Analyzing Sentiment in Classical Chinese Poetry

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Five-character Quatrain

静夜思	Thoughts in a Still Night
（李白）	(Li Bai)
床前明月光，	The bright moonlight before my bed,
疑是地上霜．	Is thought to be the frost fallen on the ground.
举头望明月，	I lift my head to gaze at the bright moon,
低头思故乡．	And then bow down to think of my native land.

Seven-character Quatrain

江南逢李龟年	Encounter of Li Gui-Nian in Jiangnan
（杜甫）	(Du Fu)
岐王宅里寻常见，	Often we used to meet in Prince Chi's palace,
崔九堂前几度闻．	Or I would hear you song at Tsui Chiu's Mansion;
正是江南好风景，	How fair the scene is here, South of the River,
落花时节又逢君．	Where I meet you once more, the petals falling!

| 春望	Spring Prospect
（杜甫）	(Du Fu)
国破山河在，	The nation broken, remain hills and streams;
城春草木深.	The city sinks deep in weeds and trees about.
感时花溅泪，	If flowers knew the times, they'd draw tears;
恨别鸟惊心.	Birds seems to alarm for the hatred of partings.
烽火连三月，	The warfire is burnt continuously for three months;
家书抵万金.	A letter from home is worth ten thousand ounces.
白头搔更短，	I feel my white hair fewer as I scratch it;
浑欲不胜簪.	It's too thin to hold up a hairpin light.

The Complete Anthology of Tang Poetry (Quan Tangshi)

- the zenith of the art of classical Chinese poetry
- the Tang Dynasty (AD 618 – 907)
- 42,860 poems
- more than 2,500 poets

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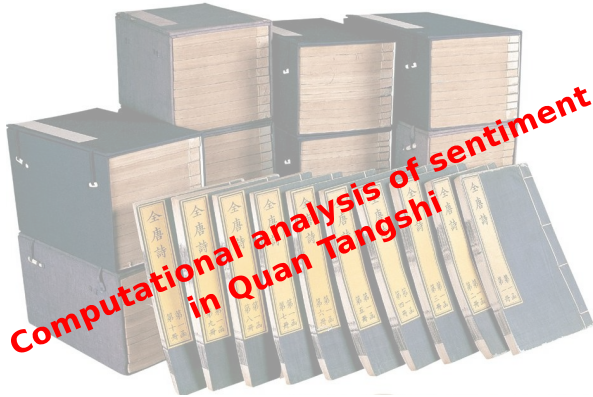
Computational analysis of sentiment in Quan Tangshi

- the zenith of the art of classical Chinese poetry
- the Tang Dynasty (AD 618 – 907)
- 42,860 poems
- more than 2,500 poets

Outline

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- only a few sentiment lexicons for **contemporary** Chinese are available (*sentiLexicons*)

- *sentiLexicons* only has a small coverage for classical Chinese poetry

Lexical Types	Quan Tangshi	sentiLexicons	overlap
single-character	7,480	1,130	570
	4,779 (freq> 10)		
two-character	3,877 (freq> 50)	13,433	374

Building a sentiment lexicon for classical Chinese poetry

- Creating a lexical network based on Quan Tangshi

- Applying Weighted Personalized PageRank over the lexical network

Lexical Network Construction

床 前 明 月 光
疑 是 地 上 霜
举 头 望 明 月
低 头 思 故 乡

岐 王 宅 里 寻 常 见
崔 九 堂 前 几 度 闻
正 是 江 南 好 风 景
落 花 时 节 又 逢 君

国 破 山 河 在
城 春 草 木 深
感 时 花 溅 泪
恨 别 鸟 惊 心
烽 火 连 三 月
家 书 抵 万 金
白 头 搔 更 短
浑 欲 不 胜 簪

......

- 4,799 (freq > 10) single-character items
- 3,877 (freq > 50) two-character items
- ⇒ In total, 8,656 lexical item types
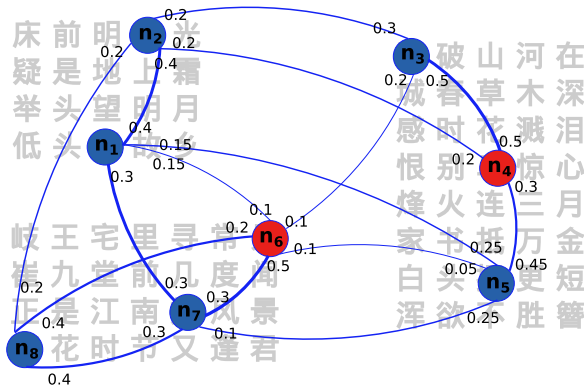
Lexical Network Construction
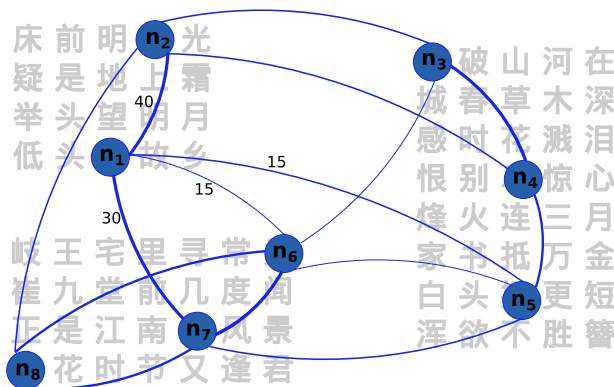
- 8,656 nodes, 8,832,234 edges
- f_{ij}: freq. of n_i and n_j co-occur in a five-character window
- $w_{ij} = \frac{f_{ij}}{\sum_{k=1}^{N} f_{ik}} \Rightarrow w_{12} = \frac{40}{40+30+15+15} = 0.4$

Weighted Personalized PageRank (WPPR)

- computes the importance of nodes in a graph relative to one or more root nodes
- take edge weights into account
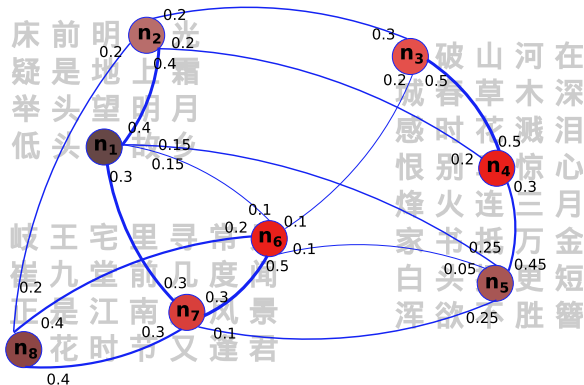
Weighted Personalized PageRank (WPPR)

