

Appendix 1

Table 1: Hashtag clusters related to 7 events (11 sub-events) during Summer 2014

SAX* parameters: $W = 10, \Delta = 1day, \tau = 2, \delta = 0, 35, \Sigma = 2, f_{english} > 49$ K-means parameters: as in (?), with K=73 (average # of clusters in SAX* when $f_{english} > 49$)				
SAX* Δ -clusters when selecting only English tweets (noisy hashtags are in bold)	SAX* Δ -clusters with multilingual tweets (noisy hashtags are in bold, non-english are in italics)	SAX* cluster peak-date	Best k-means cluster in 10-days windows, with K=73 (event-related hashtags are underlined)	Event Description
C27 [Freedom, America, GodBlessAmerica, Happy4thofJuly, merica, Happy4th, Merica, HappyIndependenceDay, Murica, fireworks, happy4th, indepencceday, murica, freedom, america] C5 [happy4th, Happy4thofJuly, indepencceday, fireworks, Happy4th, GodBlessAmerica, HappyIndependenceDay]	C7 [independenceday, BornInAmericaVideo] C10 [4thofJuly, 4thofJuly2014, fourthofjuly] C14 [indepenceday, merica, Happy4th, America, Merica, Happy4thofJuly, Murica, america, fireworks, freedom, murica, happy4th]	July 4 th	<u>[4thOfJuly, 5SOSCANADIAN-TOUR, 5sosAmnesiaMusicVideo, BestFeelingKapag, Boston, FIR365, GazaUnderAttack, GermanyBattleReady, HappyIndependenceDay, JustKeke, KatonBoboBarengWal-iSGB, LeBronToClev, MentionKe, MoreRealisticVideoGameTitles, NeverForget, NowPlaying, OSFSMARTFREN8, RBDivasATL, RT, RelationshipGoals, TurkishLovaticsLovesYouDemi, USMNT, Virgo, WeFight4BatBSDCC, facepalm, icant, true, whatislife, writing]</u>	Independence Day
C49 [GERBRA, BRAGER, BrazilvsGermany, GERvsBRA, BRAvsGER, HarryPotterIsBack , BREALL, BrasilvsGermany] C36 [Germany, Klose, TeamGermany, germanyforworldcup2014, DieMannschaft, German, germany, GERMANY] C13 [WWE, Brazil, bra, brazil, BRA, DavidLuiz, Bra] C56 [TeamGermany, GER, ger, germanyforworldcup2014, Deutschland, Ger, German, GoGermany, Klose, Neuer] C35 [football, germany, goals, soccer, FIFA, Germany, fifa, win, Fifa, winner, DieMannschaft, FIFA2014, Final, Football, RPSGoal, Soccer, final]	C28 [PoneloANeymar, SilencioAtroz, TristezaNaoTemFin, BRAvsGER, ExplotaBrasil, GERBRA, BRAGER, GermanyVSBrazil, BrazilvsGermany, <i>Alemania</i> , BRAvsALE, <i>Alemania</i> VS <i>Brasil</i> , GERvsBRA, BraGer, HarryPotterIsBack , PrayForBrazil, brager] C20 [GERMANY, germanyforworldcup2014, Germany, Klose, TeamGermany, <i>Alemania</i> , Muller, germany] C15 [brazil, BRA, Brazil, bra, Bra, Neymar, DavidLuiz, Scolari, Brasil, Fred]	July 8 th	<u>[ARGvsSUI, AfterMemories, Astros, BrazilNeedsOnTheRoadAgainTour, Emblem3FollowSpree, FOLLOWBACKSEGURO, GermanyVSBrazil, GoGermany, HouseRules, JustWaitOnIt, LFC, NeymarWhileYouWereAway, P2, PTI, Spain, TFBSCOTLAND, Taurus, TelehitAustinMahone, TheAnupamKherShow, UpcomingArtist, WCT, camsupdatevideo, crc, follow4follow, free, gym, icecream, miprimerTweet, nohomo, sex, thearchers, thestruggle, workoutout]</u>	Germany Brazil (World Cup)

