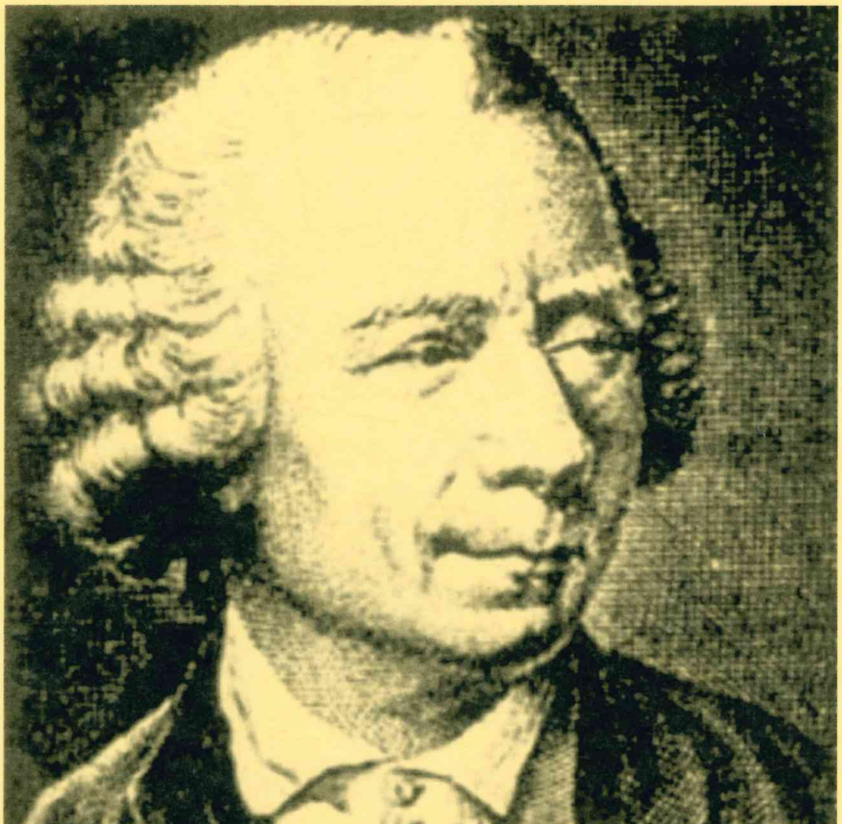
2007年組合數學(新苗)研討會

2007 Combinatorics Conference

時間：2007年08月10日至08月11日

地點：高雄市國立中山大學理學院小劇場

網址：http://mail.math.nsysu.edu.tw/~comb2007/



Leonhard Euler (1707~1783)

主辦單位：國立中山大學應用數學系

贊助單位：國科會數學研究推動中心

2007 組合數學新苗研討會

時間：2007.08.10~08.11
地點：高雄市國立中山大學理學院小劇場
網址: mail.math.nsysu.edu.tw/~comb2007/

大會主講:張鎮華教授(台灣大學數學系)
傅恆霖教授(交通大學應用數學系)

主辦單位：國立中山大學應用數學系
贊助單位：國科會數學研究推動中心
籌備委員：朱緒鼎、王彩蓮、董立大

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Email : comb2007@math.nsysu.edu.tw

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封面：偉大數學家 Leonhard Euler (出生 300 年紀念)*

*在 Graph Theory 或 Discrete Mathematics 的課程裡，應該會接觸到七橋問題(或 Problem of the Königsberg Bridges)與平面圖的點邊面公式(或 Euler's formula)；這兩個重要的古典理論就是由大數學家 Euler 提出來的。Euler 出生於瑞士 Basel，在數學許多領域皆有很大的成就。雖然在他人生的最後 17 年過著眼盲的日子，他仍然持續數學的思考與創作。

2007 年組合數學(新苗)**研討會議程(Conference Program)**

地點：國立中山大學**理學院小劇場**

<u>08 月 10 日 星期五</u>

08:00~8:50 報到(Registration)

08:50~9:00 開幕(Welcoming Remarks) 主持人(Chairman): 朱緒鼎教授

Session 1. 邀請演講(Invited Talk) 主持人(Chairman): 李國偉教授

09:00~09:50 演講者(Speaker): 張鎮華教授(臺灣大學數學系)

題目(Title): Vertex Coloring Induced by Edge Weighting

09:50~10:00 休息(Tea Break)

Session 2. 主持人(Chairman): 葉鴻國教授

10:00~10:25 演講者(Speaker): 蔡馬良(東華大學應用數學系) 博士

題目(Title): The $L(3,2,1)$ -Labeling of Graphs

10:25~10:50 演講者(Speaker): 張宏鏞(中山大學應用數學系) 博士

題目(Title): Game Colourings of Graphs

✓ 10:50~11:15 演講者(Speaker): 鄧乃心(臺灣大學數學系) 碩士

題目(Title): Vertex Ranking of Graphs

11:15~11:20 休息(Tea Break)

Session 3. 主持人(Chairman): 潘俊杰教授

11:20~11:45 演講者(Speaker): 陳宜廷(交通大學應用數學系)

題目(Title): Cyclic Triples

11:45~12:10 演講者(Speaker): 郭志銘(交通大學應用數學系)

題目(Title): Diameters of Generalized De Bruijn Graphs

12:10~13:10 午餐(Lunch)

Session 4. 主持人(Chairman): 林 強教授

13:10~13:35 演講者(Speaker): 李張圳(交通大學應用數學系)

題目(Title): Transversals in $m \times n$ Arrays

13:35~14:00 演講者(Speaker): 陳億庭(中央大學數學系)

題目(Title): 2-decomposable and 3-decomposable Star Forests

14:00~14:25 演講者(Speaker): 葉政峰(中央大學數學系)

題目(Title): On List Coloring of Graphs

14:25~14:35 休息(Tea Break)

Session 5. 主持人(Chairman): 郭大衛教授

14:35~15:00 演講者(Speaker): 黃俊瑋(東華大學應用數學系)

題目(Title): The List-$L(2,1)$-labeling Problem of Digraphs

15:00~15:25 演講者(Speaker): 洪連志(東華大學應用數學系)

題目(Title): The Oriented-k-graceful Labelings of Graphs

15:25~15:50 演講者(Speaker): 賴麗鈴(東華大學應用數學系)

題目(Title): Global Defensive Alliance of Trees and Cartesian Product of Graphs

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16:00~16:25 演講者(Speaker): 廖虹雅(逢甲大學應用數學系)

題目(Title): Graph Labelings with Three Levels of Constraints

16:25~16:50 演講者(Speaker): 宋彥萱(逢甲大學應用數學系)

題目(Title): Distance Labeling on Cartesian Products of Elementary Graphs

16:50~17:15 演講者(Speaker): 楊千慧(逢甲大學應用數學系)

題目(Title): Radio 3-Colorings of Lattice Graphs

17:15~17:40 演講者(Speaker): 沈志文(逢甲大學應用數學系)

