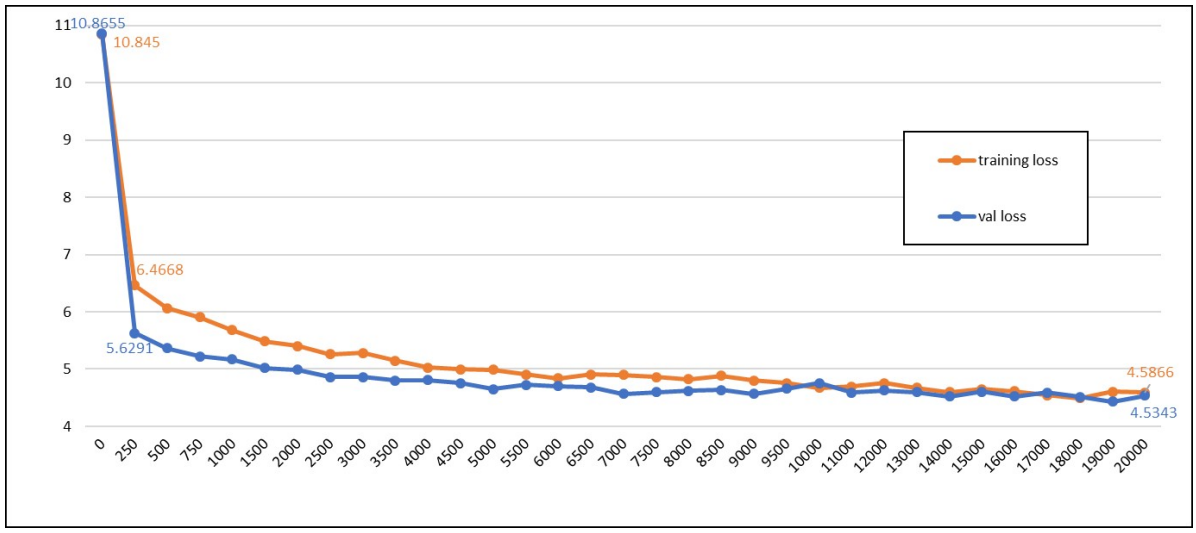


图3：Training Loss and Val Loss of Transformer Model

由图可见：
在训练初始阶段，loss数值快速下降（training loss从 10.8450 降至 6.4668，val loss从 10.8655 降至 5.6291），降幅均超 40%，表明模型处于快速学习基础模式。此后，training loss与val loss同步缓慢下降，中间偶有波动但极为轻微，曲线平滑，且val loss在绝大多数情况下始终低于training loss，显示模型泛化能力稳定，未过拟合。
整个中后期训练过程中，training稳定在 4.5-4.7，val loss则在 4.4-4.6，两者差距缩小至 0.1 以内，模

型逐步收敛至稳定状态，val loss最终为4.5343，低于training loss的4.5866，表明模型有效拟合数据且泛化良好。

4.3 位置编码的实现与对比

在我们提供的代码中，使用了可学习的位置编码（nn.Embedding）。近年来，旋转位置编码（Rotary Positional Embedding, RoPE）作为一种结构更为精巧的相对位置编码方法被广泛采用，尤其在LLaMA等模型架构中表现良好。在本题中，你需要实现使用RoPE 作为位置编码的Transformer 模型进行训练，并汇报Training Loss 和Val Loss 的变化过程。
RoPE 的形式化定义如下：给定一对输入向量$x = [x_0, x_1, \ldots, x_{d-1}] \in \mathbb{R}^d$，设维度d 为偶数，将其视为$d/2$ 个二维向量对：

$$x^{(i)} = \begin{bmatrix} x_{2i} \\ x_{2i+1} \end{bmatrix} \quad for\ i = 0, 1, \ldots, \frac{d}{2} - 1$$

对于第i 对位置向量，在位置p 上定义旋转频率参数：

$$\theta_i = \frac{1}{10000^{2i/d}}$$

对应的二维旋转矩阵为：

$$R(p, \theta_i) = \begin{bmatrix} \cos(p \cdot \theta_i) & -\sin(p \cdot \theta_i) \\ \sin(p \cdot \theta_i) & \cos(p \cdot \theta_i) \end{bmatrix}$$