- computes the importance of nodes in a graph relative to one or more root nodes
- take edge weights into account

Poetry is imbued with emotions:

- Lexical items within a small window are more likely to share the same sentiment

- Applying WPPR twice over the lexical network, using positive and negative seeds respectively:
  ⇒ trace how positive/negative sentiment information is distributed over the whole lexical network (R_p, R_n)

	Characters
positive seeds	香 (fragrant) 爱 (love) 欢 (happy) 贤 (virtuous) 喜 (delight) 瑞 (lucky)
negative seeds	寒 (cold) 愁 (anxiety) 孤 (lonely) 苦 (painful) 悲 (sorrow) 怨 (resentment)

- Sentiment vector: $Rs = Rp - Rn$

Sentiment Lexicon Evaluation

Intrinsic Evaluation

- Our method (WPPR): $Rs = Rp - Rn$
- PMI Baseline:
  $\mathrm{SO}(w) = \sum_{s \in pSeeds} \mathrm{PMI}(w, s) - \sum_{s \in nSeeds} \mathrm{PMI}(w, s)$
- SentiLexicon: 933 sentiment words (532 ☺, 401 ☹)
- ImageryLexicon: 55 imagery words manually collected from literature of imagery analysis for Tang poetry

	Characters
positive	鸳鸯 (mandarin duck) 芙蓉 (hibiscus)
	凤凰 (phoenix) 兰 (orchid) 竹 (bamboo)
negative	梧桐 (sycamore) 鸦 (crow) 柳 (willow)
	鹧鸪 (partridge) 夕阳 (sunset) 子规 (cuckoo)

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	SentiLexicon	ImageryLexicon
	Accuracy	Accuracy
PMI	60.8	70.2
WPPR	**64.4**$\star$	**74.5**

$\star$ indicates significant improvement relative to the baseline

(McNemar's test at $p < 0.05$ level)

Sentiment Lexicon Evaluation

Extrinsic Evaluation: Poem sentiment classification

- 160 poems (77 ☺, 83 ☹) from the Tang poetry analysis dictionary (Xiao, 1999)
- dev data: 30 ☺, 30 ☹
- test data: 47 ☺, 53 ☹

	Accuracy
contemporarySenti Lexicon	51.0
PMI Lexicon	57.0
WPPR Lexicon	**71.0**

Outline

A deeper analysis of sentiment in Chinese classical poetry:

- How does sentiment interferes with topics?
- Using a position-aware Sentiment-topic Model (extension of the joint sentiment-topic model [Lin & He 2009])

Position-aware Sentiment-topic Model

- For each document d,
  - Draw d's sentiment distribution $\pi_d \sim Dirichlet(\gamma)$
  -
  -
    1
    2
    3

Position-aware Sentiment-topic Model

- For each document d,
  - Draw d's sentiment distribution $\pi_d \sim Dirichlet(\gamma)$
  - For each sentiment label l, draw a topic distribution $\theta_{d,l} \sim Dirichlet(\alpha)$
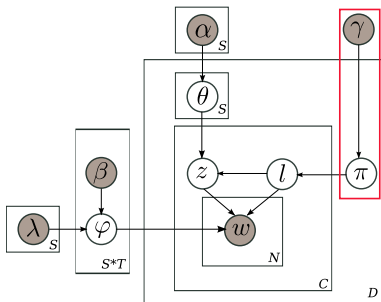 -

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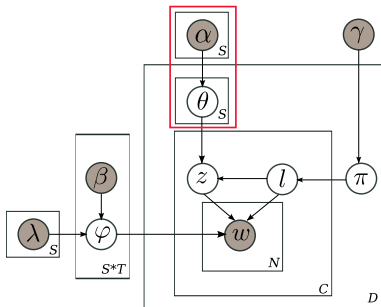
Position-aware Sentiment-topic Model

- For each document d,
    - Draw d's sentiment distribution $\pi_d \sim Dirichlet(\gamma)$
    - For each sentiment label l, draw a topic distribution $\theta_{d,l} \sim Dirichlet(\alpha)$
    - **For each couplet**,
        1. choose a sentiment label $l_i \sim Multinomial(\pi_d)$
        2. choose a topic $z_i \sim Multinomial(\theta_{d,l_i})$
        3. generate words $w \sim \varphi_{l_i, z_i}$
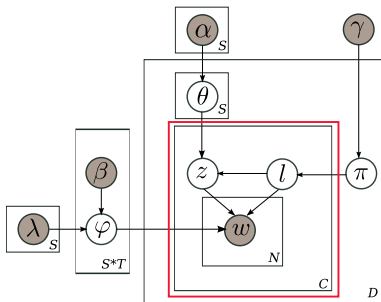
Assumption:

- Lexical items within the same couplet usually relate to the same topic and keep the same polarity