題目(Title): A Study on a Magic Labeling Problem

18:30~ **晚宴(Banquet)**

<u>08 月 11 日 星期六</u>

Session 7. 邀請演講(Invited Talk) 主持人(Chairman): 朱緒鼎教授

09:00~09:50 演講者(Speaker): 傅恆霖教授(交通大學應用數學系)

題目(Title): Unsolved Problems in Graph Decompositions

09:50~10:00 休息(Tea Break)

Section 8. 主持人(Chairman): 陳秋媛教授

10:00~10:25 演講者(Speaker): 張雁婷(交通大學應用數學系)

題目(Title): A Study of Berge's Strong Path Partition Conjecture

10:25~10:50 演講者(Speaker): 張澍仁(交通大學應用數學系)

題目(Title): Decomposing the Complete Graph into Paths

10:50~11:15 演講者(Speaker): 李維鴻 (淡江大學數學系)

題目(Title): 完全三分圖分割成星狀圖的探討

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Session 9. 主持人(Chairman): 江南波教授

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題目(Title): A Note on the Sum-saturability of Trees

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題目(Title): The Study on Joint Structural Importance in Consecutive-k Systems

12:10~13:10 午餐(Lunch)

Session 10. 主持人(Chairman): 孫一凡教授

13:10~13:35 演講者(Speaker): 賴欣豪(臺灣大學數學系)

題目(Title): Study into Full Orientable Graphs

13:35~14:00 演講者(Speaker): 陳柏澍(交通大學應用數學系)

題目(Title): Optimal All-to-all Personalized Exchange in Generalized Shuffle-Exchange Networks

14:00~14:25 演講者(Speaker): 游喬任(政治大學應用數學系)

題目(Title): The Unique Colorability of a Uniform Mixed Hypergraph

14:25~14:35 休息(Tea Break)

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題目(Title): Finding Hamiltonian Cycle on Perfect Matching of Hypotraceable Graphs

15:00~15:25 演講者(Speaker): 陳秉宏(中山大學資訊工程系)

題目(Title): Table Driven Algorithm for Joint Sparse Form

15:25~15:50 演講者(Speaker): 歐俊男(暨南大學資訊工程學系)

題目(Title): A Study on Antipodal Labellings Problems

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題目(Title): 2-decomposable, 3-decomposable Multipaths and t-decomposable Spiders

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傅恆霖	交通大學應用數學系	hlfu@math.nctu.edu.tw	Unsolved Problems in Graph Decompositions	週六 Session 7 Page 11

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陳俊達	大同大學應用數學系	u9008015@mail.ttu.edu.tw	The Study on Joint Structural Importance in Consecutive-*k* Systems	張薰文	週六 Session 9 Page 13
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張宏鏞	中山大學應用數學系	gianni.chang@msa.hinet.net	Game Colourings of Graphs	朱緒鼎	週五 Session 2 Page 15
張凱涵	中央大學數學系	942201005@cc.ncu.edu.tw	2-decomposable, 3-decomposable Multipaths and t-decomposable Spiders	林 強	週六 Session 11 Page 16

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陳柏澍	交通大學應用數學系	chen.poshu@gmail.com	Optimal All-to-All Personalized Exchange in General Shuffle-Exchange Networks	陳秋媛	週六 Session 10 Page 27
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Vertex Coloring Induced by Edge Weighting

于青林教授提出

Gerard Jennhwa Chang 張鎮華
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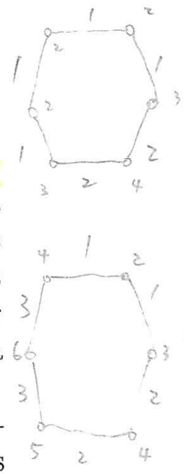
C6 has no vertex-coloring 2-edge weighting ✗ 2不行



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A *k-edge-weighting* of a graph is an assignment of an integer weight from the set $\{1, 2, \ldots, k\}$ to each edge. An edge-weighting is *vertex-coloring* (respectively, *vertex-injective*) if for any edge uv (respectively, every pair of distinct vertices u and v), the colors c_u and c_v are distinct, where the color of a vertex is defined as the sum of the weights on the edges incident to that vertex. Karoński, Luczak and Thomason [8] asked if a connected graph of at least three vertices permits a vertex-coloring 3-edge-weighting. They gave a positive answer when the graph is 3-colorable or when a set of real weights is allowed. Addario-Berry et al. [2] showed that a connected graph of at least three vertices permits a vertex-coloring 30-edge-weighting. Minimum k for which a graph is k-vertex-injective is called the em irregularity strength of a graph (cf. [7]).

Conjecture

An edge-weighting is *adjacent vertex-distinguishing* (respectively, *vertex-distinguishing*) if for any edge uv (respectively, every pair of distinct vertices u and v), the multiset of weights appearing on edges incident to u is distinct from the multiset of weights appearing on the edges incident to u. Adjacent vertex-distinguishing edge-weighting and vertex-distinguishing edge-weighting have been studied by many researchers [3, 4, 5, 6]. It is clear that a vertex-coloring (respectively, vertex-injective) edge-weighting is adjacent vertex-distinguishing (respectively, vertex-distinguishing), but the converse is not necessarily true. Karoński, Luczak and Thomason [8] proved that every grapg without an edge component permits an adjacent edge-distinguishing 213-edge-weighting and that graphs with minimum degree at least 10^{99} permit an adjacent vertex-distinguishing 30-edge-weihting. Addario-Berry et al. [1] improved the results to that every graph without an edge component permits an adjecent edge-distinguishing 4-edge-weighting and that graphs with minimum degree at least 1000 permit an adjacent vertex-distinguishing 3-edge-weighting.

P6 has a vertex-coloring 2-edge weighting

Even people are still not able to verify that a connected graph of at least three vertices permits a vertex-coloring 3-edge-weighting, many graphs are in fact permit vertex-coloring 2-edge-weighting. The current paper is devoted to study bipartite graphs with such property. In particular, we prove that

An edge-weighting is vertex-injective if $c_u \neq c_v$ for any two distince vertices u and v. 全部不一樣

a k-regular bipartite graph with $k \geq 3$ permits a vertex-coloring 3-edge-weighting. (confirm by (Chang, Lu, Wu and Yu)

a connected bipartite graph G of at least three vertices permits a vertex-coloring 2-edge-weighting if one of the following property hold: (1) G has a bipartition set of even size; (2) $\delta(G) \geq 3$ and $d(u) \neq \lceil d(v)/2 \rceil$ for any edge uv; (3) $\delta(G) = 1$. While there are example of connected bipartite graphs permit no vertex-coloring 2-edge-weighting, it remains open to characterize such kind of graphs.

For a bipartite graph G, someone prove 2/ is enough.