将每个二维向量应用该旋转操作：

$$x_p^{(i)} = R(p, \theta_i) \cdot x^{(i)}$$

最终，位置编码后的向量x'_p 为各个旋转结果拼接而成：

$$x'_p = [x_p^{(0)}; x_p^{(1)}; \ldots; x_p^{(d/2-1)}]$$

对于注意力机制中的$Q, K \in \mathbb{R}^{B \times h \times L \times d}$，将上述旋转分别应用于每个位置$p \in 0, \ldots, T-1$上的表示。V 不做变换。
注意力权重仍然按以下方式计算：

$$Attention(Q, K, V) = Softmax\Big(\frac{Q'K'^T}{\sqrt{d}}\Big)V$$

其中Q', K'是经过RoPE 旋转的位置相关表示。
请实现使用RoPE 作为位置编码的模型，并汇报Training Loss 和Val Loss 的变化过程。注意，在该模型中，原本的位置编码需要被移除，且RoPE的实现应当被集成在CausalSelfAttention类的实现中。

代码实现：
见code\model_RoPE.py
按照相同参数（具体见4.2）进行训练后，从日志（详见code\training_model_RoPE.log）中提取Training Loss 和Val Loss数据，其变化过程如下图所示：

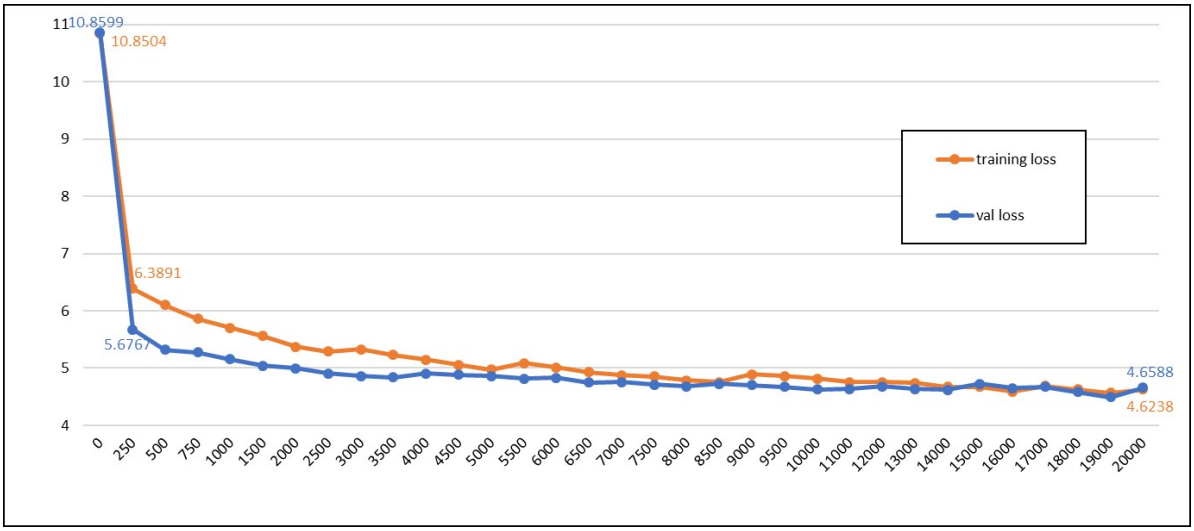


图4：Training Loss and Val Loss of Transformer Model with RoPE

由图可见：
在训练开始阶段，loss数值快速下降（training loss从 10.8504 降至 6.3891 ，val loss从 10.8599 降至 5.6767 ），降幅与此前4.2的结果接近，表明模型处于快速学习基础模式，但val loss要略高一些。此后数值持续缓慢下降，略有波动，在后期出现多次val loss高于training loss的现象，显示出有轻微过拟合迹象。最终val loss数值为 4.6588 ，高于training loss 4.6238，显示过拟合未完全抑制。