岐 王 宅 里 寻 常 见
崔 九 堂 前 几 度 闻
couplet

正 是 江 南 好 风 景
落 花 时 节 又 逢 君
couplet

Topics Under Positive Sentiment

Topics	Lexical items
PT0: beautiful women	玉 (jade) 金 (gold) 红 (red) 罗 (silk) 香 (perfume) 女 (women) 翠 (green jade) 歌 (song) 舞 (dance) 楼 (building) 画 (painting) 珠 (pearl) 眉 (eyebrow) 双 (pair) 锦 (brocade)
PT1: feast drinking	酒 (wine) 醉 (drunk) 歌 (song) 杯 (cup) 欢 (happy) 殷勤 (attentive) 客 (guest) 对 (face to face) 饮 (drink) 弦 (chord) 乐 (happy) 劝 (advise) 酌 (drink) 醩 (intoxicated) 筵 (feast)
PT2: war_victory	军 (military) 旌 (banner) 旗 (banner) 马 (horse) 将军 (general) 天 (god) 剑 (sword) 骑 (ride) 弓 (bow) 戎 (army) 功 (achievement) 旌旗 (banner) 箭 (arrow) 战 (battle) 射 (shoot)
PT3: literary	诗 (poetry) 文 (article) 书 (letter) 名 (reputation) 题 (inscribe) 句 (sentence) 君 (gentleman) 字 (character) 章 (chapter) 才 (gift) 篇 (article) 咏 (sing) 赋 (compose) 笔 (pen) 高 (high)
PT4: royal graciousness	德 (moral) 神 (god) 礼 (ritual) 乐 (music) 圣 (holy) 灵 (spirit) 明 (bright) 万 (great number) 惟 (only) 肃 (pay respect) 皇 (emperor) 帝 (emperor) 国 (country) 功 (achievement) 天 (god)
PT5: supernature	仙 (god) 玉 (jade) 丹 (vermilion) 天 (god) 神 (god) 霞 (rosy clouds) 紫 (violet) 灵 (spirit) 龙 (dragon) 烟 (mist) 神仙 (god) 瑶 (fairy) 清 (clean) 蓬 (fairyland)
PT6: Buddhism	香 (perfume) 禅 (meditation) 师 (master) 心 (heart) 世 (world) 法 (dharma) 清 (clean) 真 (truth) 莲 (lotus) 道 (Taoism) 净 (clean) 钟 (bell) 界 (world) 士 (scholar) 佛 (buddhism)
PT7: traveling	楼 (building) 高 (high) 上 (go up) 登 (climb) 陵 (hill) 游 (travel) 州 (province) 台 (terrace) 南 (south) 长安 (place name) 下 (go down) 临 (overlook) 佳 (beautiful) 浮云 (clouds) 武陵 (place name)
PT8: flowers	香 (perfume) 花 (flower) 枝 (twig) 露 (dew) 芙蓉 (hibiscus) 桃 (peach) 光 (light) 芳 (fragrant) 轻 (gentle) 袅 (delicate) 艳 (charming) 团 (round) 新 (fresh) 翠 (green jade) 兰 (orchid)

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Topics Under Positive Sentiment

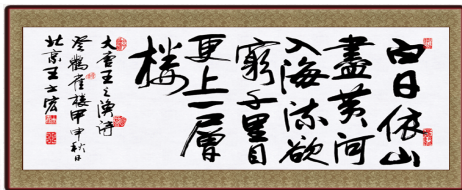| Topics	Lexical items
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Topics Under Positive Sentiment

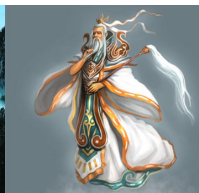| Topics	Lexical items
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PT8: flowers	香 (perfume) 花 (flower) 枝 (twig) 露 (dew) 芙蓉 (hibiscus) 桃 (peach) 光 (light) 芳 (fragrant) 轻 (gentle) 袅 (delicate) 艳 (charming) 团 (round) 新 (fresh) 翠 (green jade) 兰 (orchid)

Topics Under Positive Sentiment

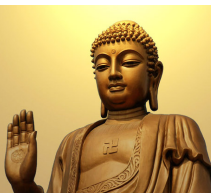| Topics	Lexical items
PT0: beautiful women	玉 (jade) 金 (gold) 红 (red) 罗 (silk) 香 (perfume) 女 (women) 翠 (green jade) 歌 (song) 舞 (dance) 楼 (building) 画 (painting) 珠 (pearl) 眉 (eyebrow) 双 (pair) 锦 (brocade)
PT1: feast drinking	酒 (wine) 醉 (drunk) 歌 (song) 杯 (cup) 欢 (happy) 殷勤 (attentive) 客 (guest) 对 (face to face) 饮 (drink) 弦 (chord) 乐 (happy) 劝 (advise) 酌 (drink) 醅 (intoxicated) 筵 (feast)
PT2: war_victory	军 (military) 旌 (banner) 旗 (banner) 马 (horse) 将军 (general) 天 (god) 剑 (sword) 骑 (ride) 弓 (bow) 戎 (army) 功 (achievement) 旌旗 (banner) 箭 (arrow) 战 (battle) 射 (shoot)
PT3: literary	诗 (poetry) 文 (article) 书 (letter) 名 (reputation) 题 (inscribe) 句 (sentence) 君 (gentleman) 字 (character) 章 (chapter) 才 (gift) 篇 (article) 咏 (sing) 赋 (compose) 笔 (pen) 高 (high)
PT4: royal graciousness	德 (moral) 神 (god) 礼 (ritual) 乐 (music) 圣 (holy) 灵 (spirit) 明 (bright) 万 (great number) 惟 (only) 肃 (pay respect) 皇 (emperor) 帝 (emperor) 国 (country) 功 (achievement) 天 (god)
PT5: supernature	仙 (god) 玉 (jade) 丹 (vermilion) 天 (god) 神 (god) 霞 (rosy clouds) 紫 (violet) 灵 (spirit) 龙 (dragon) 烟 (mist) 神仙 (god) 瑶 (fairy) 清 (clean) 蓬 (fairyland)
PT6: Buddhism	香 (perfume) 禅 (meditation) 师 (master) 心 (heart) 世 (world) 法 (dharma) 清 (clean) 真 (truth) 莲 (lotus) 道 (Taoism) 净 (clean) 钟 (bell) 界 (world) 士 (scholar) 佛 (buddhism)
PT7: traveling	楼 (building) 高 (high) 上 (go up) 登 (climb) 陵 (hill) 游 (travel) 州 (province) 台 (terrace) 南 (south) 长安 (place name) 下 (go down) 临 (overlook) 佳 (beautiful) 浮云 (clouds) 武陵 (place name)
PT8: flowers	香 (perfume) 花 (flower) 枝 (twig) 露 (dew) 芙蓉 (hibiscus) 桃 (peach) 光 (light) 芳 (fragrant) 轻 (gentle) 袅 (delicate) 艳 (charming) 团 (round) 新 (fresh) 翠 (green jade) 兰 (orchid)