References

[1] L. Addario-Berry, R. E. L. Aldred, K. Dalal and B. A. Reed, *Vertex colouring edge partitions*, J. Combinatorial Theory B 94 (2005), 237-244.

[2] L. Addario-Berry, K. Dalal, C. Mcdiarmid, B. A. Reed and A. Thomason, *Vertex-colouring edge-weightings*, Combinatorica 27 (2007), 1-12.

[3] M. Aigner, E. Triesch and Zs. Tuza, *Irregular assignments and vertex-distinguishing edge-colorings of graphs*, Combinatorics 90, (A. Barlotti et al., editors), Elsevier Science Pub., New York (1992) 1-9.

[4] , A. C. Burris and R. H. Schelp, *Vertex-distinguishing proper edge colorings of graphs*, J. Graph Theory 26 (1997) 73-82.

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[7] A. Frieze, R. J. Gould, M. Karoński, F. Pfender, *On graph irregularity strength*, J. Graph Theory 41 (2002) 120-137.

[8] M. Karoński, T. Luczak and A. Thomason, *Edge weights and vertex colours*, J. Combinatorial Theory B 91 (2004), 151-157.

C_{4k+2} needs 3

$C_{8k+2}+e$ needs 3

Among all vertices of G, we choose the vertex v such that ...

Unsolved Problems in Graph Decompositions

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Let G be a graph and $\mathcal{H}$ be a collection of graphs. Then, we say that G has an $\mathcal{H}$-decomposition if the edge set of G can be partitioned into subsets such that each of them induces a graph in $\mathcal{H}$. If $\mathcal{H}$ contains exactly one graph H, then we say that G has an H-decomposition, denoted by $H|G$.

The most well-known problem in graph decomposition is to determine whether a λ-fold complete graph λK_v has a K_k-decomposition whenever the following conditions hold: (1) $v \geq k$, (2) both $\lambda(v-1)/(k-1)$ and $\lambda v(v-1)/k(k-1)$ are positive integers. This is equivalent to the existence of a balanced incomplete block design (BIBD), a $2-(v,k,\lambda)$ design. Note that the existence of a group divisible design (k-GDD) can also be considered as a K_k-decomposition of the balanced complete multipartite graph.

Besides those decompositions close related to design theory, there are quite a few problems in graph theory remained unsolved. In this talk, some of them will be mentioned. Mainly, we start with a problem and report the progress of tackling the problem. For references, several techniques which have been utilized will be included in this talk.

A Note on the Sum-saturability of Trees

Yao-Ren Lin 林耀仁
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Tatung University
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ADVISOR: Nam-Po Chiang 江南波

Let $G = (V, E)$ be a graph of order n and s be the integer $n(n+1)/2$. A 1-1 mapping f from V to {1,2,...,n} is a saturating labelling of G if for each integer $r \epsilon [1, s]$ there is a connected subgraph H of G such that $\sum_{x \epsilon V(H)} f(x) = r$. If a saturating labeling of G exists, then we say G is sum-saturable. In this note, we determine thoroughly the sum-saturability of all trees of order $n \leq 7$. And also we find that all perfect complete n-ary trees are sum-saturable.

Keywords: Sum-saturable, perfect complete n-ary tree.

The Study on Joint Structural Importance in Consecutive-k Systems

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ADVISOR: Hsun-Wen Chang 張薰文

The *joint structural importance* (JSI) is an important measure of how two components interact in contributing to the system reliability. The value of JSI is positive (negative) if and only if one component becomes more important (less important) when the other works. A *consecutive-k-out-of-n system* is a linear arrangement of n components such that the system is failed if and only if some consecutive k components are all failed. In this thesis, we study joint structural importance in the consecutive-k-out-of-n system.

We first completely solve $JSI(i, j)$ for $k = 1$ (the series system), $k = n$ (the parallel system), $k = n-1$, and $k = n-2$, respectively. For the other k, $JSI(1, j') = JSI(1, k) < 0 < JSI(1, n) = JSI(1, j+2) < JSI(1, j) < JSI(1, k+1)$, for $2 \leq j' \leq k-1$ and $k+3 \leq j \leq n-1$. Given a fixed i, we prove that the $JSI(i, j)$ is decreasing for $i-k \leq j \leq i-1$ and for $n-k+1 \leq j \leq n$, and is nondecreasing for $i+1 \leq j \leq i+k$. Hence we state the graph of $JSI(i, j)$ has a W-shape property for $i-k-1 \leq j \leq i+k+1$ with $JSI(i, i) = 0$. Furthermore, we show that $JSI(1, j) = JSI(1, n+k+2-j)$. We also present exact formula for several $JSI(i, j)$ and obtain many comparisons among them.

On the other hand, we present further results on joint structural importance in the consecutive-2 system. We prove that $JSI(i, i+k) > JSI(i, i+2k) > JSI(i, i+3k)$ and $JSI(i, i+k) > JSI(i, j) > JSI(i, n)$ for $j \geq i+3$. We also present results on half-line case and on combinatorial case. Finally, we make a comparison between structural importance and joint structural importance.

Keywords: Birnbaum importance, joint structural importance, consecutive-k system.

Table Driven Algorithm for Joint Sparse Form

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在密碼學的電子簽章系統中，多項相乘計算(Multi-computations)是最重要也是最耗時的計算。該問題始見於Shamir 計算方法，爾後研究便是建立在此基礎上加速運算。其中，有號二進位表示重編法(Binary signed-digit representation recoding algorithm) 中的稀鬆格式(Sparse Form), DJM 查表式編碼，聯合稀鬆格式(Joint Sparse Form)等等有效降低非零位元的數量。而另一種便是預先計算建表法(Pre-computing algorithm)先將部分結果預算起來並儲存，在藉由移位或者部份碼一起計算來減少計算的次數。所以增加運算速度是建立在減少運算數量。在這篇論文中，DJM 查表編碼是以查表的方式編碼，所以該方法簡單易懂。對聯合稀鬆格式而言，建立一個簡單查表編碼方法來完成聯合稀鬆格式以及推廣，使得聯合稀鬆格式更簡單，更方便人去研究與探討，便是我們的主要撰寫論文的目的。

Game Colourings of Graphs

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Suppose f is a graph function which assigns to each graph H a positive integer $f(H) \leq |V(H)|$. An f-colouring of G is a mapping $c : V(G) \to N$ such that every subgraph H of G receives at least $f(H)$ colours, i.e., $|c(H)| \geq f(H)$. The f-chromatic number, $\chi(f, G)$, is the minimum number of colours used in an f-colouring of G. This thesis studies the game version of f-colouring of graphs. Suppose G is a graph and X is a set of colours. Two players, Alice and Bob, take turns colour the vertices of G with colours from the set X. A partial colouring of G is legal (with respect to graph function f) if for any subgraph H of G, the sum of the number of colours used in H and the number of uncoloured vertices of H is at least $f(H)$. Both Alice and Bob must colour legally (i.e., the partial colouring produced needs to be legal). The game ends if either all the vertices are coloured or there are uncoloured vertices but there is no legal colour for any of the uncoloured vertices. In the former case, Alice wins the game. In the latter case, Bob wins the game. The f-game chromatic number of G, $\chi_g(f, G)$, is the least number of colours that the colour set X needs to contain so that Alice has a winning strategy. The f-game chromatic index of a graph G, $\chi'_g(f, G)$, is the f-game chromatic number of its line graph. This thesis studies the f-game chromatic number for the case that f is one of the following graph functions:

1. Rel_d defined as $\text{Rel}_d(K_{1,d+1}) = 2$ and $\text{Rel}_d(H) = 1$ otherwise.

2. Acy defined as $\text{Acy}(K_2) = 2$ and $\text{Acy}(C_n) = 3$ for any $n \geq 3$ and $\text{Acy}(H) = 1$ otherwise.

3. Path_i defined as $\text{Path}_i(K_2) = 1$ and $\text{Path}_i(P_i) = 3$ and $\text{Path}_i(H) = 1$ otherwise, where P_i is the path on i vertices.

In this thesis, we prove that for any outerplanar graph G, $\chi_g(\text{Acy}, G) \leq 7$. If $i \geq 8$, then for any tree T, $\chi_g(\text{Path}_i, T) \leq 9$. On the other hand, if $i \leq 6$, then for any integer k, there is a tree T such that $\chi_g(\text{Path}_i, T) \geq k$. Suppose $d \geq 2k^2 + 5k - 1$ and G is k-degenerate, then we have $\chi'_g(\text{Rel}_d, G) \leq 2k + \frac{(\Delta(G)+k-1)(k+1)}{d-2k^2-4k+2}$.

2-decomposable, 3-decomposable Multipaths and t-decomposable Spiders

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A graph G is t-decomposable if and only if G can be decomposed into t isomorphic subgraphs. A multipath is a path with multiple edges allowed. A spider is a tree which has a unique vertex with degree ≥ 3. In this thesis, we investigate 2-decomposable and 3-decomposable multipaths and t-decomposable spiders.

Keywords: decomposition, multipaths, spiders.

2-decomposable and 3-decomposable Star Forests

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A graph G is n-decomposable if G can be decomposed into n isomorphic subgraphs. A star forest is a forest of which each component is a star. In this thesis, we will investingate 2-decomposable and 3-decomposable star forests.

Keywords: decomposition, star forest.

On List Coloring of Graphs

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In this paper we present some results on list coloring and its variants. A Nordhaus-Gaddum type result on choosability with separation s is presented which generalizes a theorem of Erdős, Rubin and Taylor (Congr. Numer. **26** (1979) 125-157). A new graph parameter $\mathrm{ch}_s^g(G)$ is introduced, and its nontrivial upper bound is provided which generalizes a theorem of Waters (J. London Math. Soc. **73** (2006) 565-585). In (Discrete Applied Math. **45** (1993), 277-289.), Tesman showed that if P_n is a path of n vertices then $\mathrm{ch}_s(P_n) = \lfloor 2s(1-\frac{1}{n})\rfloor + 1$. He also remarked that almost the same proof can be easily extended to prove that $\mathrm{ch}_s(T_n) = \lfloor 2s(1-\frac{1}{n})\rfloor + 1$ for a tree T_n of n vertices. Here we give a much shorter and neater proof for Tesman's result on $\mathrm{ch}_s(P_n)$ (and hence also on $\mathrm{ch}_s(T_n)$). In (Discrete Appl. Math. **82** (1998) 1-13) Alon and Zaks proved that $\mathrm{ch}_s(K_{n,n}) = O(s\log n)$. In this paper we present a slightly stronger version of their result. For any finite graph G, Waters (J. London Math. Soc. **73** (2006) 565-585) showed that $\lim_{s\to\infty}\mathrm{cch}_s(G)/s$ exists, and define this limit as $\tau(G)$. In the last part of this paper, we show that there is another characterization of $\tau(G)$, $\tau(G) = \inf_{s\in\mathbb{N}}\mathrm{cch}_s(G)/s$.

Keywords: list coloring.

Vertex Ranking of Graphs

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Vertex ranking of a graph G is a mapping f from $V(G)$ to the set of all natural numbers such that for any path between two distinct vertices u and v with $f(u) = f(v)$ there is a vertex w in the path with $f(w) > f(u)$. In this definition, we call the value $f(v)$ the rank of the vertex v. A vertex ranking of G is optimal if the largest rank assigned is the smallest in value among all vertex rankings of G. The vertex ranking number $r(G)$ is the largest rank used in an optimal vertex ranking. The vertex ranking problem is to determine the vertex ranking number $r(G)$ of a given graph G. The edge ranking problem can be defined analogously except that the mapping f is now from the edge set to the set of all nature numbers.

In the literature, vertex ranking numbers are determined for paths, cycles and cographs. There are also polynomial-time algorithms for the vertex ranking problem and the edge ranking problem on trees. In this thesis, we give a simple proof for the correctness of the algorithm for the vertex ranking on trees. We also propose an algorithm which gives an optimal vertex ranking of a block graph. Finally, we establish results for the vertex ranking problem on cacti.

Keywords: ranking, vertex ranking.

Study into Fully Orientable Graphs

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Assume that D is an acyclic orientation of a graph G. An arc is dependent if its reversal creates a directed cycle. Let $d(D)$ be the number of dependent arcs in D. Let $d_{\min}(G)$ ($d_{\max}(G)$) be the minimum (maximum) number of dependent arcs in all acyclic orientations of G. A graph G is said to be fully orientable if, for each integer d satisfying $d_{\min}(G) \leq d \leq d_{\max}(G)$, there is an acyclic orientation D of G with $d(D) = d$.

We begin this thesis by introducing basic definitions, notation, and known results about fully orientability of graphs. In order to characterize $d_{\min}(G)$, we then introduce several parameters about triangles and covering graphs. A graph is called a covering graph if it is the underlying graph of the Hasse diagram of a partially ordered set.

We generalize results in Collins and Tysdal [1] about $d_{\min}(M_m(G))$ of generalized Mycielski graphs $M_m(G)$. A method to construct generalized Mycielski graphs $M_m(G)$ with $d_{\min}(M_m(G)) = 1$ is also given.

We discuss the following graph operations that preserve fully orientability: the union of two graphs whose intersection is an edge, addition of a path of length at least 2 and addition of an edge between two vertices of degree 2 with a unique common neighbor. We introduce a graph operation called adding a skirt in the following manner. We add a new cycle to a given graph. For each vertex in the cycle, add at most one edge incident to a vertex in the given graph. Except one case, we can prove that the new graph operation preserving fully orientability.