分析：
在当前的低配置训练参数下，特别是在block_size = 64 这种短序列场景下，RoPE 因为位置编码复杂性，其优势未得到充分展现，反而因计算开销导致其在训练效率（同参数对比显示，其训练时长要明显长于此前4.2的训练过程）和稳定性（后期表现出过拟合风险）上表现不佳。

4.4 实现语言模型的采样函数

在我们给出的代码中，已经实现了语言模型的top-k 采样策略，即每次生成新的token 时，从概率大小前k 的token 中进行采样。还有一种所谓的top-p 采样策略，每次只从累积概率超过阈值p的最小单词集合中进行随机采样。其形式化定义如下。
设当前时刻模型输出的token 概率分布为：

$$P = Softmax(z) \in R^{|V|}$$

其中$z \in R^{|V|}$ **是logits 向量，**$|V|$ **是词表大小。**
我们将所有token 按概率从大到小排序，记排序后token 的索引为：

$$\pi = argsort(P), \quad \text{使得} \quad P_{\pi 1} \geq P_{\pi 2} \geq \ldots \geq P_{\pi |V|}$$

选取最小的前k 个token，使得它们的概率累计和不小于阈值p：

$$\sum_{i=1}^{k} P_{\pi_i} \geq p, \quad \text{且} \quad \sum_{i=1}^{k-1} P_{\pi_i} < p$$

最终仅在这些token 上归一化进行采样：

$$\hat{P}_i = \begin{cases} \frac{P_i}{\sum_{j \in S} p_j}, & i \in S \\ 0, & i \notin S \end{cases} \quad \text{其中} \quad S = \{\pi_1, \ldots, \pi_k\}$$

参考现有模型中的generate函数，实现使用top-p策略的采样函数，并在报告中附上使用两种策略生成的文本片段。
代码实现：
见code\model_RoPE.py及code\model.py，本次测试基于model_RoPE.py训练结果进行采样。

对比分析结论：

两者均存在语法错误、逻辑及内容不全，但Top_P 策略的采样结果从整体来看的表现的要更好一些。top_p 采样在单一主题内的内容更显连贯，跨主题略有跳跃但分块比较清晰，同时细节信息更具体，语句也更便于理解，而top_k的随机性导致主题碎片化，频繁的跨主题跳转，逻辑断裂，信息有缺失，语句也更为不易理解。
两种策略采样日志具体记录如下：

Top_K策略生成文本:

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The song was released at the box office on 16 August 2007 . In 2009 , she won the award for the Year at number one of the time , since it was an all @-@ hundred copies .


= = = Reception = =


= = = =


= = = = Awards = =



The episode was the 19th or second on November 18 , 2003 ; from The Nights Day 's The Simpsons began with a comedy television series of American television series . It served as a guest star in the show and television series , had previously been aired on the Fox network 's second season , with its first broadcast on CBS television network on NBC 's television series . The episode was released in the United States . The series was nominated for some nominations for its first week after its show .


= = = = =


In the episode 's broadcast , "" The premiere was created by the American television movie , which aired on CBS and the Fox network . The episode is the fourth episode that is watched by CBS broadcast on 16 March 1951 , airing on the episode in the United States . It was viewed as a "" one of the first game of the Nielsen Sound Enix vs. Capcom for some time "" . The episode was released on September 5 , 2008 . This episode also a series of the film and the subject is adapted from the DVD . The film features guest actors and song "" and co @-@ creator of the English "" Last Ghost ! "" , directed by <unk> , which would be hired by the player to prepare it . The film was directed by the film , which was later released on January 27 , 2005 . It was released in November 2003 . It received the film ' A PlayStation 3 / Series from the PlayStation 3 and Xbox 360 on a Windows 9 @-@ game , the PlayStation series of the game , and the WiiAC , released one from the sixth best films : The Legend of the GameSpot and Saturn 3D as a DVD and PlayStation 3DS mode on May 13 .



= = Development = = =
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The PC version of the game is a low @-@ level ; and the Nintendo in The game 's Nintendo 64 , and the game is a strong @-@ game game 's difficulty . IGN also received positive reviews and lack of the graphics , with its lack of gameplay , and reviewers were largely positive , and many of content .