Topics Under Positive Sentiment

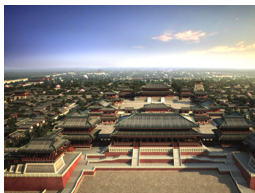| Topics	Lexical items
PT0: beautiful women	玉 (jade) 金 (gold) 红 (red) 罗 (silk) 香 (perfume) 女 (women) 翠 (green jade) 歌 (song) 舞 (dance) 楼 (building) 画 (painting) 珠 (pearl) 眉 (eyebrow) 双 (pair) 锦 (brocade)
PT1: feast drinking	酒 (wine) 醉 (drunk) 歌 (song) 杯 (cup) 欢 (happy) 殷勤 (attentive) 客 (guest) 对 (face to face) 饮 (drink) 弦 (chord) 乐 (happy) 劝 (advise) 酌 (drink) 醑 (intoxicated) 筵 (feast)
PT2: war_victory	军 (military) 旌 (banner) 旗 (banner) 马 (horse) 将军 (general) 天 (god) 剑 (sword) 骑 (ride) 弓 (bow) 戎 (army) 功 (achievement) 旌旗 (banner) 箭 (arrow) 战 (battle) 射 (shoot)
PT3: literary	诗 (poetry) 文 (article) 书 (letter) 名 (reputation) 题 (inscribe) 句 (sentence) 君 (gentleman) 字 (character) 章 (chapter) 才 (gift) 篇 (article) 咏 (sing) 赋 (compose) 笔 (pen) 高 (high)
PT4: royal graciousness	德 (moral) 神 (god) 礼 (ritual) 乐 (music) 圣 (holy) 灵 (spirit) 明 (bright) 万 (great number) 惟 (only) 肃 (pay respect) 皇 (emperor) 帝 (emperor) 国 (country) 功 (achievement) 天 (god)
PT5: supernature	仙 (god) 玉 (jade) 丹 (vermilion) 天 (god) 神 (god) 霞 (rosy clouds) 紫 (violet) 灵 (spirit) 龙 (dragon) 烟 (mist) 神仙 (god) 瑶 (fairy) 清 (clean) 蓬 (fairyland)
PT6: Buddhism	香 (perfume) 禅 (meditation) 师 (master) 心 (heart) 世 (world) 法 (dharma) 清 (clean) 真 (truth) 莲 (lotus) 道 (Taoism) 净 (clean) 钟 (bell) 界 (scholar) 佛 (buddhism)
PT7: traveling	楼 (building) 高 (high) 上 (go up) 登 (climb) 陵 (hill) 游 (travel) 州 (province) 台 (terrace) 南 (south) 长安 (place name) 下 (go down) 临 (overlook) 佳 (beautiful) 浮云 (clouds) 武陵 (place name)
PT8: flowers	香 (perfume) 花 (flower) 枝 (twig) 露 (dew) 芙蓉 (hibiscus) 桃 (peach) 光 (light) 芳 (fragrant) 轻 (gentle) 袅 (delicate) 艳 (charming) 团 (round) 新 (fresh) 翠 (green jade) 兰 (orchid)

Topics Under Positive Sentiment

Topics	Lexical items
PT0: beautiful women	玉 (jade) 金 (gold) 红 (red) 罗 (silk) 香 (perfume) 女 (women) 翠 (green jade) 歌 (song) 舞 (dance) 楼 (building) 画 (painting) 珠 (pearl) 眉 (eyebrow) 双 (pair) 锦 (brocade)
PT1: feast drinking	酒 (wine) 醉 (drunk) 歌 (song) 杯 (cup) 欢 (happy) 殷勤 (attentive) 客 (guest) 对 (face to face) 饮 (drink) 弦 (chord) 乐 (happy) 劝 (advise) 酌 (drink) 醅 (intoxicated) 筵 (feast)
PT2: war_victory	军 (military) 旌 (banner) 旗 (banner) 马 (horse) 将军 (general) 天 (god) 剑 (sword) 骑 (ride) 弓 (bow) 戎 (army) 功 (achievement) 旌旗 (banner) 箭 (arrow) 战 (battle) 射 (shoot)
PT3: literary	诗 (poetry) 文 (article) 书 (letter) 名 (reputation) 题 (inscribe) 句 (sentence) 君 (gentleman) 字 (character) 章 (chapter) 才 (gift) 篇 (article) 咏 (sing) 赋 (compose) 笔 (pen) 高 (high)
PT4: royal graciousness	德 (moral) 神 (god) 礼 (ritual) 乐 (music) 圣 (holy) 灵 (spirit) 明 (bright) 万 (great number) 惟 (only) 肃 (pay respect) 皇 (emperor) 帝 (emperor) 国 (country) 功 (achievement) 天 (god)
PT5: supernature	仙 (god) 玉 (jade) 丹 (vermilion) 天 (god) 神 (god) 霞 (rosy clouds) 紫 (violet) 灵 (spirit) 龙 (dragon) 烟 (mist) 神仙 (god) 瑶 (fairy) 清 (clean) 蓬 (fairyland)
PT6: Buddhism	香 (perfume) 禅 (meditation) 师 (master) 心 (heart) 世 (world) 法 (dharma) 清 (clean) 真 (truth) 莲 (lotus) 道 (Taoism) 净 (clean) 钟 (bell) 界 (world) 士 (scholar) 佛 (buddhism)
PT7: traveling	楼 (building) 高 (high) 上 (go up) 登 (climb) 陵 (hill) 游 (travel) 州 (province) 台 (terrace) 南 (south) 长安 (place name) 下 (go down) 临 (overlook) 佳 (beautiful) 浮云 (clouds) 武陵 (place name)
PT8: flowers	香 (perfume) 花 (flower) 枝 (twig) 露 (dew) 芙蓉 (hibiscus) 桃 (peach) 光 (light) 芳 (fragrant) 轻 (gentle) 袅 (delicate) 艳 (charming) 团 (round) 新 (fresh) 翠 (green jade) 兰 (orchid)