We generalize the color-first tree algorithm in Fisher, Fraughnaugh, Langley and West [2] to obtain the following stronger result. For each spanning tree T obtained by depth-first search, there exists an integer k_T such that, for each d satisfying $k_T \leq d \leq d_{\max}(G)$, there is an acyclic orientation D of G with $d(D) = d$.

A graph is called 2-degenerate if every subgraph has a vertex of degree at most two. A Halin graph is a plane graph obtained by drawing a tree without vertex of degree 2 in the plane, then drawing a cycle through all leaves in the plane. We prove that 2-degenerate graphs, Halin graphs, graphs with maximum degree at most 3 and graphs with $d_{\min}(G) \leq 1$ are fully orientable. Furthermore, we characterize $d_{\min}(G)$ of these graphs.

In the final chapter, we give brief conclusions and pose some open problems for further study.

Keywords: 2-degenerate graphs, acyclic orientations, dependent arcs, fully orientable graphs, Halin graphs..

References

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Transversals in $m \times n$ Arrays

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An m by n array consists of mn cells in m rows and n columns, where $2 \leq m \leq n$. A partial transversal in an m by n array is a set of m cells, one from each row and no two from the same column. A transversal in an m by n array is a partial transversal which m symbols are distinct. Define $L(m,n)$ as the largest integer such that if each symbol in an m by n array appears at most $L(m,n)$ times, then the array must have a transversal. In this thesis, we extend the study of finding transversals in a Latin square to find transversals in $m \times n$ arrays. Mainly, we are interested in determining the value $L(m,n)$ for certain pairs of positive integers m and n.

Keywords: transversal, array.

A Study of Berge's Strong Path Partition Conjecture

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A family $\mathcal{P} = \{P_1, P_2, \ldots, P_m\}$ of paths is called a path partition of G if its members are vertex disjoint and $V[\mathcal{P}] = V(G)$. Let k be a positive integer, then the k-norm of a path partition $\mathcal{P}$ is defined by $|\mathcal{P}|_k = \sum_{i=1}^{m} \min\{|P_i|, k\}$. A path partition $\mathcal{P}$ minimizes $|\mathcal{P}|_k$ is called k-optimal.

A k-coloring of G is a family $\mathcal{C}^k = \{C_1, C_2, \ldots, C_k\}$ of k vertex disjoint independent sets called color classes. A k-coloring $\mathcal{C}^k$ is orthoganal to a path partition $\mathcal{P} = \{P_1, P_2, \ldots, P_m\}$ if $\mathcal{C}^k$ meets every path in $\mathcal{P}$ in $\min\{|P_i|, k\}$ different color classes. Berge conjectured that for every k-optimal path partition $\mathcal{P}$, there exists a k-coloring orthogonal to it, and this is known as Berge's strong path partition conjecture.

This conjecture is still open today, but several results have been obtained in some special cases. In this thesis, we verify this conjecture to be true for certain special digraphs.

Keywords: Berge, path partition.

是否可以考慮 linear k-aboricity 在 directed graph 上.

Decomposing the Complete Graph into Paths

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It is known that if $m \mid \binom{v}{2}$, then the complete graph K_v can be decomposed into paths of length m as long as $1 \leq m \leq v-1$. But, for a given positive integer $1 \leq m \leq v-1$, m may not be a factor of $\binom{v}{2}$. Therefore, we are interested in the case $m \nmid \binom{v}{2}$. In these cases, we need a path of distinct length. Let P_t denote a path with t edges. Then, it is proved in this thesis that the complete graph K_v can be decomposed into k P_m's and one P_r if and only if $\binom{v}{2} = km + r$ where $0 \leq r < m \leq v-1$.

Keywords: complete graph, decomposition, path.

Diameters of Generalized De Bruijn Graphs

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The generalized de Bruijn digraph denoted by $G_B(n, m)$ is the digraph (V, A) where $V = \{0, 1, \ldots, m-1\}$ and $(i, j) \in A$ if and only if $j \equiv in + \alpha \pmod{m}$ for some $\alpha \in \{0, 1, 2, \ldots, n-1\}$. By replacing each arc of $G_B(n, m)$ with an undirected edge and eliminating loops and multi-edges, we obtain a generalized undirected de Bruijn graph $UG_B(n, m)$. In this article, we prove that for each $n \geq 2$ and $n^2 + (\frac{\sqrt{5}+1}{2})n \leq m \leq n^3$ the diameter of $UG_B(n, m)$ is equal to 3. We also point out there are pairs (n, m) with $n^2 < m < n^2 + (\frac{\sqrt{5}+1}{2})n$ such that the diameter of $UG_B(n, m)$ can be 2 or 3.

Keywords: de Bruijn graph, generalized de Bruijn graph, diameter.

Cyclic Triples

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Let $\mathbb{C}$ denote the complex field and let d be a positive integer. We essentially determine all the triples A, B, C of $(d+1) \times (d+1)$ matrices over $\mathbb{C}$ that satisfy

$$A^{d+1} = \alpha I, \ B^{d+1} = \beta I, \ C^{d+1} = \gamma I, \ BA = qAB, \ CB = qBC, \ AC = qCA$$

for some nonzero complex numbers α, β, γ, and a primitive root q of unity of order $d+1$.

Keywords: cyclic, linear transformation.

Optimal All-to-All Personalized Exchange in General Shuffle-Exchange Networks

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All-to-all personalized exchange communication has been widely applied in many parallel and distributed processing applications. By the Latin square method, Yang and Wang proposed an optimal all-to-all personalized exchange algorithm for the unique-path, self-routable multistage interconnection networks (MINs). All the networks considered by Yang and Wang, including the famous shuffle-exchange networks, satisfy $N = 2^{n+1}$, in which N is the number of inputs (outputs) and $n+1$ is the number of stages of the network. Do notice that Yang and Wang's algorithm requires the states of all the switches of a stage to be identical; i.e., the stage control technique is used. Padmanabham proposed the general shuffle-exchange network (GSEN) with $2^n < N \leq 2^{n+1}$. Since a GSEN is not necessarily a unique-path MIN, Yang and Wang's algorithm may not apply. The purpose of this paper is to propose two optimal all-to-all personalized exchange algorithms for GSENs. Unlike Yang and Wang's algorithm, we abandon the Latin square method and the requirement on the unique-path property. The first algorithm uses the stage control technique and works for arbitrary N. We will prove it is optimal when the stage control technique is assumed for $2^{n-1} + 2^n \leq N \leq 2^{n+1}$. On the contrary, the second algorithm does not use the stage control technique and works only for $N = 2^n + 2$. We will prove that it is optimal.

Keywords: multistage interconnection network, parallel and distributed computing, all-to-all communication, all-to-all personalized exchange.