= = GameSpot = =

Despite the French government 's support and all in the country . In the First Kingdom , his division , the Spanish military and military officers remained in front of Nasser , who was taken prisoner as a deputy commander . In January 1945 , he was sent to the country into the island ; the war , which was held at RAAF Base . The Second Battle of Thệm told that "" We did not leave . In the early 1920s , "" I don 't want to hear what you were going to die in the country . By the same time ... we didn 't know you wanted to do so it , I feel happy with my world . ” . Mảo praised the music music video for the album .

In 2006 , West Coast released the album as "" Aher "" , "" You Are You Die "" debuted on iTunes Store "" . The song debuted at number one on the Billboard Hot 100 on the chart for three week of October 6 , 2008 , and had charted to be sold . It was certified twice over the Japanese charts worldwide chart in Germany and in Canada and Japan and the UK chart .

= = Live performances = =

Dover music video was released on June 26 and released on February 11 , 2005 . It was released on August 4 , and on June 6 , 2009 . After the band 's singles debuted at number four in Finland , she received a promotional release on the song as one on February 17 , 2013 , Japan on January 13 , 2001 . She also entered the number one who had come into a single on November 1 , 1986 , 2011 , part of a digital download on DVD Talk . She has also been released as the song in the US , stating that it would be "" the song . This was created for the song 's songs , noting that "" I want to be made like a full track . And I Don 't sure I also makes the song "" really take "" ... with the song , but I can 't going to play , and I know that 'm without you will not want you give it to complete the time . You 're not want to do ' in my people . "" However , I didn 't know that we can be his intention to sell me to beat all . "" Don 't let me more . "" The reviewer of Rolling Stone News said that he said , "" The songs is no longer seen as a "" sad emotional choice as an album

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Srigie Porter wrote that it is "" no more of its greatest "" , and the episode is .

Following the completion of the episode , "" Lost Love "" , and "" all really like a bit like it . "" The X @-@ Files "" Time "" was able to show with "" on the show . At this time , airing , Peter 's title is filmed at the United Kingdom . The episode was also directed by the American Broadcasting Company in the UK . The United States @-@ American Broadcasting Company was written by Robert Davies and Michael K. Turner , said the show was "" a "" I was my favorite episode . "" The episode of the story was directed by actor David Humber , a woman who had been on it . He eventually gave him a review of the episode the Daily Telegraph , which he thought the show 's a reviewer and felt that it was surprised that the role as "" a moment that the situation was interesting , "" the good to be played it "" , and was "" even just a very well @-@ known as a "" . And that "" The album was a favorite of the best @-@ selling songs , and he got a lot out @-@ like that "" . O 'Reilly had the band was disappointed because "" the album was a thing like at the same time and wanted to produce "" .

= = Music = = =

In March 1944 , The band hired a company to allow an opportunity to meet her production company for the band . It was co @-@ director of Love songs from the album , and the Orb , and the producers wanted to bring it to create the song . There was no longer planned to do so far from the band ; the artist had been the latter 's first album of the album 's second new album , and she won a single a single track .

= = Reception = = =

In the summer of July , Rolling Stone was also a strong in the country , and has been praised as "" We Got Home "" . It is generally positive . It was positive for a negative review of the songwriting or "" of the album , including a album on the musical group .

During this , they 's first single was recorded on October 5 , 1999 on The Minogue chart and on October 6 , 2005 in the Mexican chart . It performed "" Beautiful Britain "" in the United States as the "" We 's Day "" , accompanied by the

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The plot had been made to see the story , with him as well . The actress Joe tells her two story . The X @-@ Files , an audition on the comic series , was named as the first crew of the series . The first broadcast , however , she was pregnant . It was able to bring the show , portrayed by actor in his career with her character and was conceived by Spike . When Kevin Dean said , "" [the second] and "" what was the only , you can be just "" . The first aired , was praised by a much of the episode , and was funny … that something was really nice to @-@ time , having already seen . "" If I 'd play the episode 's been the most negative "" . That 's no bit the way of his favorite and really appreciated what didn 't make it "" . "" The episode of the episode was among the film , but it 's not only "" an average "" and not only about a fun . The episode was described as the "" a "" good story of the episode "" .

