多佇列系統中佇列選擇法則的分析與研究

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摘 要

日常生活中只要有人、事、物等待接受服務就可能形成排隊的現象，這類排隊等候服務就會形成佇列系統，而佇列理論即是對於佇列內等待被服務的人/事/物(或統稱為事件)分析事件的等待時間、佇列長度、或事件有效進入率等的研究。 佇列問題的研究隨著不同的需求可衍生出不同的形態，例如(I)將相同屬性的事件歸類於同一佇列，將有利於資源的分配與調度，因此單佇列問題將轉換為多佇列模式的研究。(II)現今佇列問題大都假設容量無限，然而真實系統大多是屬於有限容量，因此有限容量佇列問題的研究較具有應用價值，而且有限容量佇列模式的極限行為應類似於無限容量的佇列模式。(III)若佇列內的事件有時效性的需求，則系統必須具有強健的排程能力，以預防或降低事件逾時服務的機率。 針對以上所述本論文主要探討多佇列的問題，並依無限與有限容量佇列模式分析求解佇列參數，另外本論文也提出具有學習能力的訊息排程控制器，以提高在時變系統時佇列的排程能力。關於無限容量的模式(q-M/G/1/inf/FCFS/EDF)的研究，本文以最早截止期限優先(EDF)為佇列選擇規則(QSR)，並藉由定義等待時間的機率密度函數，計算佇列訊息的等待時間及訊息逾時服務率。另外根據相對截止期限的極限行為，以EDF為佇列選擇規則的佇列問題可等效於以先到先服務(FCFS)或優先服務(PRI)的佇列問題。 關於有限容量模式 (q-M/G/1/Ki/FCFS/QSR)的研究，將以多種佇列選擇規則(QSR)分析其排程的優劣。這一部份的研究以多維度聯合狀態轉移，及以嵌入式馬可夫鏈(EMC)或馬可夫鏈(MC)求解佇列的狀態機率。針對EMC模式共有四個求解步驟，包括(1)訊息抵達機率、(2)佇列轉移機率、(3)離開佇列瞬間的狀態機率、與(4)任意時間的狀態機率等。針對MC模式則需要二個步驟，即(1)佇列轉移機率與(2)任意時間的狀態機率。由模擬實驗得知，本方法可正確的分析佇列以FCFS, PRI, WFQ, RR等為佇列選擇規則(QSR)的佇列參數。 另一部份的研究是以具有學習能力的訊息排程控制器(MSC)為佇列選擇規則，以滿足時效性的需求並求解相關的佇列參數。MSC屬於閉迴路的控制流程並提供事前學習(Type I)或事後學習(Type II)調整內部參數，以適應時變系統達到預防或降低訊息逾時服務發生的目的。本論文提出三種建構MSC的方法，包括輻射基底函數網路(RBFN)、模糊神經網路(NFN)、與關聯向量機(RVM)等。由模擬實驗得知訊息排程控制器比傳統的QSR更具強韌性且有較低的訊息逾時服務率。 最後本文也將針對當佇列負載趨近於無窮時，推導包括以MSC, EDF, FCFS, WFQ, RR, PRI等為QSR的訊息等待時間上界。由模擬實驗得知本文的方法能夠準確的估測不同QSR的等待時間上界。

關鍵詞 : 多佇列有限容量、狀態機率、佇列選擇規則、訊息排程控制器

目錄

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