The Oriented-k-graceful Labelings of Graph

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Let G be a graph with $|V(G)| = n$ and $|E(G)| = m$, a *graceful labeling* of is a one-to-one function $f : V(G) \to \{0, 1, 2, ..., m\}$ such that $\{|f(u) - f(v)| : uv \in E(G)\} = \{1, 2, \cdots, m\}$. A graph is graceful if it has a graceful labeling. Given integers n, k with $k \geq 2$, we use n_k to denote the number $n \bmod k$, and use $n_{/k,i}$ to denote the number $\lfloor \frac{n}{k} \rfloor + \delta_i$, where

$$\delta_i = \begin{cases} 1. & \text{if } i \leq ((m+1) \bmod k) - 1, \\ 0, & \text{if } i \geq (m+1) \bmod k. \end{cases}$$

For a given graph G, an *orientation* of G is a digraph D obtained from G by choosing an orientation ($x \to y$ or $y \to x$)for each edge $xy \in E(G)$. For a digraph D, a labeling $f : V(D) \to \{0, 1, 2, \cdots, k-1\}$ is called a *k-graceful labeling* of D if $\max\{(m+1)_{/k,i} + n - m - 1, 0\} \leq |f^{-1}(i)| \leq (m+1)_{/k,i}$ for each i, $0 \leq i \leq k-1$, and for all j, $0 \leq j \leq k-1$, the sets $A_j = \{uv : (f(v) - f(u))_k = j, uv \in E(D)\}$ satisfy the condition that $\lfloor \frac{m}{k} \rfloor \leq |A_0| \leq |A_{k-1}| \leq |A_{k-2}| \leq \cdots \leq |A_2| \leq |A_1| \leq \lceil \frac{m}{k} \rceil$. And we say that G is *oriented-k-graceful* if there exists an acyclic orientation D of G which has a k-graceful labeling f defined on it.

In this thesis, we fix some notation and terminologies and derive some basic properties in Section 2. And we show that every tree is oriented-2-graceful, oriented-3-graceful and oriented-4-graceful in Section 3. In Section 4, we give necessary and sufficient conditions for union of cycle to be oriented-2-graceful, oriented-3-graceful and oriented-4-graceful.

The List-L(2,1)-labeling Problem of Digraphs

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Given a graph G with n vertices and a function $L : V(G) \to 2^{\mathbb{N}}$, let $A_L = \bigcup_{v \in V(G)} L(v)$, we say that L is $(2,1)$-*choosable for* G if there exists a function $c : \Im = \{L(v_i) : 1 \leq i \leq n\} \to A_L$, $c(L(v_i)) = a_i$ for all i, $1 \leq i \leq n$, which satisfies the following conditions:

(1) $a_i \in L(v_i)$,
(2) $|a_i - a_j| \geqslant 2$ if $d_G(v_i, v_j) = 1$,
(3) $|a_i - a_j| \geqslant 1$ if $d_G(v_i, v_j) = 2$.

In this case, the function c is said to be a $(2,1)$-*choosable function of* G *with respect to* L. If for all the function L with $|L(v_i)| \geqslant k$ for all $v_i \in V(G)$, there is a $(2,1)$-choosable function of G with respect to L, then we say that G has a k-*list*-$L(2,1)$-*labeling*. The *list*-$L(2,1)$-*labeling number of* G, denoted by $\lambda_l(G)$, is defined by $\lambda_l(G) = \min\{k : G \text{ has a } k\text{-list-}L(2,1)\text{-labeling}\}$.

We considered the case when the transmitters have direction constraints, that is, the *list*-$L(2,1)$-*labeling on digraphs*. Recall that in a digraph D the distance $d_D(x, y)$ from vertex x to vertex y is the length of a shortest dipath (directed path) from x to y. We then may define list-$L(2,1)$-labeling, k-list-$L(2,1)$-labelings and list-$L(2,1)$-labeling numbers for digraphs in precisely the same way as for graphs. However, to distinguish with the notation for graphs, we use $\overrightarrow{\lambda_l}(D)$ for the list-$L(2,1)$-labeling number of a digraph D.

In this paper, we study the list-$L(2,1)$-labeling number of digraphs. We give some basic properties for the list-$L(2,1)$-labeling number of digraphs in Section two, and consider the list-$L(2,1)$-labeling number of those digraphs D whose underline graphs are paths, cycles or trees in Section three. And in the last section, we give the exact value of the list-$L(2,1)$-labeling number of the digraph $\overrightarrow{K_{2,n}}$.

Keywords: list-$L(2,1)$-labeling, digraph, dipath, path, cycle, tree.

The $L(3,2,1)$-Labeling of Graphs

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Given a graph G, the $L(3,2,1)$-*labeling* of G is a function f from the vertex set $V(G)$ to the set of all nonnegative integers such that $|f(u)-f(v)| \geqslant 1$ if $d(u,v)=3$, $|f(u)-f(v)| \geqslant 2$ if $d(u,v)=2$ and $|f(u)-f(v)| \geqslant 3$ if $d(u,v)=1$. For a nonnegative integer k, a k-$L(3,2,1)$-*labeling* is an $L(3,2,1)$-labeling such that no label is greater than k. The $L(3,2,1)$-*labeling number* of G, denoted by $\lambda_{3,2,1}(G)$, is the smallest number k such that G has a k-$L(3,2,1)$-labeling.

In this thesis, we study the $L(3,2,1)$-labeling numbers of several classes of graphs. We give some basic properties, and give upper bounds for the $L(3,2,1)$-labeling numbers of general graphs and trees. Following, we study the the $L(3,2,1)$-labeling numbers of Cartesian product of paths and cycles and the power of paths. Then, we consider the $L(3,2,1)$-labeling numbers of those graphs which are obtained from the union, join, and Corona of some special graphs. And, in the last section, we determined the $L(3,2,1)$-labeling numbers of a special class of graphs-the Sierpiński graphs.

Keywords: $L(3,2,1)$-labeling, Cartesian product, cograph, complete graph, corona, cycle, path, power of paths, Sierpiński graphs, trees.

Global Defensive Alliance of Trees and Cartesian Product of Graphs

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We study the global defensive alliance of graphs in this thesis. we give an algorithm to determine the global defensive alliance number of trees, and find $\gamma_a(T)$, when T is a complete k-ary tree for $k = 2, 3, 4$. We also study the global defensive alliance of the Cartesian product of paths and cycles. We give upper bounds and lower bounds for $\gamma_a(P_m \times P_n)$, $\gamma_a(C_m \times P_n)$ and $\gamma_a(C_m \times C_n)$, and show that the bounds are sharp for special m, n

Keywords: Global defensive alliance, complete k-ary tree, Cartesian product.