Topics Under Positive Sentiment

Topics	Lexical items
PT0: beautiful women	玉 (jade) 金 (gold) 红 (red) 罗 (silk) 香 (perfume) 女 (women) 翠 (green jade) 歌 (song) 舞 (dance) 楼 (building) 画 (painting) 珠 (pearl) 眉 (eyebrow) 双 (pair) 锦 (brocade)
PT1: feast drinking	酒 (wine) 醉 (drunk) 歌 (song) 杯 (cup) 欢 (happy) 殷勤 (attentive) 客 (guest) 对 (face to face) 饮 (drink) 弦 (chord) 乐 (happy) 劝 (advise) 酌 (drink) 醅 (intoxicated) 筵 (feast)
PT2: war_victory	军 (military) 旌 (banner) 旗 (banner) 马 (horse) 将军 (general) 天 (god) 剑 (sword) 骑 (ride) 弓 (bow) 戎 (army) 功 (achievement) 旌旗 (banner) 箭 (arrow) 战 (battle) 射 (shoot)
PT3: literary	诗 (poetry) 文 (article) 书 (letter) 名 (reputation) 题 (inscribe) 句 (sentence) 君 (gentleman) 字 (character) 章 (chapter) 才 (gift) 篇 (article) 咏 (sing) 赋 (compose) 笔 (pen) 高 (high)
PT4: royal graciousness	德 (moral) 神 (god) 礼 (ritual) 乐 (music) 圣 (holy) 灵 (spirit) 明 (bright) 万 (great number) 惟 (only) 肃 (pay respect) 皇 (emperor) 帝 (emperor) 国 (country) 功 (achievement) 天 (god)
PT5: supernature	仙 (god) 玉 (jade) 丹 (vermilion) 天 (god) 神 (god) 霞 (rosy clouds) 紫 (violet) 灵 (spirit) 龙 (dragon) 烟 (mist) 神仙 (god) 瑶 (fairy) 清 (clean) 蓬 (fairyland)
PT6: Buddhism	香 (perfume) 禅 (meditation) 师 (master) 心 (heart) 世 (world) 法 (dharma) 清 (clean) 真 (truth) 莲 (lotus) 道 (Taoism) 净 (clean) 钟 (bell) 界 (world) 士 (scholar) 佛 (buddhism)
PT7: traveling	楼 (building) 高 (high) 上 (go up) 登 (climb) 陵 (hill) 游 (travel) 州 (province) 台 (terrace) 南 (south) 长安 (place name) 下 (go down) 临 (overlook) 佳 (beautiful) 浮云 (clouds) 武陵 (place name)
PT8: flowers	香 (perfume) 花 (flower) 枝 (twig) 露 (dew) 芙蓉 (hibiscus) 桃 (peach) 光 (light) 芳 (fragrant) 轻 (gentle) 袅 (delicate) 艳 (charming) 团 (round) 新 (fresh) 翠 (green jade) 兰 (orchid)

Topics Under Negative Sentiment

Topics	Lexical items
NT0: lovesickness	别 (farewell) 离 (leave) 惆怅 (melancholy) 相思 (lovesick) 忆 (memorize) 望 (hope) 相逢 (meet) 恨 (hate) 送 (farewell) 年 (year) 君 (gentleman) 梦 (dream) 远 (remote) 归 (return) 泪 (tears)
NT1: hardness of life	老 (old) 病 (sickness) 多 (many) 无 (no) 白 (gray) 鬓 (temple hair) 不 (no) 吟 (sing) 愁 (anxious) 衰 (feeble) 贫(poor) 白头 (old age) 卧 (lie down) 更 (more) 难 (hard)
NT2: hardness of war	塞 (fortress) 边 (border) 城 (city) 河 (river) 胡 (barbarian) 关 (barrier) 征 (attack) 风 (wind) 月 (moon) 北 (north) 战(battle) 雪 (snow) 虏 (captive) 戍 (garrison) 鼓 (drum)
NT3: traveling by boat	江 (river) 水 (water) 舟 (boat) 湖 (lake) 波 (wave) 岸 (bank) 浪 (wave) 风 (wind) 沙 (sand) 帆 (sail) 孤(lonely) 海 (sea) 船 (boat) 浦 (riverside) 月 (moon)
NT4: homesickness	堪 (bear) 断 (break) 故 (home) 落 (fall) 乡 (home) 凄 (sorrow) 愁 (anxious) 归 (return) 泪 (tears) 路 (road) 肠(intestine, often used to describe heartbroken) 伤 (sad) 悲 (sad) 涯 (shore) 音 (news)
NT5: visiting monks	山 (mountain) 僧 (monk) 松 (pine) 寺 (temple) 石 (rock) 林 (forest) 深 (deep) 泉 (fountain) 夜 (night) 寒 (cold) 寻 (search) 客 (guest) 峰 (peak) 云 (cloud) 溪 (stream)
NT6: sad scenery	秋 (autumn) 风 (wind) 叶 (leaf) 寒 (cold) 雨 (rain) 夕阳 (sunset) 晚 (evening) 水 (water) 暮 (twilight) 霜 (frost) 菊(chrysanthemum) 蝉 (cicada) 山 (mountain) 落 (fall) 凉 (cold)
NT7: sad scenery	雨 (rain) 猿 (ape) 峡 (gorge) 啼 (cry) 江 (river) 云 (clouds) 湘 (river name) 楚 (place name) 山 (mountain) 暮 (twilight) 蹉跎(waste time) 巫峡 (gorge name) 云雨 (clouds and rain) 梦 (dream) 巫山 (mountain name)
NT8: death and destruction	死 (death) 生 (birth) 苦 (miserable) 骨 (bone) 悴 (sad) 饥 (hungry) 血 (blood) 泥 (mud) 杀 (kill) 枯 (withered) 憔悴 (thin and pallid) 鬼 (ghost) 恶 (evil) 祸 (disaster) 土 (dust)

