Corso di laurea in Matematica - AA 2020/2021

GE460 - Teoria dei grafi - Argomenti per seminari

Docente: Margarida Melo

1. **Argomenti di natura algebro-geometrica**
   (i) Kirkhoff's matrix tree theorem. ([GR, 13])
   (ii) Chip-firing games. ([GR, 14])
   (iii) Divisor theory on graphs and the Riemann-Roch problem. ([BN07])
   (iv) Lattices and Jacobians of graphs. ([BHN])
   (v) Moduli spaces of graphs and automorphisms of free groups. ([CV, V]).
2. **Argomenti legati a aspetti topologici**
   (i) Knots and graphs. ([GR, ch. 16])
   (ii) Graphs in other surfaces. ([Die, App. B])
3. **Argomenti legati a aspetti computazionali**
   (i) Tree search algorithms. ([BM1, ch. 6])
   (ii) Complexity of algorithms. ([BM1, ch. 8], [Gib, ch. 8])
   (iii) Network flows. ([BM1, ch. 7], [Wil, 29])
   (iv) Applications to search in massive graphs (e.g. google search page rank).
4. **Argomenti legati alla teoria delle Probabilità**
   (i) Random walks on graphs. ([Bol, ch. IX])
   (ii) Markov chains. ([Wil, 24])
   (iii) Ramsey theory. ([Bol, ch. VI])
   (iv) The probabilistic method. ([BM1, ch. 13])
   (v) Szemerédi's regularity lemma. ([Bol, iV.5])
5. **Aspetti legati alla teoria dei matroidi e ulteriori sviluppi**
   (i) Characterization of graphic/cographic matroids. ([Wil, ch. 9])
   (ii) Planar matroids. ([Wil, ch. 9])
   (iii) Representability of matroids. ([Wil, ch. 9])
   (iv) Connectivity for matroids. ([Wil, ch. 9])
   (v) Oriented matroids

6. **Temi di approfondimento vari**

   (i) Matchings and the Menger theorem. ([BM1, ch. 16][Wil, 25,26, 28])

   (ii) Simple applications of graph theory: the shortest path problem, the salesman problem and the Sperner Lemma. ([BM2, 1.8, 1.9])

   (iii) Colouring problems and the Kuratovsky theorem. ([Wil, ch. 5])

   (iv) Colourings and the four color theorem. ([BM1, ch.11])

   (v) Hamiltonian graphs. ([BM1, ch. 18])

Riferimenti bibliografici

[BHN] R. Bacher, P. Harpe and T. Nagnibeda: *The lattice of integral flows and the lattice of integral cuts on a finite graph.*

[BN07] M. Baker, S. Norine: Riemann-Roch and Abel-Jacobi theory on a finite graph. Adv. Math. 215 (2007), no. 2, 766–788. (https://arxiv.org/abs/math/0608360)

[Big] N. Biggs: Algebraic graph theory, Cambridge University Press.

[BM1] J. A. Bondy, U.S.R. Murty: Graph theory, Springer GTM 244.

[BM2] J. A. Bondy, U.S.R. Murty: Graph theory with applications, North Holland.

[Bol] B. Bollobás: Modern Graph theory, Springer GTM 184.

[CV] M. Culler, K. Vogtmann: *Moduli of graphs and automorphisms of free groups.*

[Die] R. Diestel: Graph theory, Spriger GTM 173.

[Gib] A. Gibbons: Algorithmic graph theory, Cambridge University Press.

[GR] C. D. Godsil, G. Royle: Algebraic Graph theory, Springer GTM 207.

[JNP] D. Joyner, M. V. Nguyen, D. Phillips: Algorithmic Graph Theory and Sage.

[Oxl] J. G. Oxley: Matroid theory. Oxford graduate texts in mathematics, 3.

[V] K. Vogtmann: *Automorphisms of free groups and outer space.*

[Wil] R. Wilson: Introduction to graph theory. Prentice Hall.