The Unique Colorability of a Uniform Mixed Hypergraph

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In this thesis, we find the lower bounds of number of vertices and edges of uniform mixed hypergraph which is uniquely colorable. We show that the size of vertex set of uniform mixed hypergraphs with unique coloring is more than $(l-1)(m-1)+1$ and we come up a way to construct uniquely colorable uniform mixed hypergraphs. If a mixed hypergraph is an r-uniform hypergraph with $\mathcal{D}$ empty, then it is uniquely colorable when $r=2$. Otherwise, an r-uniform hypergraph with $\mathcal{D}$ empty is not uniquely colorable. We will introduce two systematic ways to construct a uniform mixed hypergraph which is uniquely colorable and achieves our bounds. First,we reduce the number of $\mathcal{C}$-edges such that uniform mixed hypergraphs keep being uniquely colorable. Then we reduce the number of $\mathcal{D}$-edges. We consider r-uniform $\mathcal{C}$-hypergraphs and $\mathcal{D}$-hypergraphs and find the bounds on their number of edges.

Keywords: hypergraphs, uniquely colorable.

完全三分圖分割成星狀圖的探討

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在本篇論文中，我們主要是探討一個完全三分圖$K_{p,q,r}$是否能分割成三角星狀圖(簡稱星狀圖)。

我們先獲得$K_{p,q,r}$可以分割成星狀圖的必要條件，同時利用拉丁方陣進而得到若$K_{p,q,r}$可以分割星狀圖，則$K_{np,nq,nr}$亦可以分割成星狀圖，對於一些特殊型態的p、q、r，我們獲得$K_{p,q,r}$的星狀圖分割，同時我們將所有q為6的倍數且$q \geq r \geq \frac{q}{2}$、$\frac{5q}{2} \geq p \geq q$的$K_{q,q,r}$與$K_{p,q,q}$分割成星狀圖，最後我們給予$K_{2n,2n,2n}$分割成循環星狀圖的建構法。

Distance Labeling on Cartesian Products of Elementary Graphs

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An interesting graph labeling problem comes from the radio channel assignment problem, as well as code assignment in computer networks. One version of the radio channel assignment problem is to assign integer "channels" to a network of transmitters with distance restrictions, such that several levels of interference between nearby transmitters are avoided and the "span" of the labels used is minimized.

Given a graph $G = (V, E)$ and two numbers d_1 and d_2, an $L(d_1,d_2)$-*labeling* of G is an assignment f, f: $V \to \{0, 1, \cdots\}$ such that $|f(u) - f(v)| \geq d_i$ if the distance between u and v is i in G, for $i = 1, 2$. The $L(d_1,d_2)$-*number* $\lambda(G; d_1, d_2)$ (or $\lambda_{d_1,d_2}(G)$ in some articles.) of G is the smallest number k such that there is an $L(d_1,d_2)$-labeling of G using the largest label k.

A variation of the problem to code assignment in computer networks, i.e. to assignment integer "control codes" to a network of computer stations with distance restrictions, which allow $d_1 \leq d_2$.

This thesis studies the $L(0,1)$-labeling and the $L(1,1)$-labeling on the Cartesian product of elementary graphs.

A Study on A Magic Labeling Problem

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Let $G = (V, \mathrm{E})$ be a connected simple graph. For any nontrivial abelian group A (written additively), let $A^* = A\backslash\{0\}$. A function f: $E \rightarrow A^*$ is called a *labeling* of G. Any such labeling induces a map $f^+:V \rightarrow A$, defined by $f^+(v) = \sum f(uv)$, where the sum is over all $uv \in E$. If there is a labeling f whose induced map on V is a constant map, we say that f is an *A-magic labeling* and that G is an *A-magic graph*. The corresponding constant is called an A-magic value. The *integer-magic spectrum* of a graph G is the set $\mathrm{IM}(G)=\{k \in N | G \text{ is } Z_k\text{-magic}\}$, where N is the set of all positive integers.

This thesis studies the integer-magic spectrum on several classes of graph.

Radio 3-Colorings of Lattice Graphs

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A major question in the channel (or frequency) assignment problem is how many channels are needed under our constraints. In order to answer this question, some researchers formulate it as a graph coloring (or labeling) problem. It can be stated as follows:

Given integers $d_1 \geq d_2 \geq d_3 \geq \cdots \geq d_r \geq 1$, for some $r \geq 2$, an $L(d_1, d_2, d_3, \cdots, d_r)$-*labeling* of a graph $G = (V, E)$ is a function f, $f : V \rightarrow \{0, 1, 2, \cdots\}$ such that $|f(u) - f(v)| \geq d_i$ whenever the distance between u and v is i in G, for $i = 1, 2, 3, \cdots, r$. The $L(d_1, d_2, d_3, \cdots, d_r)$-*number* of G, $\lambda(G; d_1, d_2, d_3, \cdots, d_r)$, is the smallest number k such that there is an $L(d_1, d_2, d_3, \cdots, d_r)$-labeling on G using the largest label k.

An $L(d, d-1, d-2, \cdots, 2, 1)$-labeling ($d \geq 2$) is also called a *radio d-coloring* in some literatures. This thesis will study the radio 3-coloring in some classes of graphs.

Keywords: graph coloring,radio,labeling.

Graph Labelings with Three Levels of Constraints

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Motivated by the channel assignment problem, the following graph labeling has been proposed: Given integers $d_1 \geq d_2 \geq d_3 \geq \cdots \geq d_r \geq 1$, for some $r \geq 2$, an $L(d_1, d_2, d_3, \cdots, d_r)$-*labeling* of a graph $G = (V, E)$ is a function f, $f : V \to \{0, 1, 2, \cdots\}$ such that $|f(u) - f(v)| \geq d_i$ whenever the distance between u and v is i in G, for $i = 1, 2, 3, \cdots, r$. The $L(d_1, d_2, d_3, \cdots, d_r)$-*number* of G, $\lambda(G; d_1, d_2, d_3, \cdots, d_r)$, is the smallest number k such that there is an $L(d_1, d_2, d_3, \cdots, d_r)$-labeling on G using the largest label k. This article studies the labelings with constraints $(d, 1, 1)$ and $(3, 2, 1)$ on several classes of graphs.

Keywords: $L(2, 1)$-labeling.

Finding Hamiltonian Cycle on Perfect Matching of Hypotraceable Graphs

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The interconnected network is usually represented by a graph G where the vertices represent processors and the edges represent links between processors. A hypotraceable graph G is a graph with no Hamiltonian path, and for any vertex $v \in V(G)$, $G - v$ has a Hamiltonian path. This paper investigates a perfect matching of two or more hypotraceable graphs. It has been shown that a perfect matching of two hypotraceable graphs and a serial matching of n hypotraceable graphs with the same order are all having the Hamiltonian property.

Keywords: Hamiltonian, hypotraceable, perfect matching.

A Study on Antipodal Labellings Problems

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An antipodal labelling of G with diameter d is an function f that assign non-negative integer to the vertices of G such that for any vertices of u and v satisfying $|f(u) - f(v)| \geq d - d(u, v)$, where $d(u, v)$ is the distance between u and v. The span of an antipodal labelling f is $\max f(u) - f(v) : u, v \in V(G)$. The antipodal number of G, denoted by an(G), is the minimum span of all antipodal labelling for G. Let T be a tree and $S_{l_1,l_2,l_3,\ldots,l_n}$ with $l_1 \geq l_2 \geq \ldots \geq l_n, n \geq 3$ be a spider (tree with at most one vertex of degree more than two). In the thesis, we give two lower bounds for tree and spider, respectively. We achieve the bound on some special spider. Besides, we also give two lower bounds and two upper bounds for $P_2 \times P_n$ and $P_2 \times C_n$, respectively.