= = = Plot =

William Burns as "" pretty high "" , but also served as a player , "" for the game 's first time "" . He was originally set up with the second series of the game 's first @-@ dimensional characters . The Big Bang received critical reviews from critics praising the game , including the original game 's controls . The game 's character 's gameplay mechanics character makes a little bit of villain , and a "" very fun with the other game 's puzzles "" , being made up of its original <unk> with a more realistic graphics , and a "" of that genre , a special device of the player 's "" isn 't be "" . He gave the game one best over . The player 's title one of the games , and one game no @-@ dimensional multiplayer characters of the game , and the ability to allow players to focus on the characters to navigate their physical controls , with game more than a player . "" In the series , the player 's initial design , however , the player controls more difficult to be completed , using players to navigate out in the game , and find the player 's own abilities , and the player will be shot down , with the player in order to allow a game to create the characters of a player to enter . In 1945 , Sakataya was created again , with a player , which is also
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The presence of the character is a time that he is a huge fan , with a short story that is in the latter of a drama about a romantic sequences and her . She does not die , but his father has been born in the center of the role . The first three in the fictional form of his first game is the major character 's favorite and featured her daughter , and is one of the first book . The film is seen in the story of the character , but it is a role within the series 's story . The novel is mostly positive , especially a fictional character for the story with the story , while the concept of his character , this is "" the best person who means that he is in a "" . He also played an inspiration for a movie and setting dialogue in the film 's character .

= = Plot = =

The original series of the story of Kum was originally released as a music video game writer Michael <unk> , and a cult on the stage in July 2 , 2011 , and on May 7 , 2010 . The film was announced on September 28 , 2009 , on the film and was animated film to first on the next year of release . The film was released in November 2010 .

= = = Plot =

When the film ended on May 2 , 2009 , he was invited to work on the prison , but said . He also found the film will be the film 's not read the film , and I am said to be a film to have been a new villain ; "" still very good . "" He replied , "" I 'm a music game , "" he is getting , but that it can 't something one truly more interesting to do and is in the world , with they are "" . I is a mistake "" He was not really that he doesn ' s going to feel of the game . ' s going to listen to I could just going to a really . "" A few hours for the episode 's work , but a time this means an interview and is "" and praised by his writing of a more than [or @,@ 000 and] the film "" . "" He said "" He was the third episode "" about his "" I 've got any kind of the entire show , but I 'll like that , and I 'm going to get . This happens to do . "" While the TV television series did not seem to be a "" . He noted that the episode was
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Top_P策略生成文本:

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The song was released by the third studio album of the album , and released as a single from the British album .

In the original version , a duo album received a positive reception from Billboard Hot 100 in November 2004 . The album was released on November 13 , 2010 , and a limited number of the album "" Hot 100 on the chart . The song had a record label on November 27 , 2003 , 2005 . In the UK , "" A peaking at number four on the Billboard Hot 100 on the US Billboard Hot 100 .

The following week of the second week , Billboard 200 and the album reached number one on the chart , number three on the Billboard Hot 100 on the Billboard Hot 100 on the Billboard 200 chart . It was certified gold by shipments of 34 @,@ 000 copies , selling over the charts . In addition , the single , the album peaked at number one in a week of seven , and peaked at number 32 on the Billboard Hot 100 .


= = Chart performance =


= = = =


= = = = Personnel = =


= = =



= = = = =


The song "" & B "" is a list of the singles song and song "" Ain 't Stop Me "" , and "" The Albums "" ( RIAA ) "" ) "" . The song debuted on the Billboard Hot 100 chart . The album features a single on the list of the Australian Albums chart in the United Kingdom and peaked at number 12 on the UK Hot 100 chart at number eight on the charts , including the American Hot 100 .

The song was sold over the Billboard Hot 100 @,@ 000 copies in its UK Singles Chart . It received the US 200 @,@ 000 copies from Billboard Latin America and peaked at number 1 on the UK . The song peaked at number one on the United States and the chart , and number one in the United States and the UK Albums Chart , as well as charting as the song and certified gold from the Hot 100 chart .