<p>C6 [hollandvsargentina, netherlandsvsargentina, NEDvsARG, NEDARG, ARGvsHOL, ARGvsNED]</p> <p>C5 [TeamArgentina, ARG, <i>VamosArgentina</i>, Argentina, Messi, arg, messi, argentina, GoArgentina, Arg]</p>	<p>C20 [NEDARG, NEDvsARG, ARGvsNED, netherlandsvsargentina, semifinal, ARGPB, HOLARG, PBARG, ARGvsHOL, <i>VamosArgentinaCarajo, Holanda</i>]</p> <p>C53 [<i>VamosArgentina</i>, arg, ARG, Arg, Argentina, Messi, Romero, <i>VAMOSARGENTINAQUESEPUEDE</i>, <i>VamosArgentinaQueSePuede</i>, <i>VamosMessi</i>, <i>VamosSeleccion</i>, <i>argentina</i>, messi, ARGENTINA, Higuain, WM2014, TeamArgentina, Albiceleste, <i>Penales</i>, higuain]</p>	July 9 th	<p>[AMAs, AsianAnal, <u>BRA</u>, CFL, CalImeCam, Coblos-Nomor1_PrabowoHatta, Friends, HNYTrailerOn15thAugust, HupHollandHup, Knicks, MC-CvRoW, MCPE090, OlyYo, Summer, WeWillAlwaysBeWithYouNeymar, <u>argentina</u>, dogging, everymoment-counts, fjm, fourthofjuly, goen, iTunes, ooc, peace, sexy, sleep, strava, teamswag, videoshop]</p>	Holland Argentina (World Cup)
<p>C21 [Gaza, Israel, Palestine, PalestineUnderAttack, IsraelUnderFire]</p> <p>C19 [prayforgaza, PrayForPalestina, FreePalestine, PrayForGaza, PrayForPalestine, SaveGaza, SavePalestine, HappyHeechulDay]</p> <p>C37 [PrayForPalestine, SaveGaza, prayforgaza, SavePalestine, PrayForPalestina, FreePalestine, Palestine, PrayForGaza]</p>	<p>C35 [prayforpalestine, Gaza, Hamas, Israel, Israel, Palestine, palestine, GazaUnderAttack, PrayForPalestine, gaza, SavePalestine, PrayForGaza-Palestine]</p> <p>C52 [SavePalestine, FreePalestine, <i>Palestinalibre</i>, PrayForGaza, PrayForPalestina, PrayForPalestine, SaveGaza, <i>PalestineVaincra</i>, HappyHeechulDay]</p> <p>C1 [HelpGaza, FreePalestine, helpgaza]</p>	July 9 th	<p>[5sosLikeSocks, AskBex, Battleground, CALLMECAM, CrawfordTo190k, EUI4LTU, FebruaryWish, FreePalestine, Gemini, <u>IsraelUnderAttack</u>, ItalyWantsToHug1D, LIFTOFF106, MLBAllStarGame2014, MicoRestaurantLife, NeverForget, TAF, WWEBattleground, dailyquote, fandompurge, iloveyou, masterchef, mozcon, science, tweet, ultraeurope, whoops]</p>	Gaza war
<p>C57 [WC2014, WorldCup, WorldCup2014, WORLDcup, WorldCup2014Brazil, bbcworldcup, Brasil2014, Brazil2014, CafeRio, FIFA2014, SSFootball, worldcup, worldcup2014]</p> <p>C31 [ARGvsGER, FifaWorldCupfinal2014, GERvsARG, WorldCupFinal, ArgentinaCampeonBrasil2014, NewZalfieVideo, argentinavsgermany2014, ArgentinaHasMySupport, Champions, DOSTheDanielPadillaConcert, GERARG, GermanyvsArgentina, ALLARG, GERvARG, WorldCupFinal2014, worldcupfinal, ARGGER]</p>	<p>C65 [<i>EsperandoLaFinal</i>, <i>VamosArgentina</i>, FinalBrasil2014, GERvsARG, ARGvsGER, <i>ArgentinaCampeonBrasil2014</i>, WorldCupFinal, <i>FinalMundial2014</i>, GERARG, ARGALL, <i>FinaleCDM2014</i>, ALLARG, Gotze, GermanyvsArgentina, argentinavsgermany2014, worldcupfinal2014, Shakira, <i>esperandolafinal</i>, DOSTheDanielPadillaConcert, <i>FinaleMondiale</i>, Kroos, ALEvsARG, ARGvsALE]</p>	July 12 th , 13 th	<p>[24LAD, 2inTO, 5SOSKIM-MEL, AutoFollow, Brazil, Call18002004074, ENGvIND, <u>FifaWorldCup</u>, <u>Final</u>, GoGermany, HAHN, KimKardashianGame, LosArgentinosNoSabenPerder, Mature, OITNB, Pisces, TRXYE, TeamArgentina, VoteAVFSiobhan, <u>WeAreTurnt</u>, ZaynAppreciationDay, asktrevor, dream, followcircle, home, kingjames, It, peace, rap, single, sunday, tcot, welcomeTweet, worthit]</p>	Germany Argentina (World Cup)