Keywords: Channel assignment problem, radio k-labelling, antipodal labelling, radio number, antipodal number.

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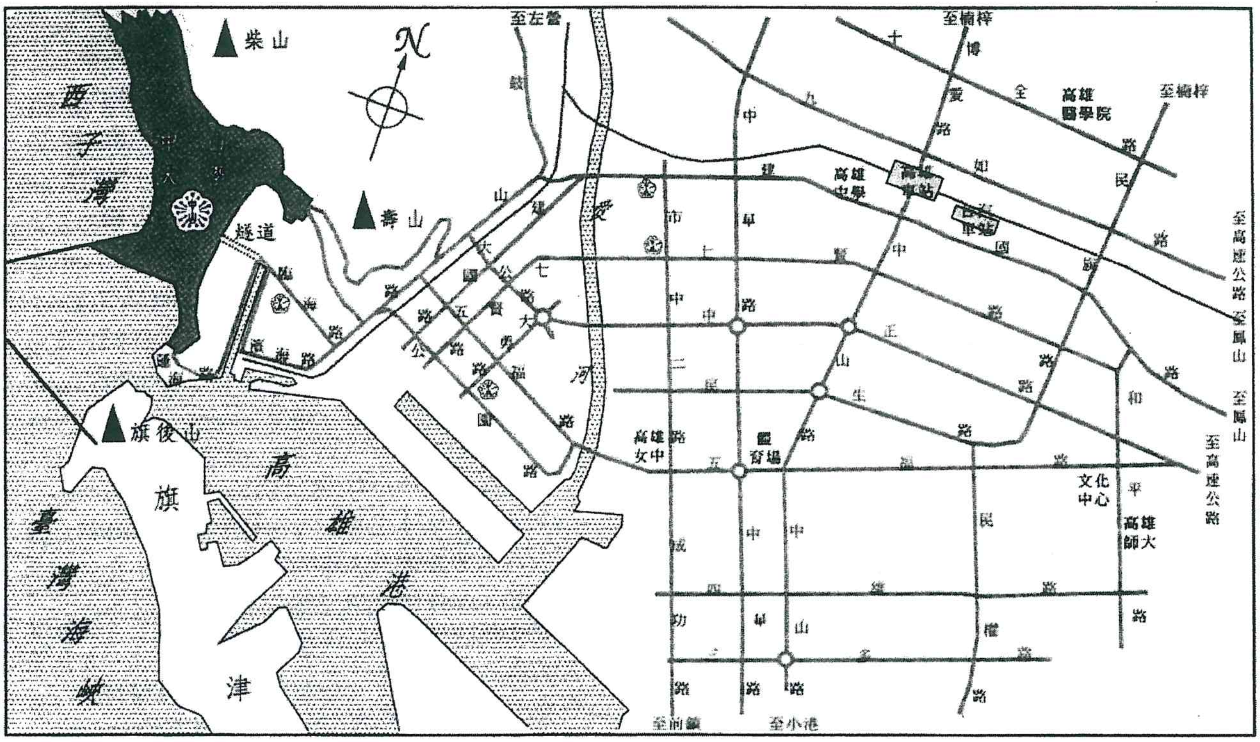
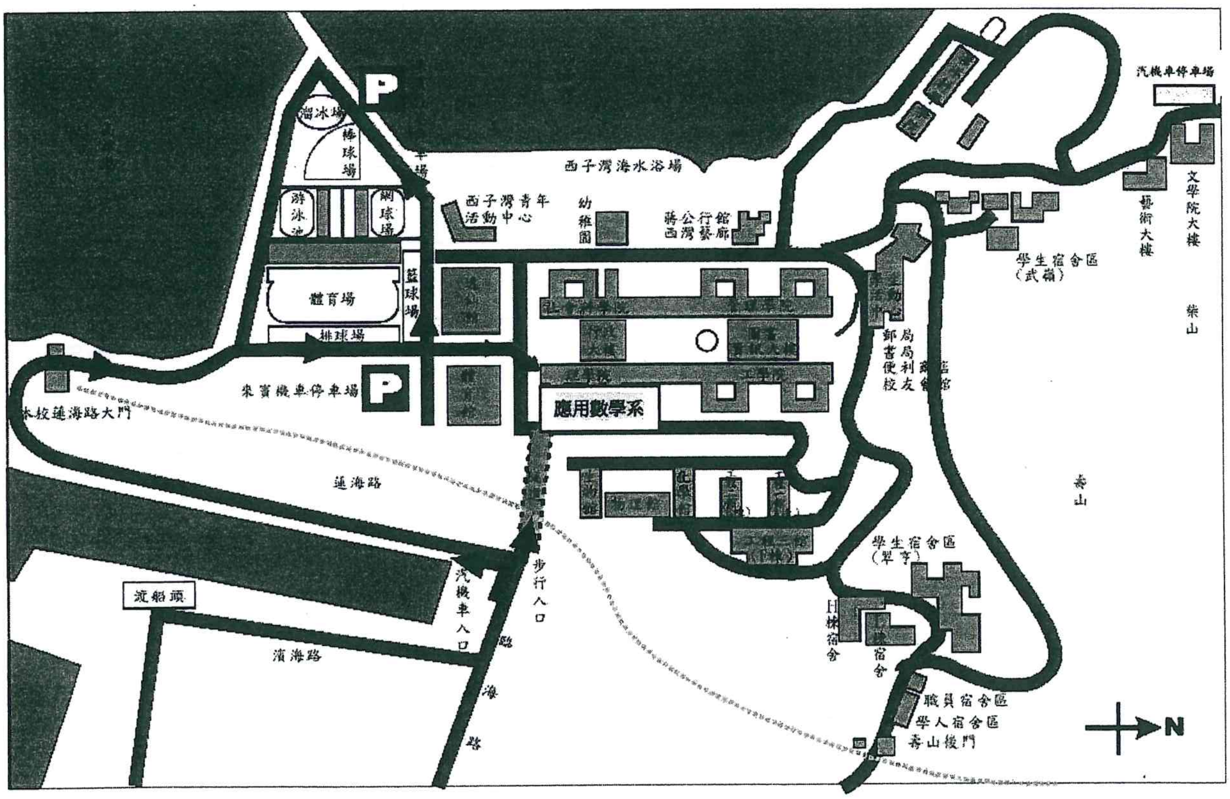
*8/6前所登錄名單

學校附近地圖：



校園位置圖：



國立中山大學校區平面圖