Topics Under Negative Sentiment

Topics	Lexical items
NT0: lovesickness	别 (farewell) 离 (leave) 惆怅 (melancholy) 相思 (lovesick) 忆 (memorize) 望 (hope) 相逢 (meet) 恨 (hate) 送 (farewell) 年 (year) 君 (gentleman) 梦 (dream) 远 (remote) 归 (return) 泪 (tears)
NT1: hardness of life	老 (old) 病 (sickness) 多 (many) 无 (no) 白 (gray) 鬓 (temple hair) 不 (no) 吟 (sing) 愁 (anxious) 衰 (feeble) 贫(poor) 白头 (old age) 卧 (lie down) 更 (more) 难 (hard)
NT2: hardness of war	塞 (fortress) 边 (border) 城 (city) 河 (river) 胡 (barbarian) 关 (barrier) 征 (attack) 风 (wind) 月 (moon) 北 (north) 战(battle) 雪 (snow) 虏 (captive) 戍 (garrison) 鼓 (drum)
NT3: traveling by boat	江 (river) 水 (water) 舟 (boat) 湖 (lake) 波 (wave) 岸 (bank) 浪 (wave) 风 (wind) 沙 (sand) 帆 (sail) 孤(lonely) 海 (sea) 船 (boat) 浦 (riverside) 月 (moon)
NT4: homesickness	堪 (bear) 断 (break) 故 (home) 落 (fall) 乡 (home) 凄 (sorrow) 愁 (anxious) 归 (return) 泪 (tears) 路 (road) 肠(intestine, often used to describe heartbroken) 伤 (sad) 悲 (sad) 涯 (shore) 音 (news)
NT5: visiting monks	山 (mountain) 僧 (monk) 松 (pine) 寺 (temple) 石 (rock) 林 (forest) 深 (deep) 泉 (fountain) 夜 (night) 寒 (cold) 寻(search) 客 (guest) 峰 (peak) 云 (cloud) 溪 (stream)
NT6: sad scenery	秋 (autumn) 风 (wind) 叶 (leaf) 寒 (cold) 雨 (rain) 夕阳 (sunset) 晚 (evening) 水 (water) 暮 (twilight) 霜 (frost) 菊(chrysanthemum) 蝉 (cicada) 山 (mountain) 落 (fall) 凉 (cold)
NT7: sad scenery	雨 (rain) 猿 (ape) 啼 (cry) 峡 (gorge) 江 (river) 云 (clouds) 湘 (river name) 楚 (place name) 山 (mountain) 暮 (twilight) 蹉跎(waste time) 巫峡 (gorge name) 云雨 (clouds and rain) 梦 (dream) 巫山 (mountain name)
NT8: death and destruction	死 (death) 生 (birth) 苦 (miserable) 骨 (bone) 悴 (sad) 饥 (hungry) 血 (blood) 泥 (mud) 杀 (kill) 枯 (withered) 憔悴 (thin and pallid) 鬼 (ghost) 恶 (evil) 祸 (disaster) 土 (dust)

Topics Under Negative Sentiment

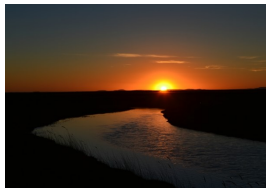| Topics	Lexical items
NT0: lovesickness	别 (farewell) 离 (leave) 惆怅 (melancholy) 相思 (lovesick) 忆 (memorize) 望 (hope) 相逢 (meet) 恨 (hate) 送 (farewell) 年 (year) 君 (gentleman) 梦 (dream) 远 (remote) 归 (return) 泪 (tears)
NT1: hardness of life	老 (old) 病 (sickness) 多 (many) 无 (no) 白 (gray) 鬓 (temple hair) 不 (no) 吟 (sing) 愁 (anxious) 衰 (feeble) 贫(poor) 白头 (old age) 卧 (lie down) 更 (more) 难 (hard)
NT2: hardness of war	塞 (fortress) 边 (border) 城 (city) 河 (river) 胡 (barbarian) 关 (barrier) 征 (attack) 风 (wind) 月 (moon) 北 (north) 战(battle) 雪 (snow) 房 (captive) 戍 (garrison) 鼓 (drum)
NT3: traveling by boat	江 (river) 水 (water) 舟 (boat) 湖 (lake) 波 (wave) 岸 (bank) 浪 (wave) 风 (wind) 沙 (sand) 帆 (sail) 孤(lonely) 海 (sea) 船 (boat) 浦 (riverside) 月 (moon)
NT4: homesickness	堪 (bear) 断 (break) 故 (home) 落 (fall) 乡 (home) 凄 (sorrow) 愁 (anxious) 归 (return) 泪 (tears) 路 (road) 肠(intestine, often used to describe heartbroken) 伤 (sad) 悲 (sad) 涯 (shore) 音 (news)
NT5: visiting monks	山 (mountain) 僧 (monk) 松 (pine) 寺 (temple) 石 (rock) 林 (forest) 深 (deep) 泉 (fountain) 夜 (night) 寒 (cold) 寻 (search) 客 (guest) 峰 (peak) 云 (cloud) 溪 (stream)
NT6: sad scenery	秋 (autumn) 风 (wind) 叶 (leaf) 寒 (cold) 雨 (rain) 夕阳 (sunset) 晚 (evening) 水 (water) 暮 (twilight) 霜 (frost) 菊(chrysanthemum) 蝉 (cicada) 山 (mountain) 落 (fall) 凉 (cold)
NT7: sad scenery	雨 (rain) 猿 (ape) 峡 (gorge) 啼 (cry) 江 (river) 云 (clouds) 滩 (river name) 楚 (place name) 山 (mountain) 暮 (twilight) 蹉跎 (waste time) 巫峡 (gorge name) 云雨 (clouds and rain) 梦 (dream) 巫山 (mountain name)
NT8: death and destruction	死 (death) 生 (birth) 苦 (miserable) 骨 (bone) 悴 (sad) 饥 (hungry) 血 (blood) 泥 (mud) 杀 (kill) 枯 (withered) 憔悴 (thin and pallid) 鬼 (ghost) 恶 (evil) 祸 (disaster) 土 (dust)