C26 [HeroesArgentinos, TeBancoIgual]

C1 [BRANED, NED, BRAvsNED, BrazilVsNetherlands, braned, SuperSoccerPencetakGolTerakhir]

C52 [MEX, NoEraPenal, COL]

C54 [Putin, Russia, MH17, Ukraine, Malaysia, MalaysiaAirlines, prayforMH17, 5DaysFor1D, PrayForMH17, **LouisDeservesTheWorld**, **WeLoveYouLouis**, MH370, MalaysianAirlines, PrayforMH17]

C34 [MH370, Malaysia, MalaysiaAirlines]

C18 [MH17, MalaysiaBerkabung]

C51 [MH17, Ukraine] **C57** [MH17, Ukraine, mh17, *MalaysiaBerkabung*] **C88**[Putin, Russia, MH17, Ukraine, Malaysia, MalaysiaAirlines, PrayForMH17, MH370, MalaysianAirlines, PrayforMH17, prayforMH17, ukraine, mh17, **LouisDeservesTheWorld**, **WeLoveYouLouis**, **SmileLouis**, **reinasdeluiscoronel**, **LuisCoronelPJ**, **luiscoronelpj**, **mejorvestidoluiscoronel**, **luiscoronelfansdecorazon**, **LouisWeLoveYou**, **JBalvinEnPremiosJuventud**, **MejorVestidoGerardoOrtiz**, **MejorVestidoLuisCoronel**, **MejorVestidoPrinceRoyce**, **OriginalesDeSixtoRein**, **PrinceRoyce**, **PrinceRoycePJ**, **SixtoReinEnLaAlfombraAzulPJ**, **TuSombraPJ**, **premiosjuventud**, **princeroyce**, **ChiquisPJ**, **ChiquisPj**, **MejorVestidoChiquis**, **SuerteChiquis**, **LuisCoronelFansDeCorazon**, **luiscoronelpremiosjuventud**, **AlboranistasEnPJ**, **CamilaEnPJ**, **MejorVestidoMarioDommm**]

July 17th

[49ers, 5sosRockOutWithYourSocksOutTour, ASG2014, BGC12, ChicagoMusic, DepressingDisney, EminemWembley, GirlProblems, HappyEngagementElounor, HitTheLightsTo100Million, MalaysiaAirlines, NYC, NiallsNeymarTattoo, PopAsiaGOT7, PrayForMH17, RoadTripLyrics, TTO, Thanks, TopPop, Yankees, askricky, asksam, chatwithtyler, football, heat, nervous, saintsfc, selfies, winner, yeet]