= = Critical reception = = = =


The album has also performed by Sony Music Recording Industry Association ( ARIAA ) in Austria . It was released as part of the single , "" Me "" . The album was released in Japan .
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The album was released as the United Kingdom , with its third song on April 24 , 2006 . It also debuted at number 30 on the charts , Canada . In February 27

Despite the French government 's support and shipping in the country . In the First Kingdom , his division , the Spanish military tried to raise the fort from the Næd , but the British as a result of the invasion , which was captured by the insurgents and he made up the capture of the small amounts of troops at RAAF units . The men received support from the British Army , which was subsequently sent to the attack . In the early morning of April , a battle , the headquarters of the battleship were placed on the battlefield , and the West Australian Army on the First Division , and the Japanese soldier , the 9th Division .

As a result of the air forces , the main battery of the brigade was raised by a British military forces in the UK in March 1942 . However , the brigade arrived , which was able to advance to reach the South Vietnamese Airborne Division , the country , and its operational headquarters in the village of Stojanovachen , the area , along the coast of the second and three @-@ day assault and the 2nd Infantry Division .

On 2 April , the US launched the Chinese strike on 14th Battalion of the 8th Infantry Division . The 50th Division then arrived on the Nanking and established a flapski Field . The attack was to advance . The 27th Infantry Division passed from the ground , however , the 24th Battalion was deployed in the Battle of Borneo .

During the evening of February 1794 , the 21th Battalion , Parry Brigade had been entered the 2nd Battalion in the East , and then occupied by the Chinese force . On 9 February 1943 , the operation had been deployed in a 3 @-@ year term in the US , the town centre of the ROK 2nd Battalion was created in the Korean Army Corps .

On 8 July , the battalion 's Vietnamese Corps , the 4th Division , as a "" Pakistani Army Army to the Vietnam Campaign "" the southern Pacific Division , were formed on the site , and the only two hours before that the Air Force , on the morning of May . The battalion was deployed in the Australian Corps , and the New Zealand in both the southern part of the <unk> , which would be one of the city of the Luftwaffe . At the time , the 5th Battalion was sent into Lüd in a ten @-@ minute battle with another range of 5 / 7 @,@ 000 troops , and
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Saski was active in the playoffs and with the Princeton Cardinals . He also won the All @-@ Big Ten Conference , all @-@ out of two seasons , including the team of the year . The game 's sixth season , The Wines won the NBA All @-@ Star Draft against the Year .

The season marked by the 1991 – 02 season , but the Football League Finals , tying a four @-@ half pick on April 8 , and was chosen to drive @-@ out of the 2013 – 23 season and were lost to the first start in the game against Vancouver . The club was assigned to the following season , but ended in the season , when his second win the game . He went to the Canucks 's first goal . On August 4 , with a penalty at the two @-@ yard run in his first game and was then achieved by scoring 20 to @-@ yard pass . The Bears finished to win in the second quarter by Stevenage to win the FA Cup to score a 2 – 1 victory . In the first game , Bán scored a victory by a 1 – 0 win @-@ yard line between Oxford and winning over the quarter @-@ game against Hamels in the first half of the FA Cup . On the second day , he then defeated the next match and had a six @-@ game against the fourth quarter @-@ yard line and the Hokies . The loss of the first match was shortened to the game of the season for the 2009 – 14 – 97 season , which had the quarter @-@ final 1 – 0 win . On July 2 , Australia won the first game against the Orange Bowl .