Topics Under Negative Sentiment

Topics	Lexical items
NT0: lovesickness	别 (farewell) 离 (leave) 惆怅 (melancholy) 相思 (lovesick) 忆 (memorize) 望 (hope) 相逢 (meet) 恨 (hate) 送 (farewell) 年 (year) 君 (gentleman) 梦 (dream) 远 (remote) 归 (return) 泪 (tears)
NT1: hardness of life	老 (old) 病 (sickness) 多 (many) 无 (no) 白 (gray) 鬓 (temple hair) 不 (no) 吟 (sing) 愁 (anxious) 衰 (feeble) 贫(poor) 白头 (old age) 卧 (lie down) 更 (more) 难 (hard)
NT2: hardness of war	塞 (fortress) 边 (border) 城 (city) 河 (river) 胡 (barbarian) 关 (barrier) 征 (attack) 风 (wind) 月 (moon) 北 (north) 战(battle) 雪 (snow) 虏 (captive) 戍 (garrison) 鼓 (drum)
NT3: traveling by boat	江 (river) 水 (water) 舟 (boat) 湖 (lake) 波 (wave) 岸 (bank) 浪 (wave) 风 (wind) 沙 (sand) 帆 (sail) 孤(lonely) 海 (sea) 船 (boat) 浦 (riverside) 月 (moon)
NT4: homesickness	堪 (bear) 断 (break) 故 (home) 落 (fall) 乡 (home) 凄 (sorrow) 愁 (anxious) 归 (return) 泪 (tears) 路 (road) 肠(intestine, often used to describe heartbroken) 伤 (sad) 悲 (sad) 涯 (shore) 音 (news)
NT5: visiting monks	山 (mountain) 僧 (monk) 松 (pine) 寺 (temple) 石 (rock) 林 (forest) 深 (deep) 泉 (fountain) 夜 (night) 寒 (cold) 寻(search) 客 (guest) 峰 (peak) 云 (cloud) 溪 (stream)
NT6: sad scenery	秋 (autumn) 风 (wind) 叶 (leaf) 寒 (cold) 雨 (rain) 夕阳 (sunset) 晚 (evening) 水 (water) 暮 (twilight) 霜 (frost) 菊(chrysanthemum) 蝉 (cicada) 山 (mountain) 落 (fall) 凉 (cold)
NT7: sad scenery	雨 (rain) 猿 (ape) 峡 (gorge) 啼 (cry) 江 (river) 云 (clouds) 湘 (river name) 楚 (place name) 山 (mountain) 暮 (twilight) 蹉跎 (waste time) 巫峡 (gorge name) 云雨 (clouds and rain) 梦 (dream) 巫山 (mountain name)
NT8: death and destruction	死 (death) 生 (birth) 苦 (miserable) 骨 (bone) 悴 (sad) 饥 (hungry) 血 (blood) 泥 (mud) 杀 (kill) 枯 (withered) 憔悴 (thin and pallid) 鬼 (ghost) 恶 (evil) 祸 (disaster) 土 (dust)

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书法易

Topics Under Negative Sentiment

Topics	Lexical items
NT0: lovesickness	别 (farewell) 离 (leave) 惆怅 (melancholy) 相思 (lovesick) 忆 (memorize) 望 (hope) 相逢 (meet) 恨 (hate) 送 (farewell) 年 (year) 君 (gentleman) 梦 (dream) 远 (remote) 归 (return) 泪 (tears)
NT1: hardness of life	老 (old) 病 (sickness) 多 (many) 无 (no) 白 (gray) 鬓 (temple hair) 不 (no) 吟 (sing) 愁 (anxious) 衰 (feeble) 贫(poor) 白头 (old age) 卧 (lie down) 更 (more) 难 (hard)
NT2: hardness of war	塞 (fortress) 边 (border) 城 (city) 河 (river) 胡 (barbarian) 关 (barrier) 征 (attack) 风 (wind) 月 (moon) 北 (north) 战(battle) 雪 (snow) 虏 (captive) 戍 (garrison) 鼓 (drum)
NT3: traveling by boat	江 (river) 水 (water) 舟 (boat) 湖 (lake) 波 (wave) 岸 (bank) 浪 (wave) 风 (wind) 沙 (sand) 帆 (sail) 孤(lonely) 海 (sea) 船 (boat) 浦 (riverside) 月 (moon)
NT4: homesickness	堪 (bear) 断 (break) 故 (home) 落 (fall) 乡 (home) 凄 (sorrow) 愁 (anxious) 归 (return) 泪 (tears) 路 (road) 肠(intestine, often used to describe heartbroken) 伤 (sad) 悲 (sad) 涯 (shore) 音 (news)
NT5: visiting monks	山 (mountain) 僧 (monk) 松 (pine) 寺 (temple) 石 (rock) 林 (forest) 深 (deep) 泉 (fountain) 夜 (night) 寒 (cold) 寻(search) 客 (guest) 峰 (peak) 云 (cloud) 溪 (stream)
NT6: sad scenery	秋 (autumn) 风 (wind) 叶 (leaf) 寒 (cold) 雨 (rain) 夕阳 (sunset) 晚 (evening) 水 (water) 暮 (twilight) 霜 (frost) 菊(chrysanthemum) 蝉 (cicada) 山 (mountain) 落 (fall) 凉 (cold)
NT7: sad scenery	雨 (rain) 猿 (ape) 峡 (gorge) 啼 (cry) 江 (river) 云 (clouds) 湘 (river name) 楚 (place name) 山 (mountain) 暮 (twilight) 蹉跎(waste time) 巫峡 (gorge name) 云雨 (clouds and rain) 梦 (dream) 巫山 (mountain name)
NT8: death and destruction	死 (death) 生 (birth) 苦 (miserable) 骨 (bone) 悴 (sad) 饥 (hungry) 血 (blood) 泥 (mud) 杀 (kill) 枯 (withered) 憔悴 (thin and pallid) 鬼 (ghost) 恶 (evil) 祸 (disaster) 土 (dust)