Malaysia
Airplane Crash
and Ukraine
crisis

C61 [rip, robinwilliams, RIPRobinWilliams, RobinWilliams, RIP] C58 [RobinWilliams, sosad, DeadPoetsSociety, MrsDoubtfire, Jumanji, Legend, Robin, legend, RIPRobin, RIPRobinWillams, Rip, riprobinwilliams, RIPRobinWilliams, robinwilliams, RIP, rip, sad] C3 [heartbroken, RIPRobinWilliams, RobinWilliams, rip, riprobinwilliams, robinwilliams, RIP, sad, DeadPoetsSociety, MrsDoubtfire, Jumanji, Robin, RIPRobin, RIPRobinWillams, Rip]	C28 [RIP, RobinWilliams, robinwilliams, RIPRobinWilliams, rip, riprobinwilliams] C53 [RIP, Legend, MrsDoubtfire, RIPRobinWilliams, RobinWilliams, legend, robinwilliams, Jumanji, makeuptransformation, rip, RIPRobinWilliams, sad, QEPD, RipRobinWilliams, riprobinwilliams, DEP]	August 11 th	[19MillionSalmaniacsOnFB, 1MonthOf1DInPortugal, ArianaNOW, BBZach, BledisloeCup, Chiefs, DownloadDirtyDancerNow, EngvInd, GetToKnowYouOnItunes, JAKE-BOYS, JustWaitOnIt, LLWS2014, LetsBeCops, Monday, Prophet-Muhammad, RIProbinwilliams, RenomRule, SMTOWNSEOUL, SobatIndonesia, TeamFollowWack, TelehitOneDirectionReto, TheFoooMeetKlaudia, Twitter, auspol, bittersweet, goldenticket, grind, oldschool, poker, random, sick]	Robin Williams suicide
C72 [Ferguson, MichaelBrown, Missouri, michaelbrown, police, racism, CNN, ferguson, FERGUSON] C2 [JusticeForMikeBrown, MichaelBrown, Missouri] C1 [JusticeForMikeBrown, MichaelBrown]	C37 [Ferguson, MikeBrown] C7 [Ferguson, IfTheyGunnedMe-Down] C73 [PrayForFerguson, mediablack-out] C27 [ferguson, CNN, MichaelBrown, FERGUSON, Ferguson]	August 14 th	[4riefP4crnyaEvrita, AOLFollowJc, DeadPoetsSociety, FSOE350, Family, Fastergraph, FergusonRiot, GGMU, IDanceWhen, ILHooked, LCS, Liverpool, New, Oye_Victor, PortugalWantsLittleMixOnOMGSpring-Break2015, RIPMikeBrown, SO, SharkWeek2014, TV, TabletTrio, Viggling, WIN, WeWantNStoResignNow, ad, gameinsight, rickychat, tennis, vegas]	Michael Brown shooting and Ferguson protest
C21 [ISIS, JamesFoley] C50 [USA, ISIS, JamesFoley, usa, isis]	C41 [ISIS, JamesFoley] C0 [Iraq, ISIS]	August 20 th	[BBB, BPL, BREAKING, BintangRaflesiaRaflessTawa, BoycottSofitelPHDay38, LOVE, LessFunFilms, LotsOfLiamsFollowParty, LoveJihad, MattsLivestream, PBB13thEvictionNight, RIPJamesFoley, SegueSDVcom-FanaticosPeloTwitter, TellyTimesY-outhIconShantanuMaheshwari, TheLeftovers, VMworld, WhoDat, beauty, cashdash, health, lauren-followspree, omg, pll, rickychat, weather, yikes]	James Foley executed by ISIS