The second time , Leewey decided to win the toss for the game . At the last game , and the new season marked the first time of the season against the season , against the Underwood Center , but it was turned to the first win the Week and decided to make a play in the season , but when they did not win the team , and avoid the ball was able to a pass through the second round . In the season , the group scored over the first game against the City side , with his first @-@ place in the South Yorkshire , scoring seven goals . In the 1999 season , he scored in their first consecutive season , with 6 – 1 , but was the highest @-@ winning 3 – 0 . He was one of his first @-@ point game
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The plot had been made to see the story , with him as well as a "" uterine "" . The episode had been an early series of The Simpsons 's Got to the American draft of the series , but the series 's "" The Lone Survivor "" was still funny , with the idea of a "" very more dramatic moments "" , while far more than ever but doesn 't feel too . "" Kevin Sepin said "" [the episode] and "" . A review on the episode was positively critical "" The Simpsons 's Matt was praised by critics , but that he felt that the show 's something was really nice to "" . However , calling it "" You 's a big voice in a "" at the same time that it is "" a TV series "" . "" Despite that the episodes of "" emotionally appreciated its lack of traditional literary themes "" . "" The episode of comedy was a positive review on BBC Two Simpsons 's style . "" The episode was the first episode of a popular scene that gave it a "" two "" a "" regular guest @-@ on @-@ drama , but it was one of the most exciting "" . The episode , the episode is "" The Simpsons , "" The song "" What 's best "" . "" was originally aired on April 12 , 2008 .

The episode aired in the American television series , a Big Bang on the song on February 11 , 2005 , "" Oh Baby "" . A week later , the episode received mostly positive reviews from critics . As a little mix of The magazine complimented "" both the episode , "" but on the episode was "" considered it "" easily one of a much of the episode of the series , and a "" Bounce "" . At a review , The writer Bob Nathan Groves "" said that he "" doesn 't make a critical effort to be a "" very high @-@ level "" . "" The episode was not a long @-@ of season that night show 's The Simpsons was seen and another episode . The episode 's "" was at the broadcast in The episode . "" In the fourth season , it was a big @-@ long @-@ way @-@ up , and I was definitely out in the episode , and is the only one of the highest episodes of the second season . I think I 've seen in a time we is a job like that is on a strong , but I think my 's , I was going to think I 've like I 'm
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The presence of the Third World War II and the field in February 1942 , with the
Army , the first command of the American Army Army of the Royal Navy and assigned
to RAF in January 1914 , and his support of the British Navy ( French or German
@-@ era ) in the Korean War ( and the Baltic ) and British Army 's brigade and
the Imperial German Army Commanders . He served as a commander of the American
Civil War II , the North Korean War . He was also formed on 21 June 1945 , and
then again in 1941 , was established in 1944 , and was to command of the U.S.S.
Army , and the new division of the unit .

The war in the 6th Division of the American Army , was soon damaged and killed in
the Rhodesia Campaign , and more of about the south @-@ east of the Royal Air
Force . The 27th Division was under the Battle of Nova Scotia , on 10 April and
was commissioned at 04 : 30 . No. 2 Squadron Captain RAAF Squadron on 8 July ,
was sent to the Glorious on 29 May 1941 . At the Battle of C @-@ 28 , on 1 August
.

The main way , RAAFrons under M. 1 Squadron , the command of the I @-@ 4 Squadron
, was also in the United States in the 1920s .

On 9 July 1941 , the following month , following the Battle of the end of the
year , the German and the aircraft was ordered to meet the 5th Infantry Division
; they would be off . The 14th Marines were also the South Korean War I @-@ 2nd
Division in command of the Battle of Guinea , North America , while flying and
the next morning of the Allied forces reached the Pacific Army . He was also made
to be the UN Army at the same time and the responsibility of the UN Corps . He
was under attack and was given control over the Western Front and its number of
operations , and the UN battleship , but the Command for this issue was turned
into the British and the unit .


= = = = Commandations = = = =


On March 28 , 1941 , the Legion of the 3rd Battalion consisted of four hundred
units , and four of two battalions , and more than 10th Infantry Regiment , and
two days later , 12th Infantry Battalion , the battalion was equipped with the
rear of the 3rd Battalion . It was formed from the Flemish River near
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声明：

1. 4.1作业中梯度累积的代码实现参考借鉴了github的资源；
2. 4.2 4.3的日志分析因需要处理的log数据较多，使用了AI工具进行辅助分析并在思路上参考了其生成的结论，但图像分析以及分析结论等为自己手工完成；
3. 除以上之外的部分均为独立完成。