Topics Under Negative Sentiment

| Topics	Lexical items
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NT1: hardness of life	老 (old) 病 (sickness) 多 (many) 无 (no) 白 (gray) 鬓 (temple hair) 不 (no) 吟 (sing) 愁 (anxious) 衰 (feeble) 贫(poor) 白头 (old age) 卧 (lie down) 更 (more) 难 (hard)
NT2: hardness of war	塞 (fortress) 边 (border) 城 (city) 河 (river) 胡 (barbarian) 关 (barrier) 征 (attack) 风 (wind) 月 (moon) 北 (north) 战(battle) 雪 (snow) 虏 (captive) 戍 (garrison) 鼓 (drum)
NT3: traveling by boat	江 (river) 水 (water) 舟 (boat) 湖 (lake) 波 (wave) 岸 (bank) 浪 (wave) 风 (wind) 沙 (sand) 帆 (sail) 孤(lonely) 海 (sea) 船 (boat) 浦 (riverside) 月 (moon)
NT4: homesickness	堪 (bear) 断 (break) 故 (home) 落 (fall) 乡 (home) 凄 (sorrow) 愁 (anxious) 归 (return) 泪 (tears) 路 (road) 肠 (intestine, often used to describe heartbroken) 伤 (sad) 悲 (sad) 涯 (shore) 音 (news)
NT5: visiting monks	山 (mountain) 僧 (monk) 松 (pine) 寺 (temple) 石 (rock) 林 (forest) 深 (deep) 泉 (fountain) 夜 (night) 寒 (cold) 寻(search) 客 (guest) 峰 (peak) 云 (cloud) 溪 (stream)
NT6: sad scenery	秋 (autumn) 风 (wind) 叶 (leaf) 寒 (cold) 雨 (rain) 夕阳 (sunset) 晚 (evening) 水 (water) 暮 (twilight) 霜 (frost) 菊(chrysanthemum) 蝉 (cicada) 山 (mountain) 落 (fall) 凉 (cold)
NT7: sad scenery	雨 (rain) 猿 (ape) 峡 (gorge) 啼 (cry) 江 (river) 云 (clouds) 湘 (river name) 楚 (place name) 山 (mountain) 暮 (twilight) 蹉跎(waste time) 巫峡 (gorge name) 云雨 (clouds and rain) 梦 (dream) 巫山 (mountain name)
NT8: death and destruction	死 (death) 生 (birth) 苦 (miserable) 骨 (bone) 悴 (sad) 饥 (hungry) 血 (blood) 泥 (mud) 杀 (kill) 枯 (withered) 憔悴 (thin and pallid) 鬼 (ghost) 恶 (evil) 祸 (disaster) 土 (dust)

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NT2: hardness of war	塞 (fortress) 边 (border) 城 (city) 河 (river) 胡 (barbarian) 关 (barrier) 征 (attack) 风 (wind) 月 (moon) 北 (north) 战(battle) 雪 (snow) 虏 (captive) 戍 (garrison) 鼓 (drum)
NT3: traveling by boat	江 (river) 水 (water) 舟 (boat) 湖 (lake) 波 (wave) 岸 (bank) 浪 (wave) 风 (wind) 沙 (sand) 帆 (sail) 孤(lonely) 海 (sea) 船 (boat) 浦 (riverside) 月 (moon)
NT4: homesickness	堪 (bear) 断 (break) 故 (home) 落 (fall) 乡 (home) 凄 (sorrow) 愁 (anxious) 归 (return) 泪 (tears) 路 (road) 肠(intestine, often used to describe heartbroken) 伤 (sad) 悲 (sad) 涯 (shore) 音 (news)
NT5: visiting monks	山 (mountain) 僧 (monk) 松 (pine) 寺 (temple) 石 (rock) 林 (forest) 深 (deep) 泉 (fountain) 夜 (night) 寒 (cold) 寻(search) 客 (guest) 峰 (peak) 云 (cloud) 溪 (stream)
NT6: sad scenery	秋 (autumn) 风 (wind) 叶 (leaf) 寒 (cold) 雨 (rain) 夕阳 (sunset) 晚 (evening) 水 (water) 暮 (twilight) 霜 (frost) 菊(chrysanthemum) 蝉 (cicada) 山 (mountain) 落 (fall) 凉 (cold)
NT7: sad scenery	雨 (rain) 猿 (ape) 峡 (gorge) 啼 (cry) 江 (river) 云 (clouds) 湘 (river name) 楚 (place name) 山 (mountain) 暮 (twilight) 蹉跎(waste time) 巫峡 (gorge name) 云雨 (clouds and rain) 梦 (dream) 巫山 (mountain name)
NT8: death and destruction	死 (death) 生 (birth) 苦 (miserable) 骨 (bone) 悴 (sad) 饥 (hungry) 血 (blood) 泥 (mud) 杀 (kill) 枯 (withered) 憔悴(thin and pallid) 鬼 (ghost) 恶 (evil) 祸 (disaster) 土 (dust)

How Does Sentiment Differ Between Individual Poets?

Poet	Lifetime	Number of Poems
李白 (Li Bai)	701 − 762	891
杜甫 (Du Fu)	712 − 770	1,151
王维 (Wang Wei)	701 − 761	350
白居易 (Bai Juyi)	772 − 846	2,640
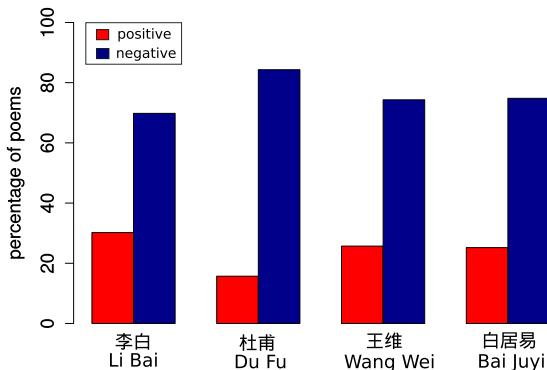
How Does Sentiment Differ Between Individual Poets?

Li Bai

passion, elegance
imagination

Du Fu
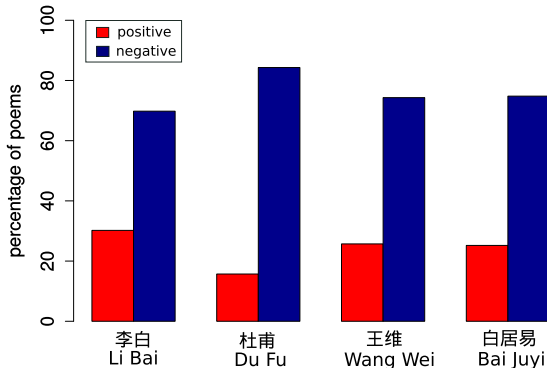
anti-war stance
concers for the poor

Wang Wei

poet of landscape

Bai Juyi

political criticism
leisurely mood
(late years)

Conclusions

- We propose a novel graph-based method (WPPR) to build a sentiment lexicon for classical Chinese poetry
- Our method beats the strong baselines on different evaluation settings
- We analyze sentiment in Tang poetry using a position-aware sentiment-topic model
- Our analysis results are in line with the main findings established in classical Chinese literary studies

Poetry sentiment lexicon is freely available at:

- http://www.cl.uni-heidelberg.de/~hou/resources.mhtml