C52 [RobinWilliams, Emmys, Emmys2014, TheEmmys, TheNormalHeart, emmys, EEmmys, Emmy, EmmyAwards, OITNB, HappyBirthdayDylanObrien]	C3 [niallreleasethesextape, HappyBirthdayDylanObrien, EEmmys, Emmys, Emmy, EmmyAwards, Emmys2014, OITNB, emmys, EmmysRai4]	August 25 th	[BeyMAs, EmmyAwards, FilmJombloKeepSmileOnSctv-MalamIniii, FollowNGain, Lovatics-ForTheWin, LoveMarriottRewards, MadeOfBlack, MattTo2Mill, NW, NYC, RHOC, RIPTrueBlood, SYTYCD, ShmoneyDance, SoccerSixQueueSkip, TeamNoSleep, TellyTimesYouthIconJenniferWinget, WTF, callmecaminternational, happiness, hot, networking, shakeitoff, song, usopen]	Emmy Award tribute to Robin Williams
C31 [RussiainvadedUkraine, UkraineUnderAttack] C21 [RussiaInvadedUkraine, UkraineUnderAttack, RussiainvadedUkraine]	C57 [RussiainvadedUkraine, UkraineUnderAttack] C10 [Russia, Ukraine]	August 27 th	[2A, ALS, BamComeToMy-HouseForXMas, BlockTheBoat, DogBands, EverySimpsonsEver, HTTR, Leadership, LovaticAttack, Mariners, Matt2ToMill, MiCNYC, PLLchat, TeenWolf, Tweet4Taiji, <u>UkraineUnderAttack</u> , askricky, bae, cool, football, hope, joke, results]	Russia invaded Ukraine

Stilio and Velardi

Hashtag Sense Clustering based on Temporal Similarity

Appendix 2

Table 2: The first 10 SAX* events in the window starting on July 2_{nd} trough July 11_{th}, with the related best hit page and an explanation.

C. #	Date	Cluster	Eval.	Web Link	Event
1	03-07-14	[4thofJuly2014, 4thofJuly, fourthofJuly]	OK	https://www.youtube.com/watch?v=RinK52M7XfM	Independence day
2	03-07-14	[catfish, catfishmtv]	OK	http://heavy.com/entertainment/2014/07/jeff-megan-catfish-mtv-episodes-watch-season-3/	Catfish episodes on mtv
3	03-07-14	[callmecam, CalIMeCam, CallMeCam, Callmecam, CALLMECAM, CaIMeCam, CallmeCam]	OK	https://www.youtube.com/watch?v=4-VWameDPBc	Cameron Dallas (internet personality and actor) tweets
4	03-07-14	[Bring1DToSerbia, SerbiaNeedsOneDirection]	OK	https://www.facebook.com/Where-We-Are-Tour-One-Direction-2014-Croatia-Bosnia-and-Serbia-519922548074435/	Where we are tour of One Direction in Serbia
5	03-07-14	[HurricaneArthur, IndependenceEve]	OK	http://nypost.com/2014/07/03/rainy-weather-expected-to-clear-by-4th-of-/07/y-eve/	Rainy weather expected on Independence day
6	03-07-14	[independenceday, BornInAmericaVideo]	OK	https://www.facebook.com/officialmagicmack/videos/346354782180581/	Independence day video
7	03-07-14	[3AM, 3am]	nothing found		
8	03-07-14	[JANOSKIANStour, JANOSKIANSTour, JANOSKIANtour]	OK	http://www.songkick.com/artists/6692944-janoskians	The Janoskian's tour on /07/y 2014
9	03-07-14	[TelehitAustinMahone, TelehitCD9, OneDirectionEsMejorQueTheBeatles, TelehitJB, TelehitOneDirectionRetoKit, RetoTelehitJary, RetoTelehit, RetoTelehitJB, TelehitJonasBrothers2, TelehitJonasBrothersGuitarra, retotelehit, JonasBrothers, Retotelehit, PoderDirectioner, RetoTelehitCD9, TelehitJonasBrothersGuitarra2, TelehitOneDirectionKit, TelehitOneDirectionRetoKid, TelehitOneDirectionRetokit, RetoTelehitKitOneDirection, TelehitPerfume-JustinBieber, TelehitOnedirectionRetoKit, Telehitonedirectionretokit]	OK	https://www.facebook.com/telehit/photos/a.146482682947.112844.131292887947/10152576091587948/	Telehit prizes on July 3rd 2014

10	<i>03-07-14</i>	[SaveTwitterFromBOT, HBDCancerian]	nothing found
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